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*"To the solid ground*
*Of nature trusts the Mind that builds for aye"* —WORDSWORTH

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Saturday, April 21, 1956

Some of our difficulties arise because we have not met the challenge to fresh thinking which changed conditions have brought. The appeal which Lord Woolton and Sir John Stopford have recently launched to raise one million pounds over the next ten years to finance the building of halls of residence at the University of Manchester expresses, indeed, an attempt to meet two such challenges from changed conditions. Lord Woolton commended the appeal as an attempt to build a residential university which would more surely supply the leaders and teachers which we are failing to find in sufficient numbers, and he referred particularly to the value of residential colleges for the acquisition of that knowledge of how to live in a world where human relations are as important as intellectual capacity.

Halls of residence of themselves will not necessarily bridge the gulf unless their purpose is clearly understood and they receive the full support of the community. The two main challenges which they are intended to meet were clearly indicated by Sir John Stopford. First, there is that of specialization. We are in danger, he said, of becoming such isolated units as to produce a generation incapable of understanding education as it was understood by earlier generations. The danger was strikingly emphasized by Sir Walter Moberly in his book six years ago; but although in some universities, such as at Glasgow, something has been done to explore the problem, as Mr. J. F. Sleeman's article in the *Universities' Review* of February shows, very little effective action has been taken to break down the isolation.

Halls of residence will provide one opportunity, but we have still to ensure that it is used; that may well depend on the university staff and on the home as much as on the student. This is no less true of the second challenge. We are offering students to-day very good educational facilities; but it is not only at Manchester that too few are exposed to those broadening and cultural influences which full participation in a corporate life and extra-curricular activities can provide, or are learning to undertake responsibility, to find a real purpose in life, to acquire poise and to develop those qualities of character and personality which are essential for leadership. Moreover, we have to take due account of the fact that the striking changes in the social composition of the student body over the past few decades mean that an increasing proportion of undergraduates is drawn from homes without a tradition of study, and where the environment tends to stifle rather than foster character and culture. Nor can we disregard the possibility that such developments as television may be detrimental, rather than conducive, to learning and culture.

To check narrowness and excessive specialization, to encourage breadth and a balanced personality as well as a balanced mind, is not simply a matter of buildings or of grants to students at an appropriate level to encourage them to make use of such facilities; it is a matter of outlook and atmosphere also. Industry itself, for example, could attest the genuineness of its concern for more breadth and balance not only by financial contributions to the building and equipment of halls of residence in the civic universities, but still more by the attention it pays in recruitment to those who have used the opportunities of corporate and more spacious living which residence affords.

That would do much to counter the narrowing effect which home influence or close preoccupation with obtaining a degree may have; but university authorities could probably do even more by their policy in such matters as university entrance, general education or the transfer from one faculty to another. The more that is done to encourage and facilitate communication between one faculty or one specialism and another, the more fruitful are halls of residence and similar means likely to prove in enriching the life and outlook of the student. It should not be forgotten also that, as Dr. Eric Ashby has emphasized, halls of residence are not the only or even the most economic means of providing the stimulus desirable. With the right tactics and encouragement, student centres could provide valuable opportunities at much less cost, while it might equally be possible to organize a fuller use of existing halls of residence. If, for example, we fail to give those specializing in the arts an understanding of science and the scientific method at some stage of their education, failure of communication may well persist, and even in a residential college the arts student and the science student will be unable to take part effectively in those informal debates which go far to correct the defects of specialization.

This is the problem which demands first attention, and it should be noted that even at the staff-level Mr. Sleeman, in the article already noted, admits that real contact and understanding between colleagues in other departments is still difficult so far as deep professional interests are concerned. To remedy this would increase the adaptability of the arts graduate and also correct that danger of a specialized scientific education in Britain—neglect of the full study of man. It should be the first step to making possible that conversion of the arts graduate, through intensive one-year courses in the fundamentals of science, as a means of overcoming the shortage of science teachers, which Dr. B. V. Bowden, principal of the Manchester College of Technology, has suggested.

The solution, however, does not lie in adding fresh courses to the overloaded curriculum of the undergraduate. At that level, it is the way in which science is taught, for example, that matters. As Dr. Eric James has urged, science can be presented as an intellectual discipline in its own right, capable of developing all the breadth and human interest required and with due weight on the limitations as well as the potentialities of science. If this is to be done, however, and the arts student likewise to appreciate the significance of the scientific approach to knowledge and its place in the development of thought and culture, apart from its bearing on living in the modern world, the beginnings must be made in the schools—in the teaching of science in such a way and at such a level that its importance is grasped, as well as the openings and interest it

# THE BROADENING OF UNIVERSITY EDUCATION

AN important chapter in the recent report of the Appleton Committee on the supply of teachers of mathematics and science in Scotland discusses some questions regarding the universities which were raised in the memoranda submitted to the Committee. The three most important of these related to entrance qualifications, to the content of honours degree courses and to the extent to which graduates stay on at the universities to undertake research immediately after taking their first degree. On the last question, the Committee merely observes that conflicting views are held, and it enters no further on a difficult and debatable subject than to suggest that university professors, in considering whether or not to admit students to research courses, should have regard to the urgent national need for scientists in other capacities in the various professions and in industry.

Beyond that, it is clear that there is room for some fresh thinking as to the place of research in university life, or even as to our conception of what we mean by the advancement of knowledge. It is not to be confused with the accumulation of fresh facts in a restricted field; and the Appleton Committee shows that it is aware of this when, discussing the content of honours degree courses, it refers to the real and widespread desire for a less highly specialized honours course which would provide a better all-round knowledge of the subject in question and be concerned less with the immediate introduction to a limited field of research. The Appleton Committee reached no firm conclusion. It regards the difficulty of an honours degree course as its prime characteristic, not its concentration on a limited field on the frontier of knowledge, and suggests as worthy of consideration the institution of an honours B.Sc. degree in two branches of science, less specialized than the present degree in one subject, and yet less general than the so-called general honours course.

Such proposals, however, infringe on the third question—that of university entrance requirements. Here the Appleton Committee is concerned chiefly that lack of opportunity to study, or inability in, a foreign language should not by itself be allowed to debar a person from entering a university to study mathematics, science or technology, if he is otherwise well qualified to do so. It suggests that this is a matter which the universities in Britain might appropriately consider, bearing in mind that the nation requires all the skilled scientists and technologists it can produce.

This difficulty is sometimes due to a false choice made by students—for lack of guidance or in spite of it—at some stage in their career. There will always be such students, and for this reason the Committee suggests that the universities should consider revision of their faculty and class requirements so that as many students as possible can have the opportunity of taking scientific courses. A related problem is that of the later development of latent scientific ability, and there can be no question that easier transfer between university departments would be in the national interest and not merely at the present time as a means of increasing the number of science students.

University entrance is, however, equally of importance in relation to general education. In a recent conference, "Education in a Changing World", at the Manchester Training College, the chairman, Mr. F. Heywood, urged that there should be no narrowing of the curriculum at schools and universities and claimed that industry needs graduates of broad general education rather than specialists. Dr. P. F. R. Venables said that education should train for flexibility, and that there is need for a broad training in other subjects besides technology and science. Prof. F. A. Vick likewise said that the university courses of a student of physics should be a fusion of thoroughness and breadth.

What needs to be remembered above all is that the problem of finding sufficient science teachers for schools in Britain can no more be discussed in isolation than the expansion of higher technological education or of technical education. All such specific problems ultimately must be considered in relation to the educational policy of the country as a whole. There must be some clear understanding of the purpose of education before we can wisely determine the resources which can be allocated to meet particular needs and purposes. Nor will the priorities be wisely assigned without an understanding that goes far outside the ranks of the educationist and embraces not simply the administrator and the politician but also the citizens in general whose sons and daughters are to be educated. Well did Prof. W. R. Niblett write in his recent book, that one of the most urgent needs for education in Britain is a much more whole-hearted effort to secure closer understanding between home and school; but it is equally true that if the universities are to play their full part in educating men and women of quality and purpose, vision and intelligence, belief and will—if they are to release the powers of leadership in more people—it will be in large measure as the community itself understands and co-operates with the university.

Prof. Niblett here makes the point about co-operation which Dr. Margaret Read made so effectively in discussing education and social change before the British Association in Edinburgh four years ago. If the educational system of Britain is really to fit modern society and to meet its needs, it must be understood by the nation and approved to the extent required for such co-operation to be achieved. That is the first task in communication. It has to be remembered constantly that what is educationally desirable may be socially unacceptable; and again that what is socially desirable may be economically unattractive, or even if economically attractive it may be politically unfeasible.

offers as a career, and in making it easier for pupils in the sixth forms to change to, or from, the science side if they wish.

Once again we come back to the critical importance of the science teacher, and a clear understanding of the exact function of the science teacher and his real contribution to the needs of the nation to-day would go far to overcome the difficulty of prestige which Prof. R. E. Peierls and Dr. James stressed as of particular importance in a discussion at the Home Universities Conference last December. If we could secure widespread recognition of the worth of the science teacher by the community generally, one major difficulty in securing enough teachers would be overcome; and at the same time something would have to be done to make science teaching itself more effective. When the teaching career is in itself highly regarded, men and women are both encouraged to give of their best in their teaching, and those efforts are likely to be more fruitful.

It is not, however, simply a matter of more generous support and understanding by the community in general. Special sections, as has already been indicated, bear particular responsibilities. More vision is essential on the part of some sections of the teaching profession itself, and less disposition to insist on uniformity instead of encouraging merit and conspicuous ability. Industry and professional bodies, particularly those concerned with science and technology, have their own part to play, both in securing greater prestige for the teacher and in making the schools and colleges more deeply representative of, and more closely in touch with, the nation. The universities in particular have a very significant part to play, both in turning the thoughts of undergraduates towards science-teaching as a career, and by a carefully thought-out series of measures as already indicated. Such measures should check the weaknesses of over-specialization, facilitate transfer between one faculty and another, and encourage communication between one discipline and another and that wide outlook and human understanding which are so essential in the man of affairs and which are the monopoly of no one faculty.

This is asking a great deal of the universities. It means abandoning some old ideas and practices and accepting some new responsibilities, certainly for closer co-operation with the schools, possibly also in adult education, to foster a deeper public understanding of the whole system of education and what it is attempting to do. It means looking at university policy not alone, but as part of the educational policy of Britain as a whole and putting fundamentals first and not departmental interest or administrative convenience. It means, as part of that whole policy, a clear understanding of the purpose and function of the university itself, not in isolation but in relation to what the colleges of technology, the technical colleges, the technical schools and the grammar schools themselves are doing to provide the nation with the trained man-power it needs. It may well be that the growing dependence of the universities upon public support will enforce on them, as Dr. Eric Ashby pointed out in his recent broadcast talks on the British universities, much closer attention to the interpretation of their work to the public. Prof. Niblett's book fully endorses Dr. Ashby's argument that, while to foster such a public understanding may be a condition of preserving academic autonomy, universities must also to some extent be in opposition to the superficial currents of society, as well as responsible to its deeper needs. The most important consequence, however, of attempts to re-think the functions of the university in relation to national needs and to re-shape policy in terms of educational policy as a whole could well be to stimulate communication between the specialists; as Dr. Ashby suggested, it might encourage the faculties of medicine, of science and of technology to adopt the long-established tradition of the teaching of arts subjects, and bring their own students face to face with genius, in the presence of which most educational problems evaporate.

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# ROMAN ROADS IN SOUTHERN ENGLAND

Roman Roads in Britain

By Ivan D. Margary. Vol. 1: South of the Foss Way—Bristol Channel. Pp. 255+17 plates and 11 maps. (London: Phoenix House, Ltd., 1955.) 42*s*. net.

THE excellent map at the end of Mr. I. D. Margary's book is its full justification, were justification needed. It is, in effect, the road-map of modern England. Even the industrial Midlands melt into it without major distortion. It is the sort of map from which the schoolroom study of the Roman Empire should properly begin, intelligent and purposeful with scarcely anything fortuitous about it. It might be described as the skeletal analysis of our countryside. The more is the wonder that more than half a century has elapsed since any survey was made of it on a commensurate scale. In 1924 the Ordnance Survey produced an up-to-date chart without commentary, and its successor, now in active preparation, will shortly present a revised version on a grander scale which must owe much to Mr. Margary himself. During recent years much has altered, roads have been lost and found, and methods of research have been improved, above all by the arrival of air-photography. Only in one respect are the aeroplane and the car inferior to the transport available to Thomas Codrington in 1903 or William Stukeley in 1776: the back of a horse offered the right sort of mobility and the perfect viewpoint for the actual fieldwork involved. Indeed, the author finds it necessary in his preface to warn motorists of the special dangers inherent in the point-to-point pursuit of Roman roads along the modern highway.

The book is a plain topographical description of the roads as they presented themselves to the explorer in 1954. Controversial points are dealt with conservatively, with no hint of the extravagancies which are prone to cloud this study. Here and there the identifications of place-names might have been argued a little more fully, and the impositions of Bertram of Copenhagen, which are not even yet as completely forgotten as they should be, more specifically countered. But these are incidental matters, not for emphasis. Old problems of interest and some new ones arise at many points. The elaborate road-system in the environs of London is not yet entirely solved; for example, it is of more than pedantic concern to know whether the Watling Street from Kent by-passed the site of the city by way of the old Horseferry at Westminster and Hyde Park to the Edgware Road. It is worth recording that nearly half a century ago the late Sir Alfred Clapham, with this point in mind, secured permission to cut a trench in Hyde Park on the line which such a road should have followed, with entirely negative result. Again, how literally, if at all, does the Foss Way represent an early Roman frontier-line? The author's reading of the evidence at Cirencester is against a primary date for that mysterious Way, and his diagnosis is supported by that of Dr. Kathleen Kenyon at Leicester, where also the Foss appears to be secondary to the lay-out of the Roman town. Yet another complex of outstanding interest occurs at the famous site of the town and potteries at Castor in Northamptonshire. In matters such as these, the new survey will, it is to be hoped, serve as a stimulus to fresh investigation with the spade.

The air-photographs, mostly taken by Dr. J. K. S. St. Joseph for the University of Cambridge, are of superb and even dramatic quality. Less can be said of the ground-photographs, some of which seem to be out of focus. But the book is one which should be on the shelves not merely of the specialist but also of all who have an interest in the shaping of England, and an urge to refresh their history with the open air. R. E. MORTIMER WHEELER

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# PETROLOGY IN PERSPECTIVE

## A Historical Survey of Petrology

By Prof. F. Y. Loewinson-Lessing. (Translated from the Russian by Dr. S. I. Tomkeieff.) Pp. x+112. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 12*s*. 6*d*. net.

"ROCKS, like everything else, are subject to change and so also are our views on them." This sentence, from the preface, sets the key-note of this admirable and stimulating book by Prof. F. Y. Loewinson-Lessing, who was one of the "grand old men" of petrology referred to by Dr. S. I. Tomkeieff in a graceful tribute to his former professor. Concise in style and richly packed with material that should send many a student back to the original sources, the book traces the development of the subject from Zirkel's application of Sorby's techniques and pioneer microscopic studies of rocks to the conclusions reached by the author and his contemporaries in 1936, when the original Russian edition was published. The pre-microscopic age of petrology is only briefly discussed and is, perhaps, too rapidly dismissed.

The translation was completed in 1939, in time for Loewinson-Lessing to give it his blessing shortly before his death. Although Dr. Tomkeieff has wisely resisted the temptation to bring the book up to date, he has helped his readers by adding some fifty references to the more important books and papers that have since appeared. As it stands the book is a unity; to have extended it would have involved the introduction of new methods and techniques unknown to the author, such as those of isotope geology.

The subject is not primarily discussed in chronological order, but rather under the five main approaches to petrology: geological (modes of occurrence of rocks, petrographical provinces, etc.); petrographical (description and classification); chemical (culminating in geochemistry); experimental (crystallization of melts and mechanics of intrusion); and synthetic (problems of petrogenesis). The various problems, which to-day are being attacked with renewed energy by intensive observation in the field and by isotopic studies in the laboratory, are here seen in their historical perspective, but they remain the same problems, and the young petrologist could have no more inspiring introduction to the development of his subject. It is, indeed, a book that should be read by all geologists. Dr. Tomkeieff and the publishers have done their work well and deserve our thanks; not least, perhaps, for the very moderate price. ARTHUR HOLMES

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# CONSUMER EXPENDITURE IN GREAT BRITAIN

## The Measurement of Consumers' Expenditure and Behaviour in the United Kingdom, 1920–1938

Vol. 1. By Richard Stone. (Studies in the National Income and Expenditure of the United Kingdom—1.) Pp. xl+448. 105*s*. net.

## Consumers' Expenditure in the United Kingdom, 1900–1919

By A. R. Prest, assisted by A. A. Adams. (Studies in the National Income and Expenditure of the United Kingdom—3.) Pp. xiii+196. 42*s*. net. A series published under the joint auspices of the National Institute of Economic and Social Research, London, and Department of Applied Economics, University of Cambridge. (Cambridge: At the University Press, 1954.)

THESE two books form part of a series of studies of the national income and expenditure of Great Britain, conceived and carried out under the general direction of Mr. Richard Stone by the National Institute of Economic and Social Research, London, and the Department of Applied Economics of the University of Cambridge. Work on the project was started in 1941 with the main object of "bringing together quantitative information relating to various aspects of the economic development of the United Kingdom, especially between the wars of 1914–18 and 1939–45". In the end it is hoped that all the estimates may be put together in the form of social accounts.

The task of collecting and bringing together the data in these two volumes must have been immense. An enormous variety of primary and secondary sources was consulted, adjustments had to be made to allow for changes in definition over time, and the reliability of the original figures had to be assessed. The sources that are used are everywhere described in detail, as are the methods of estimation employed. As an end result, Mr. Stone is able to present price and quantity series showing the demand for a large number of different foodstuffs, tobacco, rent, rates and water charges, and fuel and light. In the second book, dealing with the period 1900–19, Mr. A. R. Prest must necessarily use less reliable data, but his field of coverage is wider than Mr. Stone's; he deals with expenditure on clothes, travel, books, amusements, life insurance and funerals, and domestic expenditure other than food, in addition to the topics covered by Mr. Stone. The expenditure on those items for 1920–38 will presumably be dealt with in Mr. Stone's forthcoming second volume.

By bringing this information together and arranging for comparability and continuity, the authors have provided an invaluable service, and their final results will be of value to a much wider circle than economists as a starting-point for further investigations. Mr. Stone's book, however, is not a mere storehouse of information. He attempts an analysis of market demand by combining the time-series that he has constructed with the results of investigations of family budgets and proceeds to calculate elasticities of demand for the commodities he deals with. There is a lengthy preface which deals with the aims and methods of econometrics, and the second part of the book contains an exposition of the theory of market demand and of the statistical procedures used in its analysis. This section contains a systematic account of multivariate analysis, based on methods of matrix algebra, which have been increasingly used in recent years.

A word of praise is due to the printers for a very fine job in producing the mass of material with such clarity.

# SOLAR PHYSICS

**The Sun**

Edited by Prof. Gerard P. Kuiper. (The Solar System—Vol. 1.) Pp. xix+745. (Chicago: University of Chicago Press; London: Cambridge University Press, 1953.) 94s. net.

NOTHING comparable with this work has appeared since the publication of Vol. 4 of the "Handbuch der Astrophysik" in 1929. A comparison of the two volumes demonstrates impressively the strides solar physics has made in a quarter of a century. The identification of 'coronium', the recognition of $H^-$ absorption, postulation of the carbon–nitrogen cycle, invention of the coronagraph (and more recently the interference filter), development of the rocket spectrograph and the magnetograph, the discovery of chromospheric flares and their terrestrial effects and of solar radio noise—all these advances, though solving some problems, have raised many others. It is small wonder, then, that adequate cover of a subject dealt with in 1929 by three authors in three hundred and fifty pages now takes twenty-three authors nearly seven hundred and fifty pages.

The expressed design of the editor, Prof. G. P. Kuiper, has been to collect and systematize all significant information on the Sun into a volume that will be at once a reference handbook for the specialist and a survey intelligible to anyone versed in the physical sciences. It is a big task, but he may claim, and be accorded, a fair measure of success. If, as the preface seems to indicate, each author used his own judgment as to what material is of sufficient importance to be included, one must congratulate the editor at least on his choice of contributors. The general level of appeal is extraordinarily uniform in a work with such heterogeneous origins, and if in some chapters the hypothetical reader with no previous astrophysical leanings may be repelled by an austere approach, this will not deter the specialist from turning to the work as a handbook of research.

All men of science deplore a growing tendency towards a restrictive nationalism in scientific books. Astronomy traditionally transcends national boundaries, and it is a pleasure to record in this instance contributions from authors in six different countries, in which no such tendency can be detected. One is especially glad to welcome the dedication: at least one American book in the past has contrived to describe the coronagraph without so much as mentioning the name of Bernard Lyot. It is regrettable that the present volume includes no contribution from the U.S.S.R.; but the cause can doubtless not be laid entirely at the door of the editor, who is as well aware as anyone how much solar research carried out in Soviet territories remains a closed book to Western readers.

The book opens with an introduction which quotes fundamental data and, bringing the general reader to about 1930, directs him to the particular one of the following chapters which is appropriate to his interests. The solar interior, the photosphere, and the chromosphere and corona are each discussed with thoroughness in a chapter contributed by an acknowledged leader in the field. These chapters are primarily concerned with the quiet Sun, in which each of these rather arbitrarily defined regions is in equilibrium with its neighbours. In contrast, Chapter 6 deals with the observable transient disturbances in the solar atmosphere, and with their terrestrial effects. Fascinating though this subject is, one wonders whether its importance justifies making this the longest chapter in the book. The next chapter is devoted to an observational and theoretical discussion of solar radiation at radio wave-lengths. That this is perhaps the most controversial in the book, and the one of which the conclusions are least likely to survive unchanged, is no more than to be expected in a subject barely ten years old. Chapter 8 is entirely theoretical and comprises a critical review of recent work in solar hydromagnetics. This subject is entirely new and bristles with so many difficulties that Prof. T. G. Cowling's survey is most welcome at this stage. The last chapter in the book is a miscellany of short contributions held together by no more than the title: "Empirical Problems and Equipment". This is not to say that it does not contain some of the most interesting pages in the whole book; certainly the illustrations here are magnificent. The book is rounded off with two useful appendixes giving a wealth of data on established solar observatories (optical and radio), their instruments and the type of work they undertake.

The book is impeccably printed on the calendered paper made necessary by including half-tone plates on a lavish scale throughout. The table of contents is admirably full; the alphabetical index, however, less so. Cross-references, necessarily frequent in so heterogeneous a work, are made maddeningly difficult to trace by the omission of chapter and section numbers from the page headings.

This volume is the first of four to be devoted to the solar system. It will give the solar physicist all he can reasonably expect in the way of an advanced text for many years to come. If the standards of the present work can be maintained in the forthcoming volumes of the series, astronomers and geophysicists will be heavily in Prof. Kuiper's debt.

A. HUNTER

# CHARACTERISTICS OF SOME ANIMAL CALLS

By DR. P. MARLER

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## Sounds facilitating Location

IT is well known that some animal vocal sounds enable individuals to establish contact. The songs of various male birds, Orthoptera and Heteroptera[1,2], assist nubile females to find mates. Species which form groups at some stage of their life-history often maintain contact by special calls (for example, the great-tit, *Parus major*[3]).

The accuracy of sound location depends on the capabilities of the auditory receptors of the hearer, the physical characteristics of the sound signal and the distinctiveness of the sound, including the effects of distance from the source and of contrast with environmental noise. The auditory receptors of insects do not respond to pressure changes, like those of mammals and birds, but to variations in displacement. Since this is a vector quantity, they can locate sound sources directly[4], without reference to time, phase or intensity differences, and thus independently of frequency within their audible range (400–28,000 cycles in *Thamnotrizon*[2]).

Mammals, of which man has been most studied[5,6], and birds[7,8], locate sounds by making binaural comparisons of differences in phase, intensity and time of arrival. In contrast with insects, the efficiency of location thus varies with the frequency of the signal. Phase difference is most useful at low frequencies, because the information it provides becomes ambiguous when the wave-length is more than twice the distance between the ears. Also the refractory period of the auditory nerve (about 1 m.sec.) probably limits the perception of phase differences to frequencies less than 1 kc./sec. (that is, one cycle per m.sec.). Intensity differences are most useful at high frequencies, since obstructions in the path of a sound, such as a head, only cast appreciable sound shadows when their dimensions are greater than the wave-length of the signal. Time-difference can be used throughout the auditory range. It is clear that the most readily located signals will be complex ones, which provide clues for all three methods.

The song of the male chaffinch, *Fringilla coelebs* (Fig. 1), is known from field observations and from experiments with recorded songs to attract unmated females to its point of origin, and to repel rival males[9]. It has a wide frequency spectrum, centred on 3 kc./sec., which is within the range of maximum sensitivity of the chaffinch ear[10]. It is rich in sudden changes of frequency, which provide points of reference for binaural time-comparisons. Experiment suggests that intensity differences are actually most significant in location by the chaffinch[11], no doubt because its ears are so close together that time- and phase-differences are difficult to perceive (though for larger birds they are probably important). Emphasis on the use of intensity-differences would tend to encourage high frequencies in song, which are most effectively blocked by the head.

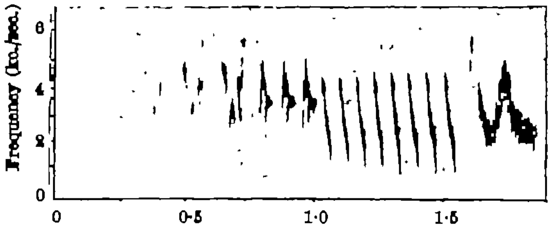

Fig. 1. A sound spectrogram of a song of a male chaffinch. Note the many sudden changes in pitch and the wide frequency range

But to serve its functions, song must be audible at a considerable distance; this sets an upper limit to frequency since, as it increases, the rate of attenuation with distance also rises rapidly. Furthermore, high-frequency sounds are easily reflected even by small objects such as tree branches, making their original source difficult to locate. Another aspect of the function of song is that it is directed to members of the species, and should therefore differ distinctively from the songs of other sympatric species. This is true of the chaffinch in Western Europe, and in the Azores[12]. It is clear from the use of song characteristics in distinguishing closely related species (for example, *Phylloscopus trochilus*, *P. collybita* and *P. sibilatrix*[13]) that this is usually the case. But when the number of co-habiting species is reduced, as on small islands, songs may become much more variable (for example, notes of the blue-tit, *Parus caeruleus*, on Teneriffe[14] and the goldcrest, *Regulus regulus*, in the Azores[12]).

Thus the physical characteristics of chaffinch song are closely adapted to the part it plays in life. The sound signals of the domestic fowl, *Gallus domesticus*, which attract small chicks[15], share the characteristics of segmentation or repetitiveness, brief duration of the component notes, and the presence of relatively low frequencies (less than 800 c./sec.). Much of the energy is concentrated at the start of the notes. Like chaffinch song, these characteristics can be related to the facilitation of sound location, the low frequencies to allow phase-difference to be used, the segmented 'click-like' properties for time-difference.

## Sounds confusing Location

There is a conflict in many animals between the need to appear conspicuous to their own species and inconspicuous to predators or prey, which is manifest in their coloration[16] and also in their vocalizations. Small Passerines have two distinct responses to a hawk or owl[3,9,17]. If the bird of prey is perched, they make themselves conspicuous by 'mobbing' behaviour, which attracts other birds' attention to the predator; if it is in flight, they dash for cover, and hide. Chaffinches use quite different calls in each case. In the first they give a 'chink' note (Fig. 2), which provides abundant location clues; in the second, males give a high, thin 'seeet' note. The former is easily located by man, the latter only with difficulty, and the same is probably true for predators.

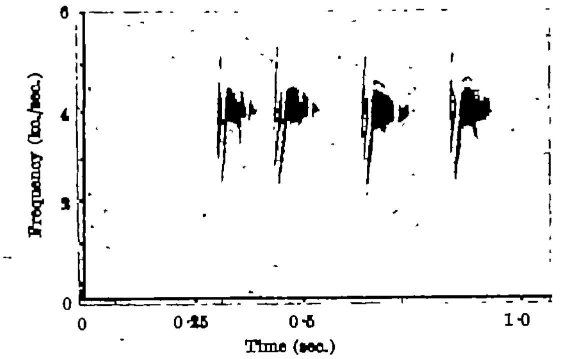

Fig. 2. Four 'chink' calls of a female chaffinch. This call shares with song the characteristics of discontinuity and wide frequency-range

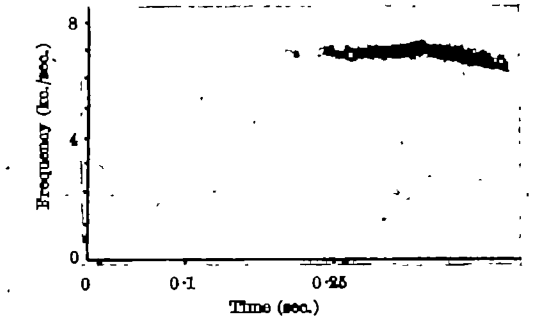

Fig. 3. A 'seeet' call of a male chaffinch, evoked by a sparrow hawk. Note the constant pitch and the absence of any sharp discontinuities

Pure tones in the region of 2–5 kc./sec. are difficult for man to locate because they are too high for binaural comparisons of phase-difference, and too low for there to be appreciable intensity differences, so that only time-differences can be used[8]. In birds of prey such as owls and hawks, the lower limit of this range of frequencies, which are difficult to locate, is probably similar to that of man (perhaps set by the refractory period of the auditory nerve around 1 kc./sec.). The upper limit must be considerably higher, since sound shadows only become appreciable when the wavelength approximates to the diameter of the obstruction. Thus the 'seeet' call of the male chaffinch probably gives no clues to its location by phase- or intensity-difference. It also begins and ends imperceptibly (Fig. 3), and thus gives no clues for comparison of binaural time-differences. Finally, its wavelength (about 5 cm.) is small enough to result in free reflexion from the trunks of small trees. Thus the 'seeet' call seems to be adjusted to avoid giving location clues of any kind to predators. Yet it serves to communicate the presence of danger to other chaffinches, which fly to the nearest cover irrespective of the location of the calling bird. Imitations which have similar characteristics evoke an identical response[9].

It is interesting to find that other unrelated Passerines such as the blackbird, *Turdus merula*, missel thrush, *T. viscivorus*, and various titmice[9] and buntings (Andrew, unpublished work) have 'hawk' calls with similar characteristics (see Fig. 4), no doubt for the same reasons. Many juvenile Passerines, which are very susceptible to predation, have calls which are difficult for man to locate (for example, the wren, *Troglodytes troglodytes*[13]) and which resemble the 'hawk' calls in structure and frequency (Fig. 5). It is possible that certain species such as the hawfinch, *Coccothraustes coccothraustes* (Fig. 6), have even adapted their contact calls to give few location clues to predators, as may be true of some small rodents and insectivores. The song of the grasshopper warbler, *Locustella naevia*, is perhaps ventriloquial for the same reason.

The warning signals of the domestic fowl differ as a group from those which attract chicks, and are in many ways their opposites[15]. They are of relatively long duration, show little segmentation or repetitiveness, and lack very low frequencies. Although never as high-pitched as the 'hawk' calls of small Passerines (400–2,700 c./sec.), they appear otherwise to be very similar, in the absence of clues by which predators might locate their source by time-difference, perhaps by phase- and intensity-differences as well.

Vertebrate predation must be an equal problem for insects which communicate by sounds. Analysis reveals that most Orthopteran songs have their main

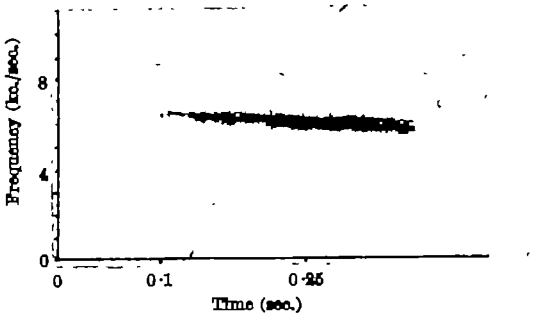

Fig. 4. A 'hawk' call of a male blackbird, scarcely distinguishable from that of a chaffinch

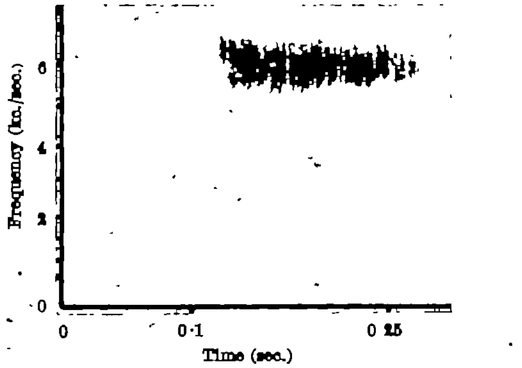

Fig. 5. The 'food-begging' call of a young wren. This shows many of the characteristics of the 'hawk' calls

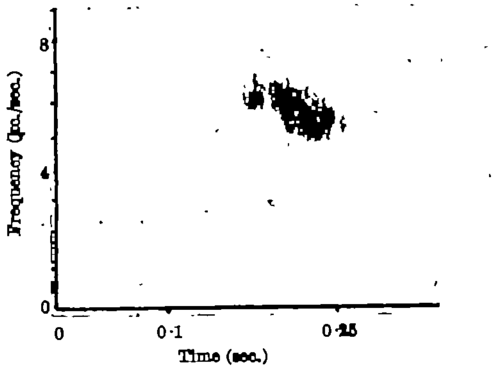

Fig. 6. A 'seep' call of a female hawfinch, used for maintaining social contact in winter

energy in the region of 6–14 kc./sec.[19]. Signals of this frequency may well be as difficult for their bird predators (Laniidae, Tetraomidae, etc.[20]) to locate as for man. Also they are well above the range of maximum sensitivity of most birds, as so far investigated[21]; and will be freely reflected by even small obstructions. Exceptions are the songs of various Grylloidae (2–4 kc./sec.)[19,22], which, in contrast with other Orthoptera, are largely crepuscular or nocturnal and, with their cryptic and often subterranean habits, may be less exposed to predation.

Another method of confusing predators may be to sing in communal groups, thus making it difficult for any one individual to be located. Pringle (unpublished work) has suggested this explanation for the habit among Cicadas (Heteroptera), and it might also be applied to the communal singing of frogs.

Thus it appears that many of the sounds used in bird and insect 'language' have not been chosen arbitrarily, but are directly adapted in structure to the function they have to perform.

I am indebted to Prof. J. B. S. Haldane and Dr. W. H. Thorpe for criticism of this article.

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# WILLIAM HIGGINS, CHEMIST (1763–1825)

By PROF. J. R. PARTINGTON, M.B.E.

ALTHOUGH William Higgins was, in his time, one of the distinguished group of Irish chemists which included Kirwan, singularly little is known of many aspects of his life, and some inaccurate statements about him and his work have been repeated by the few who have written about him. Prof. T. S. Wheeler, of Dublin, who has for some years been engaged in a study of Higgins, has recently published two articles[1] based on primary sources, including some which were unknown to previous writers, and these articles throw new light on several aspects of the life and work of Higgins.

William Higgins was born at Collooney, Co. Sligo, probably in 1763, and died in June 1825. He was the nephew of Bryan Higgins, also known as a chemist. He was from 1787 until August 1788 at Pembroke College, Oxford, previously matriculating at Magdalen Hall in 1786. He is said to have been "operator" (lecture assistant) to Beddoes, the reader, who succeeded Austin, the professor of chemistry, early in 1788. On leaving Oxford he went to London. Since he says himself that he assisted his uncle in numerous experiments which Bryan Higgins published in a book in 1786, he must have been in London before he went to Oxford. The reason why he left Oxford after so short a stay and without a degree is not clear; but since he published his book criticizing the phlogiston theory in 1789 he must have been working on it in Oxford, and since Bryan Higgins was a supporter of the phlogiston theory and made some original contributions to its later aspects, he may have withdrawn his support of his nephew. This, however, is only a conjecture.

In January 1792 Higgins was appointed chemist at Apothecary's Hall, Dublin. Hitherto, little has been known of this period of Higgins's career, and Prof. Wheeler is the first to have had access to the relevant minute books. Higgins received a salary of £200 a year, with apartments, coals and candles, taking over a "small back room" in May. He fitted out a laboratory. His salary came into arrears, and in 1795 Higgins asked for payment in such terms that his employment was terminated, the governors borrowing £200 to pay him off. In 1795 he was appointed part-time "Chymist" to the Irish Linen Board, at a salary of £100 a year, which appointment he held until 1822. He did a considerable amount of good work for the Board, publishing in 1799 an "Essay on Bleaching". His merits were appreciated by Kirwan, a phlogistonist whose theories Higgins had attacked in his book, and it was on Kirwan's recommendation that Higgins was appointed in 1795 to supervise the Leskean Collection of minerals of the Royal Dublin Society, becoming professor of chemistry and mineralogy by an Act of the Irish Parliament passed in 1796. He began to lecture in 1797. He had been elected to the Royal Irish Academy in 1794 and was elected F.R.S. in 1806 (his nomination certificate being signed by Davy), but first signed the charter book and obtained admittance in May 1817.

Although he lived in rooms in Dublin, Higgins left a considerable amount of property on his death, having purchased lands for £2,000 and £6,800 during 1818–23. He had a reputation for eccentricity, and many anecdotes of him were current. Davy, in his obituary notice, complained that Higgins did little in the later years of his life, but he seems to have been kept busy in his various appointments.

Higgins is best known for his book, "A Comparative View of the Phlogistic and Antiphlogistic Theories", published in 1789 and again in 1791. In this he argues against the phlogiston theory, which Kirwan had supported in an "Essay on Phlogiston" in 1787. An example of his style is provided by the following extract from the "Comparative View": "Although I do not think sulphur contains phlogiston, or the solid matter of light inflammable air, I by no means suppose it to be a simple body, but to be relatively to our knowledge of chemistry, as simple as the earths or the two fixed alkalies, all of which I make no doubt will be analysed at some future period, when the science of chemistry will be more cultivated than at present, by men of genius, fortune, and leisure" (p. 120). The book contains some new discoveries, such as the solution of iron in sulphurous acid without the evolution of hydrogen, and an appendix on an analysis of a human calculus which was presented to the Royal Society but was not printed. It also describes some ingenious quantitative experiments, for example, on the composition of nitric acid and of hydrogen sulphide (which, however, he regarded as a mere solution of sulphur in hydrogen, not a compound). These experiments were made in Oxford and possibly in his uncle's well-known laboratory in Greek Street, Soho, in London.

Higgins deals with chemical combination on the basis of the union of 'ultimate particles' of elements, and he clearly recognized, probably for the first time, that a particle of one element may unite with more than one particle of another, in the oxides of nitrogen up to five particles of oxygen combining with one of nitrogen. In this the law of multiple proportions is implicit. Applications of the atomic theory to chemistry had been made before, notably by Bryan Higgins, who explained the union of one particle of each of two elements to form a molecule (a name used by him) of a compound, calling the process 'saturation', a name also used by William Higgins. Bryan Higgins used the idea of central forces, while William used a different idea, more akin to modern views on valency. Bryan Higgins hints only obscurely that perhaps two particles of an element may saturate one of another.

In his "Comparative View", William Higgins paid little attention to the weights of the particles, and only once in the book does he hint that they may have different weights, without attempting to determine them. He does not seem to have realized the novelty of his conceptions.

Some have said that Higgins thought that the particles of different elements were equal in weight, but Prof. Wheeler concludes that this is unlikely. It is more probable that he assumed nitrogen, oxygen and sulphur equal (14, 16, 32/2) and that he knew that the particle of hydrogen was much lighter. He seems to have thought that the matter of all particles has the same density, and that the weights of the particles are proportional to the sizes of the hard nuclei, apart from the atmospheres of fire (caloric). He thus supposed that the particles in different gases are at different distances from one another, so that he could not draw conclusions from the densities, as Avogadro afterwards did. He did, however, consider that the numbers of particles in equal volumes of gases under the same conditions of temperature and pressures were in simple numerical ratios. He arrived at reasonable views on the composition of several molecules, such as that of water (HO) and the oxides of sulphur (SO and $SO_2$) and nitrogen (NO, $NO_2$, $NO_3$, $NO_4$ and $NO_5$). He used symbols for the particles of different elements—nitrogen P, sulphur S, oxygen D or *d*, hydrogen I, etc.—and he also made an approach to the idea of valency bonds, drawing lines between the symbols of the elements and assigning arbitrary numbers to the forces between the particles. He supposed that the force of a central particle was progressively weakened as more and more particles of another element were attached to it, the bond strength being the sum of the force of an attached atom and the force of the central particle divided by the number of particles attached to it. This idea enabled him to discuss in a very ingenious way what would now be called transition complexes. In these associations of particles, the forces are weakened when another body is brought up, and the effect of this is transmitted through the complex, leading to rearrangement and reaction. In such cases he used the idea of a preliminary orientation of particles, which had also been used by Bryan Higgins. These views are more ingenious than those of Dalton, who followed Newton in using central forces, which enabled him to explain the properties of mixed gases, a problem not considered by Higgins.

Some years after Dalton published his atomic theory, Higgins in 1814 wrote "Experiments and Observations on the Atomic Theory", in which he reproduced parts of the "Comparative View" with the intention of showing that he had anticipated Dalton. In many cases, however, he reads into these more than he said in 1789 and alters some of his conclusions. He suggests that Dalton had known of, and used, his earlier book in formulating his theory; but no evidence of this has ever been produced[2]. Prof. Wheeler believes that Dalton was unaware of the work of Higgins. Higgins and Dalton both used atomic theories in explaining chemical changes. Higgins was the first to point out clearly the combination of atoms in multiple proportions, and he used the idea of forces linking atoms in explaining reactions, adumbrating the idea of a transition state, but he paid little or no attention to the weights of atoms. Dalton's contribution was the idea of finding the relative weights of atoms and so explaining the quantitative laws of chemical combination, but he paid little attention to attractive forces exerted between the atoms. Dalton's theory includes the law of multiple proportions and, what is important, the law of reciprocal proportions, which Higgins, with his neglect of atomic weight, did not see was a consequence of the atomic theory. The atomic theories of Higgins and Dalton differ in important respects, and it is pointless and probably incorrect to say that Higgins anticipated Dalton. It was Dalton's theory which was developed in the nineteenth century, and many of his ideas appear in the modern atomic theory. Higgins was mainly concerned in refuting the phlogiston theory, and since this was no longer of interest to later chemists his atomic theory, which formed part of his argument, was not properly appreciated. He did not develop it himself and seems to have realized that he could have done so only after Dalton's theory was published.

[1] *Endeavour*, 11, 47 (1952); *Studies*, 43, 78, 207, 327 (The Talbot Press, 89 Talbot Street, Dublin, 1954).

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# SEMICONDUCTORS AND TRANSISTORS: SOME CURRENT PROBLEMS

By Dr. J. R. TILLMAN

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WHEN Bardeen and Brattain announced their discovery of transistor action in 1948, it was foreseen that much research and development would be needed before widespread applications became possible. What has followed, however, has been on a scale many times greater than generally expected. The more fundamental research has been fruitful, as witness the reports of the international conferences on semiconductors held at Reading (1950) and Amsterdam (1954). It has predicted new effects and new applications and has led to new designs of transistor. Advances in technology have also been striking, though some secondary effects, not yet well understood, introduce unwanted features in transistors.

## Transistor Materials

Germanium and silicon remain the only important transistor materials. Most of their properties as semiconductors—for example, the dependence of resistivity and Hall coefficient on impurity content (usually of a trivalent or pentavalent element) and on temperature, and the wave-length limit of the optical absorption (and the related energy gap)—have been investigated in detail. Interpretations of some of the electrical properties in terms of fundamental quantities demand that the effective mass, $m^*$, of the charge carriers be dependent on the direction of motion relative to the crystal lattice, and differ, sometimes by a factor of more than ten, from the rest mass, $m_0$, of a free electron. Attempts have recently been made to measure $m^*$ by a more direct method; the angular frequency, ω, of an electric field $E$ at which a specimen of a semiconductor exhibits a cyclotron resonance (a peak in its absorption spectrum), when a steady magnetic field $H$ is applied at right angles to $E$, is simply $qH/m^*c$. The conditions necessary to achieve unambiguous answers from the cyclotron resonance measurements are stringent, requiring that the carriers have a mean free time of at least a few cycles of the alternating electric field—a condition met only by the combination of low temperature (for example, 4° K.), at which collisions with phonons are greatly reduced, and high values of $\omega/2\pi$ (for example, $10^{10}$–$10^{11}$ c./s.). The much reduced thermal ionization of the impurity centres at the low temperature provides too low a density of charge carriers, which must be supplemented by, for example, photo-injection. The values of $m^*/m_0$ obtained confirm a dependence on the orientation of the crystal under test with respect to the direction of $H$ and differ for holes and electrons. Theoretical computations of the energy band structure for germanium and silicon have been extended to sufficient points in momentum space to account, at least qualitatively, for the cyclotron resonance results.

The effects which limit the life-times of minority carriers (such as those injected by the emitter of a transistor into the base region or produced by photons of sufficient energy) are only partially understood and not well controlled. Thus nickel and copper present large cross-sections for the capture and recombination of holes in $n$-type germanium; parts in $10^{11}$ of nickel (parts in $10^{10}$ of copper) could account for most of the recombination occurring in much of the $n$-type monocrystalline germanium prepared to-day. The same two elements also have large capture cross-sections in $p$-type germanium, where they act as recombination centres for electrons. The segregation constants of both elements, in germanium, are very small, making zone-refining apparently efficient, but they are not accurately known, partly because both elements diffuse comparatively rapidly into solid germanium at elevated temperatures; both exhibit retrograde solid solubility in germanium. Control of life-time by the addition of either element to molten germanium from which single crystals are afterwards drawn is therefore difficult. There are, however, applications which call only for a minimum value of life-time, involving no addition of a material of high recombination cross-section. Physical imperfections, particularly the dangling bond associated with the edge component of dislocation lines in the otherwise near-perfect germanium, can also act as recombination centres; their numbers must be controlled, both for this and other reasons.

## Transistor Technology and Physics

The properties of the surfaces of semiconductors are insufficiently understood. No simple complete model exists for the rectifier formed at the contact between a sharp metal point and a piece of germanium or silicon—and in general none for a formed point contact, that is, one at which sufficient electrical energy has been rapidly dissipated to produce local melting, followed by rapid cooling. Experimental studies have been made; but the interpretation of some depends on details not well under control—for example, the structure and composition of surface layers.

Changes in the contact potential of a surface when exposed to a sequence of atmospheres have been studied. Layers of $p$-type conductivity form on $n$-type material exposed to an oxidizing atmosphere and of $n$-type conductivity on $p$-type germanium exposed to water vapour; water vapour may, however, counteract the short-term effect of an oxidizing atmosphere on the growth of layers. The effective area of the layer (more usually called a channel) adjacent to a $p$–$n$ junction increases with reverse bias across the junction, but the breakdown voltage of the junction between the channel and the underlying material may be much less than that of the main junction.

The rate of recombination of minority carriers can be very high at surfaces, and, in a transistor formed by alloying two small pellets of indium opposite one another on a thin wafer of germanium, can predominate over that in the bulk material, unless the surface material damaged in preparing the wafer is completely removed before alloying, and the final etching, washing and drying carefully attended to. At the moment, surface effects may be the most important of those responsible for the failure of some transistors to have, and retain, the properties predicted.

The alloying process, though widely used, has uncertainties. The indium melts and dissolves germanium until the solution is saturated. The first part to solidify on cooling takes the structure of the underlying undisturbed germanium and may be strongly $p$-type (because indium is trivalent) if the alloying temperature is high enough. The continuity of the germanium across the $p$–$n$ junction may have regions of imperfection, however. None the less, alloy diodes, carefully processed and sealed in a dry inert gas, can have voltage/current relationships little different from those calculated, indicating that any imperfections can be apparently unimportant initially; they may still play some subsequent part in changes of performance, however.

The reliability of transistors will probably ultimately reside in the vital regions of the surface and bulk near the junctions or contacts. High electric fields (for example, $3 \times 10^4$ V./cm.) exist at the collector junction or contact, where the working temperature may, due to the power dissipation, be 70° C. or more in germanium and 150° C. in silicon units. The drift of metal ions and the diffusion of atoms across the boundary, into the base region, particularly in regions of local imperfection, may well set one limit to the life of units. The high field extends to the periphery, where it may cause dielectric breakdown in any protective film, and may lead to shunting of the junction by ionic conduction and to erosion of the germanium at the edges of the junction.

A wide variety of changes of performance can be noted when units are exposed to wet and dry atmospheres, ozone, halides and the vapours of some organic liquids; the effects of high humidity are particularly detrimental when small quantities (for example, $1/10^6$) of salts of nickel or copper are present in the final washing water. Because these metals are often used as connecting stubs or leads, great care needs to be taken in manufacture to prevent their transfer to unwanted places.

Some new designs of transistor have involved new techniques and therefore require new studies of basic phenomena. The surface barrier transistor, made by electrolytically etching two wells opposite one another in a wafer and afterwards electrolytically depositing or evaporating emitter and collector electrodes in the wells, depends for its action on the contact between the metal coating and the semiconductor as left by the electrolytic etch. Platinum, indium, copper, lead and antimony are among the metals used. As with point-contact rectifiers, the work function of the metal seems to have little influence on the overall performance. No satisfactory theory has yet been given to account for the high hole content of the current flow across such metal–semiconductor contacts.

The solar and atomic batteries are recent additions to the possible uses of silicon *p–n* junctions; each converts some of the energy of a radiation, solar or $\beta$, respectively, via the production of hole-electron pairs in the vicinity of the junction, into electrical power. Problems of damage to the lattice, with degradation of performance of the battery, may be severe in the atomic unit.

### New Semiconductors

Germanium and silicon are not ideal materials for crystal valves for several reasons. Germanium is a comparatively rare element; valves made from it lose much of their performance when operated at ambient temperatures above about 70° C. Silicon presents difficulties of purification; its technology involves accurate control of temperatures around 1,420° C. The mobilities ($\mu$) of carriers in germanium and silicon ($\sim$ 400–4,000 cm.$^2$/sec. V.) limit the speed of response of transistors. Searches continue to be made for other transistor materials less severely limited in the above ways. The compounds of elements of Group III with elements of Group V, for example, indium antimonide and gallium arsenide, were among the first to receive attention. The properties of the constituent elements disappear in the compounds, which have a diamond-like structure and the electrical properties of semiconductors. Values of $\mu$ as high as 75,000 cm.$^2$/sec. V. have been reported for electrons in indium antimonide, but the accompanying energy gap is less than 0·3 eV., and the life-time, $\tau$, of minority carriers may be severely limited (perhaps to $< 1$ μsec.). The small energy gap prohibits useful transistor action at room temperature; for a base region of indium antimonide to be extrinsic it must contain about $10^{17}$ impurity atoms per cm.$^3$ and may be nearly degenerate. Collector barriers would be very thin and unable to withstand any usable reverse voltage. Reverse currents at *pn* junctions will be large because of the small gap, large $\mu$ and small $\tau$. Some other compounds have more appropriate values of energy gap, but only moderate values of $\mu$. The search has extended to other binary compounds (elements in Groups IV and VI and also V and VI) and to ternary compounds—for example, $CuInSe_2$—the structure of which also resembles that of diamond. Some, though not suitable for transistors, have extended the range of other electrical properties. Thus the Peltier effect at the junction between bismuth and bismuth telluride has been made to produce a temperature difference of 26° C., and that between *n*- and *p*-type bismuth telluride a difference of $\sim$ 40° C. Some attention has been paid recently to quaternary compounds having the stannite structure, also akin to diamond.

### Problems in applying Crystal Valves

It is now possible to assess more adequately the likely uses of crystal valves. Diodes offer advantages of size, lack of a heater, small capacitance and, sometimes, rapid response. Triodes offer advantages of size, lack of a heater and some additional facilities compared with thermionic valves. The diodes bring few new problems; their noise factors are not well understood, but at radio frequencies are usually tolerable. Minority-carrier storage can set a limit to their speed of operation as switches, for example, in computer circuits; forward current results in an excess of minority carriers near the junction or contact, which prevents the diodes instantaneously becoming of high impedance when a reverse voltage is applied. Recovery times can vary from about 0·01 μsec. to 10 μsec. Triodes set many more, and sometimes severe, problems. The noise factor can be intolerable at audio-frequencies for some uses; here the dominating component at a frequency $f$ is often proportional to $f^{-n}$, where $n$ is about 0·9–1·2. The equivalent circuits are more involved than those of thermionic valves, and it is not always easy to relate the components of the equivalent circuit which suits the engineer to those preferred by the device designer. Methods of circuit analysis and design both for large-signal and small-signal applications are being evolved, but the limitations of upper working temperature (less stringent for silicon units), of power handling capacity and of frequency response continue to restrict the field of applications.

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# OBITUARIES

## Prof. Albert Michel-Lévy

Albert Michel-Lévy was born at Autun on July 3, 1877. His father, Auguste (1844–1911), was a very distinguished geologist and mineralogist, best known for his fundamental work on the relationship of chemical composition to optical properties in the feldspar group, which is still used as the basis for the identification of members of this most important group of rock-forming minerals. Albert at first studied agriculture and forestry at Nancy; but he soon found an opportunity to turn to geology, and in 1901 he entered the Collège de France as a student of Ferdinand Fouqué's. His early work was on the rocks of the central massif of France in Morvan and Le Loire, and his thesis for his doctorate embodied the results of many years work in that region. In 1913 he succeeded to Louis Gentil as a lecturer in petrography at the Sorbonne. Here he carried out many investigations of volcanic rocks and of mylonites, illustrating his papers on these rocks by photomicrographs of remarkable excellence. He was ever ready to lend his special skill with the polarizing microscope to workers in fields other than petrography, and this led, happily, to some work on the birefringence of nitrated cellulose and in turn to work on other explosives. Together with Henri Muraour he studied, and photographed under the microscope, the behaviour of single crystals of explosive substances, observing the products of the explosion, the light flash, and the shock waves. Later they extended their observations to the modifications in the shock waves when explosion took place in one of the heavier gases like argon, comparing these with the effects seen in atmospheres of lighter gases.

This work on explosives suggested to Michel-Lévy a way of synthesizing rock-forming minerals under pressure and in presence of water vapour. The materials for the synthesis were enclosed in a 'bomb' cleverly designed to accommodate also a small explosive charge. The 'bomb' could be heated in an electric furnace at first to a temperature of 200°, at which the explosive detonated, producing the high pressures required in the closed 'bomb'. This was then heated to higher temperatures and could be kept there for days or weeks as desired. The identification of the minerals synthesized in these experiments was made by means of X-rays by Jean Wyart, and in later experiments they had the collaboration of one of Michel-Lévy's daughters, now Mme. Mireille Christophe-Michel-Lévy, by whom the work is still being carried on.

Twice Michel-Lévy's scientific work was interrupted by wars. He came of a family devoted to the service of France. His grandfather had served in the Crimea as a surgeon and became a very distinguished officer in the French Army medical service. In the First World War Albert Michel-Lévy, *Capitaine de chasseurs à pied* and later *Chef de Bataillon*, was twice grievously wounded, and he ended the war as an officer on the General Staff. He was made a chevalier of the Légion d'Honneur, of which he became an officer in 1920, and commander in 1946. In the Second World War, after the fall of France, he was removed from his post at the Sorbonne because of his Jewish ancestry. Protests at his removal were eventually successful in having the interdiction withdrawn in January 1942, and he was able to resume his work, though not in his own laboratory. However, worse was in store. His only son, Roger, fighting in the resistance, was taken prisoner and shot in February 1944. The loss was irreparable. Michel-Lévy's health was never again very good and he retired from his professorship in 1946, though he continued work with Jean Wyart and his daughter until 1948. He died in Paris on May 2, 1955. He was made a professor of the Sorbonne in 1936, and was elected a member of the Academy of France on January 22, 1945.

W. CAMPBELL SMITH

## Prof. Madison Bentley

PROF. MADISON BENTLEY died in California, U.S.A., on May 30. He was born at Clinton, Iowa, on June 18, 1870. His early training was at the University of Nebraska. He then went to Cornell University where, in 1898, he obtained the Ph.D. degree. At Cornell he remained, first as instructor and then as associate professor of psychology, until 1912. During 1912–28 he was professor of psychology and director of the Psychological Laboratory at the University of Illinois. In 1928 he succeeded Titchener at Cornell as Sage professor of psychology, and there he remained until his retirement from official life. He became president of the American Psychological Association in 1925, he was a Fellow of the American Association for the Advancement of Science, chairman of the Division of Anthropology and Psychology in the National Research Council; and he was editor of the *Psychological Index* (1915–24), of the *Journal of Experimental Psychology* (1926–30) and co-editor for many years of the *American Journal of Psychology*.

Madison Bentley achieved a position of great influence in the relatively early days of experimental psychology in America. He was of a modest and friendly disposition, a man of complete intellectual honesty, yet willing to try to see something good in all the many systematic, and often highly dogmatic, approaches to psychology which characterized the end of the nineteenth and the beginning of the twentieth centuries. This temper of mind made him an admirable editor, and his successful editorial work, as he himself recorded, broadened his knowledge and increased his tolerance. He wrote widely but mostly in journals, or in books of the familiar American 'portmanteau' kind. There were two volumes of his own: "The Field of Psychology", published in 1924, and "The New Field of Psychology", which appeared about ten years later. In the second, Bentley showed himself rather surprisingly sympathetic to practical and applied developments of experimental psychology.

When Prof. Carl Murchison got the excellent idea of producing a series of volumes to be called "History of Psychology in Autobiography", Madison Bentley was naturally one of the people approached for an early contribution. He wrote a beautifully unassuming account of his intellectual development (Vol. 3, p. 53; 1936). He acknowledges his debt to Titchener, and it is characteristic that he should select one item of this debt as most important. He had "submitted a cherished manuscript" for criticism and got it back with these remarks: "Here it is. I don't think that I have ever told you that I thoroughly disliked anything that you had written. I do this. It is decidedly bad. Cut out your figures and have done with your fine writing". This, says Bentley, "was a major operation without anæsthetic. Recovery was slow, but it left my organism saner".

Whether or no this was the reason, it was the sanity and dependability of his judgment, as well as the wide range of his knowledge, that won for Bentley the deep respect and admiration of psychologists everywhere.

F. C. BARTLETT

## Mr. G. W. Lines, C.B.E.

GEORGE WILLIAM LINES, director of agriculture, Sierra Leone, will be well remembered in West Africa and especially in agricultural circles of Nigeria and Sierra Leone, where he had a long and distinguished career. He died at his headquarters at Njala on February 11 in his fifty-second year.

After graduating from St. Catherine's College, Cambridge, in 1924, he obtained a Cambridge diploma in agricultural science before he joined the Colonial Agricultural Service in 1925. He spent the earlier part of his service in Nigeria, where he was noted for the enthusiasm and energy he put into his work and for his genial personality. He was particularly successful in obtaining the co-operation and confidence of the native farmers to a degree seldom attained by other officers in the Service.

Lines took a leading part in establishing the co-operative preparation and marketing of cocoa in the Western Region, and later he initiated the planting of improved oil palms to replace the wild palms on which the farmers relied. In Nigeria perhaps he will be best remembered in the Bida area where, during the War, he established a thriving local fibre industry which proved of lasting benefit to the farmers and met an urgent demand for materials previously imported and then practically unobtainable.

On his transfer to Sierra Leone in 1944, he gave outstanding service in the organization of supplies and later assisted in the improvement of production and quality of piassava, a product for which Sierra Leone is famous. He was promoted to principal agricultural officer in 1945, deputy director of agriculture in 1949 and to director in 1951. It was in this latter post that he achieved his most outstanding success. Realizing the impossibility of increasing food production on the overworked and eroded uplands, he went boldly forward to apply mechanization to the cultivation of swamp rice on the vast areas of coastal and inland riverain swamps. The initial experiments met with immediate success, from which he evolved a policy which has led to the provision of a service with mechanized units over large areas of the country. In 1942 he was made an M.B.E. and advanced to C.B.E. in 1955.

By the death of G. W. Lines the Colonial Agricultural Service has lost an outstanding figure, and he leaves behind him many friends, Europeans and Africans alike. His enthusiasm was unbounding and infectious, his initiative exceptional and he gave unstinted encouragement to his staff from the most junior upwards. T. N. GREEVES

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# NEWS and VIEWS

## Imperial College of Science and Technology, London

THREE new chairs have recently been created at the Imperial College of Science and Technology, London, and the appointments to them are as follows: aeronautical structures, Dr. J. H. Argyris; applied science in the Mechanical Engineering Department, Prof. D. G. Christopherson; and light electrical engineering, Prof. A. Porter.

## Prof. J. H. Argyris

UNTIL the appointment of Dr. J. H. Argyris to the new chair of aeronautical structures at Imperial College, all professors of aeronautics in British universities were primarily associated with aerodynamics. This has inevitably biased students of aeronautics in favour of aerodynamics and has had the result that too few graduates with a primary interest in structures have entered the aeronautical engineering profession. The formation of the present chair will help to change this somewhat unsatisfactory state of affairs. Prof. Argyris studied at Munich and Zurich. He spent some years on the technical staff of the Royal Aeronautical Society, during which period he wrote papers on tapered tubes (representing aeroplane wings), diffusion of loads and panel instability, and wrote an important contribution to the "Handbook of Aeronautics". In 1949 he joined the staff of Imperial College, and in the following year was appointed reader in aeronautical structures by the University of London. Since then, an aircraft structures laboratory, including equipment for the study of fatigue, has been built up at the College. Prof. Argyris's work and published papers since 1949 have been on energy theorems, approximate stress analysis, matrix formulation of structural analysis, instability of panels, experiments on open tubes, and fatigue investigations on bonded light alloys. He is working at present on the statics and dynamics of complex aeronautical systems with particular reference to the use of digital computers.

## Prof. D. G. Christopherson

PROF. D. G. CHRISTOPHERSON was educated at Sherborne School and at University College, Oxford, graduating in engineering science in 1937. After a year at Harvard University as a Henry Fellow, he became research assistant to Sir Richard Southwell and took his D.Phil. in 1940. During the Second World War he worked for the Research and Experiments Department of the Ministry of Home Security on the subject of airborne blast, underwater shock waves and other effects of explosions, and also on the design of structures to resist these effects. In the latter part of the War his work was not so much concerned with defence as with the selection of weapons for attack on specific objectives. After the War he became a lecturer in engineering in the University of Cambridge and a Fellow, later bursar, of Magdalene College. In 1949 he was appointed to the chair of mechanical engineering in the University of Leeds. Prof. Christopherson's research and publications have been mainly on three lines: lubrication, dynamic stress analysis and plasticity. The chair of applied science at Imperial College has been created as part of the expansion plans of the College. The new professor will be particularly concerned with the methods of teaching engineering students of all kinds during their first year at the College, as well as with his own research and postgraduate work.

## Prof. A. Porter

PROF. ARTHUR PORTER is a graduate of the University of Manchester, where he became an assistant lecturer in physics. Before the Second World War he was a Commonwealth Fellow in physics and electrical engineering at the Massachusetts Institute of Technology, and during the War was engaged on special work for the Admiralty and Ministry of Supply. In 1946 he went to the National Physical Laboratory, Teddington, in charge of the Automatic Control Systems Laboratory in the Metrology Division, but soon moved on to become professor and head of the Department of Instrument Technology at the Military College of Science, Shrivenham. Since 1949 he has been in Canada as head of the Research Division at Ferranti Electric, Ltd., Toronto. Prof. Porter has published many papers in the fields of control systems, differential analysers and similar subjects, and is author of a monograph on servo-mechanisms. At the Imperial College he will work in close association with Prof. A. Tustin, the new head of the Department of Electrical Engineering (see *Nature*, January 22, p. 148).

### Physics at the University College of Rhodesia and Nyasaland : Dr. E. Leighton Yates

Dr. E. Leighton Yates, senior lecturer in physics in the University of Sheffield, has been appointed to the chair of physics in the University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia. Educated at the Grove Park Grammar School, Wrexham, he then studied under Prof. E. A. Owen at the University College of North Wales, Bangor, and graduated with first-class honours in physics. He did postgraduate work with Prof. Owen on X-rays, developing a high-temperature camera and investigating pure iron–nickel alloy systems. Proceeding to St. John's College, Cambridge, with a senior research award of the Department of Scientific and Industrial Research, he worked in the Cavendish Laboratory on the separation of the isotopes of lithium, boron and carbon. Dr. Yates is an excellent teacher, having lectured and demonstrated for many years and at all levels to general- and to special-degree students. During the Second World War he was largely responsible for conducting a two-year course at Sheffield in radiophysics and for developing a comprehensive practical course in radio. He has initiated extra-mural and postgraduate courses in electronics, metal physics and modern physics and given courses in building acoustics. Alone and with his co-workers, he has worked on the development of electronic control devices, the X-ray examination of metals and alloys, order–disorder transformation in $FeNi_3$, the growth of single crystals of iron, their magnetic properties under strain, and the design of an X-ray diffractometer for examining strained crystals, using a fine-focus X-ray tube. Dr. Yates's wide knowledge and experience have been always freely available to his colleagues. In the Student Christian Movement, his services have been greatly prized both in the universities and in schools.

### Kossuth Prizes for Research in Hungary

The Hungarian Government has awarded a number of Kossuth Prizes for research, as follows. First-class Prizes, of £1,500 each : Academician László Rédei, for work in the field of algebra and theory of numbers, and particularly for his treatise on the Pell type of equations ; and Academician Gyoző Bruckner, for research on polypeptides and proteins, significant from the biological point of view. Second-class Prizes, of £1,000 each : Dr. József Baló and his wife, for research into the pathology of the blood system and the discovery of a new enzyme which digests fibrous tissue ; Dr. Péter Dénes, for an electrolytic method of producing iron and alloy powders used in the telecommunications industry ; Academician Sándor Geleji, for research in the plastic moulding of metals : Academician Géza Hetényi, for work on the diagnosis of ulcer diseases ; Academician Árpád Kiss, for spectroscopic research on aromatic hydrocarbons and hydrated metal ions and complex salts ; and Zoltán Veress, chief engineer of the Karcag factory, for the production of special glasses, *C*9 and *G*28, for the telecommunications industry.

### Scientific Research in the U.S.S.R.

Under the title "Scientific Research in Russia", the Department of Scientific and Industrial Research has issued a translation of a brief survey of recent work which appeared in *Priroda* (1954, (3) 3–10). Some initial and final paragraphs, political in character, have been omitted, and in the absence of a bibliography some references have been added to indicate Russian periodicals received in Britain which are likely to deal with the subjects mentioned. There is still a little polemic ; but the survey indicates the scope of the Russian effort. Much work has been completed on regional tectonics and the problems of magmatogenic mineral deposits. Stress is laid on investigations relating to the construction of turbo-generators, the discovery of new types of solid fuel for metallurgy, the improvement of special alloys for machine construction, and the automatic control of blast and open-hearth furnaces. In the petroleum industry use of the turbine method of boring has been extended, and the gasification of coal has been further developed, as well as the catalytic methanization of water gas and the use of steam at high pressures and temperatures. Contributions in radio-astronomy, the physics of semi-conductors, the development of seismological methods and studies of the effect of molecular structure on the rate of isotope exchange and of the mechanism of poly-condensation are noted, as well as the introduction of a new anaesthetic, promedol, claimed to be more active and less toxic than morphine. Reference is made to studies of the action of phosphatic fertilizers with radioactive phosphorus and of the use of antibiotics for the control of plant diseases ; but, in general, it is stated that radioactive tracer materials have been used to a very limited extent and that use of the electron microscope has been unsatisfactory.

### Visual Recording of Radiation Patterns

Several different types of apparatus have been devised for the formation of visual images of patterns of ionization ; but with the exception of those described by Prof. W. V. Mayneord and co-workers at the Institute of Cancer Research, London, they all present the final picture on recording paper or film. Prof. Mayneord uses the cathode-ray tube, and in earlier models (*Nature*, 168, 762 ; 1951 ; and *Brit. J. Radiol*, 25, 589 ; 1952) a persistent screen was employed. However, at low scanning speeds the persistence was found to be insufficient, and in the most recent model, which has recently been described (*J. Sci. Instr.*, 32, 45 ; 1955), an image-storage tube is used in place of the cathode-ray tube. The picture is built up, line by line, over a long period of time, and then the complete picture is read at any later convenient time. The apparatus consists essentially of two parts : a mechanical device for moving the detector accurately over the required field of examination, and the electronic sections concerned with the detection of the radiation and the ultimate storage and presentation of the final image. The source is scanned in a series of parallel lines, and the maximum area covered can be 18 × 18¼ in. The time taken for scanning a complete frame is approximately six minutes. As the apparatus described was designed primarily for the survey of radiation fields due to γ-ray emitting isotopes, the detector is a coincidence scintillation counter ; but, by the substitution of other detectors, the use of the apparatus can be extended over a wider range of radiations. Full details of the detector system and of the storage tube are given, and problems of resolution and limits of detection are discussed and illustrated by photographs. A minor modification permitting the apparatus to be used for making radiographs is mentioned, and the application of the storage principle to an X-ray spectrograph is stated to be under consideration.

## Kodaikanal Observatory: Report for 1953

In the annual report of the Kodaikanal Observatory for the year 1953 (pp. 10. Delhi: Manager of Publications, 1954; As. 9 or 10*d*.), A. K. Das, the director of the Observatory, deals chiefly with the astronomical work. International co-operation with other observatories continues, and exchanges have been carried out with the Royal Greenwich Observatory, the Observatories of the University of Cambridge, Meudon Observatory, and Mount Wilson Observatory. Quarterly statements relating to solar flares were sent as usual to the Royal Greenwich Observatory and Meudon Observatory. The lists of instruments are classified under five headings: astronomical and spectroscopic instruments, of which thirty-three are catalogued; magnetic, with a total of eight; electronic, including nineteen; workshop machinery, eleven; and under other instruments, of which six are listed; but various other instruments not catalogued, such as galvanometers, photocells, thermo-relays, etc., are also available. Details of sunspot activity-spots, prominences, with the Doppler shifts of the H$\alpha$ line observed in prominences, heights of prominences, etc., are shown in tabular form. Under the research training scheme sponsored by the Ministry of Education of the Government of India, two senior and two junior scholars were working in the Observatory. A list of publications—seventeen altogether—during the year is given at the end of the report.

## Council for the Promotion of Field Studies: Summer Courses

A popular belief that the courses organized by the Council for the Promotion of Field Studies are confined to the summer months is discounted by the issue of the programme setting out the arrangements at each of the field centres of the Council during the autumn. All the usual courses in marine and fresh-water biology, geography and general natural history, rural studies and entomology are being continued, while, in addition, each centre is arranging courses to suit more specialist interests. At Malham Tarn, for example, a short course in meteorology is being arranged during August 24–31, the directors being Dr. C. D. Ovey (University of Cambridge) and Dr. R. S. Scorer (Imperial College of Science and Technology, London). A week's course in surveying and map-making will be held at Juniper Hall during August 10–17, while courses in the identification and ecology of lichens as well as one on local mosses are being organized at Malham Tarn. A week devoted to the study of fungi is planned for Flatford Mill during September 21–28, while Dale Fort is to hold a course, limited to twelve students, on oceanography during August 24–31. The pamphlet giving the details of these courses is obtainable from the Council at Ravensmead, Keston, Kent, or from any of the above-mentioned field centres.

## Forests of the Upper Nile Province, Sudan, 1862–1950

It is becoming apparent that under the Sudanization plan a large number of the British officials left in the Sudan Administration have decided to resign. In the case of the Forest Department, it is to be hoped that this will not result in a serious setback to the excellent work of the past eight years or so (see the annual report for 1951–52, reviewed in *Nature*, 173, 903; 1954). The good work of past years is further exemplified by Memoir No. 5 of the Sudanese Forestry Division, Ministry of Agriculture, entitled "Forests of Upper Nile Province, 1862–1950", by G. A. Booth (Khartoum, 1952). This brochure, which has excellent illustrations, is a most valuable piece of research work. After a reference to the evidence of Roman explorers and archæological evidence that the belt of high forest which stretched over Central Africa once extended as far north as Khartoum, Mr. Booth sets himself to examine how far in the provinces the forests have been overcut to supply the large demands for wood fuel made both by the towns and the river steamers since Sir Samuel Baker's time in the 1860's. It is too early to be able to agree with Mr. Booth's suggestion that possibly the supposed overcutting of the scattered forests to supply this growing demand for fuel has not seriously affected the forests on the areas from which the fellings were made.

## University of Birmingham

In the University of Birmingham the title of reader in analysis in the Department of Mathematics has been given to Dr. B. Kuttner, and that of reader in mycology in the Department of Botany to Dr. C. J. Hickman. The following have been appointed lecturers in the University: Dr. G. W. Hutchinson (physics), Dr. T. S. West (chemistry), R. Humphreys (civil engineering), Dr. Ingeborg Gurland (education—child development) and C. J. Phillips (education—psychology).

A postgraduate course in coal preparation leading to the degree of M.Sc. by examination has been established in the University; the course will consist of lectures and laboratory and tutorial classes during the normal session, and will be followed by a project carried out on an industrial coal-preparation plant or on the pilot plant of a manufacturer of coal-preparation appliances.

In the Department of Pharmacology a grant of £1,500 a year for three years has been given by Quaker Oats, Ltd., for research into the chemistry and nutritional value of cereals.

## Zoological Publications of W. D. Selensky

Prof. M. C. Meyer, professor of zoology in the University of Maine, writes to say that after considerable searching he finally obtained from abroad a copy of Waldimir D. Selensky's "Études morphologiques et systématiques sur les Hirudinées: I. L'Organisation des Ichthyobdellides", published in Leningrad (then called Petrograd) in 1915 (pp. viii + 246, 41 fig. + 8 plates; in Russian). A photostatic copy was made, and afterwards a complete translation of the text was arranged. At the time of his death in 1931 Prof. Selensky was a leading zoologist in the U.S.S.R., being head of the Parasitological Department, University of Leningrad, and his researches were devoted chiefly to the morphology, biology and the systematics of leeches, the most important contribution being the above-mentioned publication. Museum and university librarians interested in obtaining a copy of the English translation, with text-figures and plates, should write to Prof. Marvin C. Meyer, Department of Zoology, University of Maine, Orono, Maine.

## Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: D. D. Campbell (agricultural officer, Uganda), principal agricultural officer, Basutoland; R. G. Heath (deputy director of agriculture, Federation of Malaya), director of agriculture, Federation of Malaya; J. Hughes-Rice (agricultural officer, Kenya), provincial agricultural officer, Kenya; L. Johnson (economic botanist, Trinidad), senior agricultural officer, Mauritius; J. A. Sandys (agricultural officer, Nyasaland), chief agricultural officer, Nyasaland; A. H. Savile (regional assistant director of agriculture, Tanganyika), chief agriculturist, Kenya; A. I. Biggs (chemist, Department of Chemistry, Federation of Malaya), chief chemist, Department of Chemistry, Federation of Malaya; T. G. E. Gibson, assistant director of agriculture and veterinary services, Somaliland Protectorate; M. N. Harrison, plant breeder, Kenya; F. J. Smart, agricultural officer, Northern Rhodesia; L. S. Todd, agricultural officer, Uganda; B. L. Lawrence, assistant conservator of forests, Gold Coast; G. H. D. Williams, assistant conservator of forests, Northern Rhodesia; I. G. Gass, geologist, Cyprus; P. I. Morris, geologist, British Guiana; H. C. Ruick, horticulturist, Cyprus; G. H. Lampkin, research officer, East African Agriculture and Forestry Research Organization; R. Hopes, veterinary officer, Uganda.

## Royal Meteorological Society: Officers for 1955–56

THE following have been elected officers of the Royal Meteorological Society for the year 1955–56: *President*, Dr. R. C. Sutcliffe; *Vice-Presidents*, C. K. M. Douglas, Prof. G. Manley, Sir Graham Sutton, Dr. T. W. Wormell; *Vice-President for Canada*, Dr. D. P. McIntyre; *Vice-President for Scotland*, Sir Ernest Wedderburn; *Treasurer*, Dr. J. S. Farquharson; *Secretaries*, Dr. A. G. Forsdyke (*Librarian*), Dr. H. L. Penman, Dr. G. D. Robinson (*Editor*), R. G. Veryard.

## Plant-Growth Substances: Conference at Wye College, Ashford

A THIRD international conference on plant-growth substances will be held in Wye College (University of London), Ashford, during July 17–22. Nearly seventy people will be participating, twenty-six of whom will be from overseas countries as follows: United States, twelve; Sweden, five; Germany, four; Austria and The Netherlands, two each; and Norway, one. The following topics will be discussed (the chairmen are shown in brackets): natural auxins (Prof. H. Veldstra and Dr. G. S. Avery); chemical structure and biological activity (Dr. J. Bonner and Prof. T. A. Bennet-Clark); metabolism of auxins (Prof. P. Larsen); mode of action of auxins (Prof. L. J. Audus). Further information can be obtained from the honorary secretary of the conference, F. Wightman, Wye College, Ashford, Kent.

## Conference on the Physics of Nuclear Reactors

THE Institute of Physics is arranging a conference in London on "The Physics of Nuclear Reactors" during July 3–6, 1956, to be opened by Sir John Cockcroft with an address on the "Scientific Problems in the Generation of Nuclear Power". The primary purpose of the conference is to keep members of the Institute, particularly those engaged in industry, informed about recent developments in reactor physics and the cognate scientific and technical subjects, and to tell them of the problems awaiting solution. Further details will be announced in the autumn of 1955, which will include the procedure by which non-members may be considered for invitations to attend the conference.

## Announcements

DR. R. VAN DER RIET WOOLLEY, Commonwealth Astronomer and professor of astronomy in the Australian National University, Canberra, has been appointed Astronomer Royal at the Royal Greenwich Observatory in succession to Sir Harold Spencer Jones, who is to retire on December 31.

THE Paris Academy of Sciences has elected Lord Cherwell, Dr. Lee's professor of experimental philosophy in the University of Oxford, and Prof. G. Cassinis, director of the Polytechnic of Milan, to be *correspondants* for the Sections of Free Academiciens and of the Applications of Science to Industry.

DR. F. P. BOWDEN, reader in physical chemistry in the University of Cambridge, has been awarded an Elliott Cresson Medal by the Franklin Institute, "for his extensive experimental investigations of the friction between solid surfaces, investigations which combine simplicity and clarity, and for his findings regarding the detailed nature of the processes involved when one metal slides over another".

SIR JAMES CHADWICK, master of Gonville and Caius College, Cambridge, and formerly Lyon Jones professor of physics in the University of Liverpool, has been elected an honorary Fellow of the Institute of Physics.

THE Oceanographical Institute of Monaco has awarded its Commemorative Medal of Prince Albert I of Monaco (the Manley-Bendall Prize) to Dr. J. N. Carruthers, director of the National Institute of Oceanography [of Great Britain], for his distinguished work in physical oceanography.

GENERAL MATTHEW B. RIDGWAY, who recently retired from his post as chief of staff of the United States Army, has been appointed chairman of the Board of Trustees of the Mellon Institute of Industrial Research, Pittsburgh, Pa., with the responsibility of being the chief administrator of the Institute as well as acting for the Trustees in promoting their plans to expand the Institute's staff and scientific programmes. Dr. E. R. Weidlein will continue in his post as president of the Institute.

DR. S. WHITEHEAD, director of the Electrical Research Association, has been re-elected chairman of the Committee of Directors of Research Associations for a further year.

THE triennial award of the above Prize and Medal has been made by the Council of the Institution of Electrical Engineers to Mr. D. McDonald for his paper on "The Electrolytic Analogue in the Design of High-Voltage Power Transformers". The prize, which consists of a bronze medal, a certificate and about £20 in money, is awarded for the best paper on a professional subject published by the Institution during the period of the award; but only authors who are corporate members less than thirty-five years of age are eligible.

THE European Molecular Spectroscopy Group is meeting in the University of Oxford during July 7–11.

THE Nutrition Society is arranging a symposium, to be held in the Physiology Laboratory, University of Oxford, during July 8–9, on the nutritional work of the United Nations Food and Agriculture Organization, the World Health Organization, and the United Nations Children's Fund. Further information can be obtained from Dr. H. M. Sinclair, Laboratory of Human Nutrition, 10 South Parks Road, Oxford.

# NEW VISCOSE RESEARCH LABORATORY OF COURTAULDS, LTD.

THE new viscose research laboratory of Courtaulds, Ltd., has recently been completed at Coventry and was on view to visitors during the week commencing May 16. This is the latest, and at present the largest, of the Company's six research laboratories. Together with its associated pilot plants, the laboratory will be devoted almost entirely to research and development work on the manufacture of regenerated cellulose fibres by the viscose process. Broadly speaking, its main objects are to effect major improvements in the properties of the fibre and to develop improved methods of manufacture. Its activities will range from fundamental to large-scale technological work in a broadly based programme.

The man-made fibre industry operates to-day on a very large scale; it is not generally realized that it supplies nearly 20 per cent of the world's textile requirements. Of its annual world output of some two million tons, about 80 per cent is produced by the viscose process. Originally the only product of this process was continuous-filament textile yarn. The viscose process has, however, proved remarkably flexible; the range of its products has progressively widened, and to-day includes special high-tenacity yarns used mainly for industrial purposes and a number of different types of staple fibre. With the expanding range of outlets, a host of new problems has arisen in developing fibres specially suited to particular end uses.

The raw material of the industry is cellulose, predominantly in the form of highly refined wood pulp. It is abundant and relatively cheap, as are the other major chemicals employed. The industry is therefore in a position to expand its output to keep pace with the world's ever-increasing demand for textiles.

The processes involved in the production on an industrial scale of regenerated cellulose fibres with properties suited to their various uses are complex and inherently difficult to investigate; even after fifty years of activity the industry still presents many problems of considerable depth which remain to be solved. In the early days, considerable progress was made despite the lack of understanding of the background science; but the time has now come when progress will depend increasingly on a thorough understanding of the physical and chemical changes which take place during the production of the viscose solution, its extrusion into a coagulating bath and the subsequent regeneration of cellulose in the form of filaments with properties suited to their end use. A major aim of the new research laboratory will be to provide this essential background.

In the field of textile science it is not yet possible to describe satisfactorily in terms of measurable parameters many of the properties of fabrics such as drape, handle or durability, which control both their functional behaviour and their appeal to the customer. It remains also to relate these textile properties in a satisfactory manner both to the details of fabric construction and to the properties of the fibres from which they are made. The man-made fibre industry has always striven to produce fibres with the most useful properties, and, for an intelligent approach to this problem, it is necessary to relate these properties to the chemical nature of the building unit—the linear polymer molecule—and to the fine structure and morphology of the fibre. Only by the fundamental study of these problems can technological progress be firmly based, and the work of the individual sections of the new laboratory is integrated with these general aims in view.

The raw material, wood pulp, is being studied in relation to its subsequent behaviour in the viscose process and to the properties of the ultimate fibre. Some of this work is carried out in collaboration with pulp producers, and it is an interesting example of the power of co-operative effort that it has already produced useful results in a difficult field of investigation.

The extrusion or spinning of viscose solution through the fine holes of a spinnerette into an acid coagulant produces filaments of regenerated cellulose by a variety of chemical and physical processes which occur with great rapidity. Persistent physico-chemical study is slowly clarifying the picture; but the basic research tool is undoubtedly the single-end spinning machine. Direct investigation of spinning phenomena based upon the indications of more fundamental work yields positive information about the physical and chemical conditions which control the formation and properties of the filament. Every attempt is made to build the necessary basic properties of strength, flexibility and elasticity into the fibre. In addition it is possible, by the incorporation of extremely fine dispersions of white or coloured pigments into the viscose solution, to modify the lustre of the yarn and to produce a wide range of extremely fast colours. This latter development is particularly important in the field of staple fibre where many of the end uses call for extreme colour fastness and where additional effects can readily be obtained by blending fibres of different colours.

The properties of regenerated cellulose fibres can also be modified by chemical after-treatment. This is very largely the province of the organic chemist who is able to control the degree of swelling in water by means of cross-linking reactions, to confer water repellency, the power of adhesion to rubber and many other specific properties by the use of suitable reagents.

In order to facilitate the rapid utilization of research results in production, the laboratory is associated with extensive pilot plants and has a large engineering section.

The new building, which is steel-framed with floors and roof of pre-cast concrete beams, consists of a basement and four floors of laboratories in the main block. An office wing links it to an existing administrative block. The 'Cotswold grey' brick façade overlooking the main Foleshill Road contrasts with the extensive glass area of the laboratory windows on the other three sides of the building, and insulates the working areas from street noises; at the same time a maximum amount of light reaches the working areas.

On each floor the laboratories are situated on both sides of a central corridor. They are based on a standard module of 25 ft. 6 in. × 11 ft. 9 in. Provision is made for supplying all services to every module so that the internal layout can readily be modified to suit changing requirements. The services are distributed by horizontal mains running at high level throughout the basement, with branches rising up vertical ducts on each side of the central corridor. From these vertical risers branch-pipes are taken through shallow floor-ducts to the laboratory benches. The services include high- and low-pressure steam; electrical power; cold, hot and demineralized water; coal gas; compressed air and vacuum; and brine for cooling. The building is heated and ventilated by warmed and filtered air distributed from a plant in the basement by a plenum system which is directed into three zones per floor; each zone has a subsidiary heater which is under local thermostatic control. Special air-conditioning is provided for the textile research and testing laboratories where constant temperature and humidity conditions are required.

The new laboratory was designed by the Company's architects and engineers in consultation with the scientific staff and completes the post-war development of Courtaulds' viscose research facilities. Major extensions of the Company's other laboratories are in progress.

# MICROWAVE AND RADIO-FREQUENCY SPECTROSCOPY

## FARADAY SOCIETY MEETING

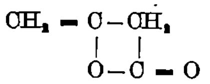
A THREE-DAY meeting of the Faraday Society was held in Cambridge during April 4–6, when the subject of the discussion was "Microwave and Radio-frequency Spectroscopy". The president, Prof. R. G. W. Norrish, opened the meeting, at which more than two hundred members were present, by welcoming more than a hundred British and foreign guests; these included contributors from Denmark, France, Germany, the Netherlands, Switzerland, the United States and the U.S.S.R.

Ten years ago the subject of microwave and radio-frequency spectroscopy embraced essentially only one experiment, namely the direct detection of the inversion frequency of ammonia by C. E. Cleeton and N. H. Williams. Consequently, the majority of members of the Society were not taught anything about low-frequency spectroscopy during their student days. Since the techniques involve a considerable amount of advanced physics and electronic engineering, most members had not had an opportunity of gaining first-hand experience and, as a consequence, were very glad of the opportunity of learning directly from the pioneers and of judging for themselves the possible applications of the new techniques to their own individual interests. They learned that a wide range of topics was concealed under the narrow-sounding title, and there were important contributions to the following subjects: chemical structures, geometrical structures of molecules, electronic structures, thermodynamics, equilibria, molecular kinetics, electrochemical kinetics, botany, biology and astronomy.

In the formal sessions, thirty papers were presented and discussed. Since a summary which would do full justice to these would either be very lengthy or would assume the reader to possess a detailed background knowledge, the rest of this article will enumerate the results presented without detailed reference to the manner in which they were obtained. Besides the original work, there were several contributions which were wholly, or in part, of an introductory or review nature. In the latter class were the accounts of nuclear properties (H. C. Longuet-Higgins), microwave or pure rotation gas spectroscopy (W. D. Gwinn; W. Gordy), non-resonant electron absorption in flames (T. M. Sugden), paramagnetic electron resonance in compounds with metal ions (J. H. E. Griffiths), free radical electron resonance (G. E. Pake), nuclear magnetic resonance (H. S. Gutowsky), and quadrupole resonance in solids (H. G. Dehmelt).

### Chemical Structure

When presented with any material, a chemist's primary task is to determine the structural formula. The structure of diketene has been established to be

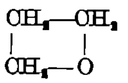


$$\begin{array}{l} CH_2=C-CH_2 \\ \quad\;\; | \quad\;\; | \\ \quad\;\; O-C=O \end{array}$$

by P. T. Ford and R. E. Richards from the proton resonance of the solid, and this has been confirmed by entirely distinct evidence, from the chemical shifts in the liquid, presented by H. S. Gutowsky. The latter type of experiment is relatively rapid and easy to interpret qualitatively, and already a table of characteristic shifts has been established and is likely to have many applications analogous to those of a table of characteristic infra-red absorption frequencies. Also, elegant proofs of the correctness of the bridge structures for diborane, for the pentaborane pyramid, and for the decarborane basket, were given by J. N. Shoolery using the nuclear 'double resonance' technique. A rather different identification of a structural unit is that of E. E. Schneider, who used the electron resonance of the free radicals obtained by the degradation of polymers by irradiation with X-rays; with polythene the evidence points to predominantly $-CH_2$ and with 'Teflon' to $-CF_2$ ends to the free radical chains. Another experiment is that of R. R. Livingston *et al.*, who identified hydrogen atoms trapped in phosphoric acid, sulphuric acid and perchloric acid on irradiation with γ-rays at 77° K.

### Geometrical Structure

For compounds of established chemical structures, a chemist is interested to discover the geometrical structure, that is the bond distances and angles, and microwave gas spectroscopy is a powerful tool for this purpose. W. D. Gwinn reported that trimethylene oxide,



$$\begin{array}{l} CH_2-CH_2 \\ | \qquad\;\; | \\ CH_2-O \end{array}$$

has a strictly planar central skeleton. J. Sheridan *et al.*, reporting the dimensions of methyl diacetylene, found the $CH_3$—C bond to be 1·46 A. and the central single bond between the two triple bonds to be 1·37 A., and these figures show a marked shortening with respect to the C—C bond in ethane, which is 1·54 A. Another short C—C bond is that reported by B. Bak *et al.*, who found 1·44 A. for the $C_{(3)}$—$C_{(4)}$ bond in furan. Nuclear resonance can be used for locating hydrogen atoms, and E. R. Andrew and D. Hyndman have used it for showing that in the solid state the hydrogen atoms of urea lie in the $CON_2$ plane. The accuracy of the method is shown by the results of

L. E. Drain, who showed that in ammonium fluoride crystals the N—H distance is 1·04 A. and the H—F distance 1·64 A., which is in complete accord with the X-ray value of 2·67 A. for the N—F distance and shows that the nitrogen, hydrogen and fluorine atoms are collinear. Structural information of another type is shown in the work of B. M. Kozyrev, who showed the electron resonance of $Cr^{+++}$, $Mn^{++}$, $Cu^{++}$, etc., in solution to be very similar to that of the hydrated salts, and so the short-range order in the hydration sheaths must be very similar in the two states.

## Electronic Structure

After the atomic positions have been settled, the chemist's next questions concern the electron distribution, and the new techniques give four new types of experimental evidence with which to supplement the energies, dipole moments and polarizabilities that have hitherto provided the major experimental checks on proposed wave functions. However, the newer quantities all refer to interactions with the nucleus and are most sensitive to the electron distribution near the nucleus, a region for which otherwise satisfactory wave functions have not previously been tested. In particular, a difficulty arises with the overlap integral required in the normalization of a molecular wave function constructed from two atomic functions, since this must be set to zero for satisfactory interpretation of the new data. Consequently, although the experimental quantities are accurately known, the interpretation has not reached a similar precision and is still a matter for individual opinion. The most often measured quantity is the second derivative of the electric potential at the nucleus, $\partial^2 V/\partial z^2$, which is obtained from nuclear quadrupole couplings. Both W. Gordy and B. P. Dailey discussed the interpretation and showed that information could be obtained about the degree to which the valency $p$ atomic orbitals are used in chemical binding and also about the relation of ionicity to electronegativity differences. The zero coupling found for cæsium chloride vapour confirms the wholly ionic nature of the bond, while the large coupling in a chlorine molecule confirms the essentially $3p_z$ character of the atomic orbitals involved in the bond. Many compounds, including methyl chloride, show an intermediate coupling for the chlorine nucleus; but the amount of reduction due to ionic character and the amount due to $sp$ hybridization depend on the choice of assumptions, since it is impossible to obtain two unknowns from one numerical observation.

The second experimental quantity is $\psi(0)$, the value at an atomic nucleus of the wave function of an unpaired electron in a free radical or a metal ion. $\psi(0)$ is only non-zero for an $s$ atomic orbital; but unpaired electrons are normally in $p$, $d$ or $f$ orbitals. Nevertheless, a coupling is found even in these cases, and it must be the consequence of admixture of a few per cent of $s$ character through configuration interaction, a complication which is omitted in many approximate theoretical calculations made for other purposes. Thus it is at present difficult to give a numerical value for the proportion of time an electron spends at each atom. But it is clear, from the results presented by G. E. Pake, that in triphenyl methyl the unpaired electron is principally on the central carbon atom, whereas in the isoelectronic triphenylamine positive ion the greater attraction of the nitrogen for electrons ensures that it is surrounded by electron pairs and the unpaired electron is relegated to the phenyl rings.

If the central atom is a metal ion surrounded by an octahedral complex in a crystal, a more detailed treatment is possible, and this was outlined by J. Owen. He showed how $d$ orbitals of the central atom may accept a pair of electrons from a chlorine ion, water molecule or other group in the complex shell, and how in exchange the unpaired electron from the metal resides partly on the outer group. The new bonds to the metal may be $\sigma$ bonds formed through endwards overlap of the $d$ orbitals, or $\pi$ bonds formed through sideways overlap. An example of the $\sigma$ type is $[Cu(H_2O)_6]^{++}$, where the unpaired electron is present to 2·3 per cent on each water molecule, and an example of the $\pi$ type is $[IrCl_6]^{-}$, where the unpaired electron is 5 per cent on each chlorine ion. For the trans-uranic elements, the susceptibilities and the resonance experiments, described by B. Bleaney, show that the $5f$ rather than the $6d$ shell is used for accommodating unpaired electrons and that one of the $5f$ orbitals is probably involved in bonding to the oxygen in the $UO_2^{++}$, $NpO_2^{++}$ and $PuO_2^{++}$ ions. C. H. Townes discussed the other interactions and showed that nitric oxide is best described as 65 per cent $N{=}O$ and 35 per cent $N^{-}{=}O^{+}$; he further indicated the principle by which magnetic effects could be used for determining absolutely the sign of an electric dipole moment.

## Thermodynamics, Potential Barriers and Equilibria

After a chemist has fully determined the molecular structure of a compound, he may be interested in its thermodynamic properties in bulk, and in this connexion P. T. Ford and R. E. Richards showed the barriers opposing rotation of the $BH_4^-$ ion to be 2·4, 3·8 and 3·9 k.cal./mole in the sodium, potassium and rubidium salts, respectively. Also using nuclear resonance, J. A. S. Smith has been able to relate the intermolecular motions in 'Teflon' to its λ-point transitions. A value of only 6·00 cal. for the six-fold internal rotation barrier in nitromethane, $CH_3NO_2$, was reported by W. D. Gwinn from the microwave spectrum, and this value is reduced to 5·17 cal. in $CD_3NO_2$, where the bending vibrations have a smaller zero-point amplitude. These very low values suggest that the three-fold barrier opposing each oxygen is close in shape to a pure cosine function, so that the barriers for two oxygens cancel almost exactly. This adds confidence to the acceptance of the many barriers previously obtained from specific heats on the assumption of a cosine shape. Barrier information was also obtained from nuclear resonance by R. A. Ogg and J. D. Ray, who found that in the hydrogen bridge compound $Al(BH_4)_3$ each $BH_4$ unit is capable of rotation by means of a tunnel effect at a frequency greater than $10^8$/sec., even though the barrier height is above 14 k.cal.

Equilibria were discussed by T. M. Sugden, who described how the non-resonant microwave absorption by the electrons in flames leads to a study of reactions such as

$$Li + OH \rightleftharpoons LiOH$$

for which the heat of reaction is 102 k.cal./mole, and also to the less-expected reaction

$$CaO + H_2O \rightleftharpoons CaOH^+ + OH^-$$

for which the heat is 96 k.cal./mole. From related experiments, F. M. Page has found the electron affinity of the hydroxyl radicals to be 65 ± 1 k.cal./mole.

## Kinetics

In cases of known equilibria, the chemist is interested in the rates of attainment of such states, and W. A. Anderson and J. T. Arnold were able to show that in extremely pure alcohol the exchange of protons between molecules occurs less than once per second, but that with $10^{-5}$ gm.-ions/l. of $H^+$ present the nuclear resonance lines broadened, indicating the reaction

$$[C_2H_5OH_2]^+ + C_2H_5OH \rightarrow C_2H_5OH + [C_2H_5OH_2]^+$$

to have a mean time between exchanges of about 0·2 sec. There was also mention of an unusual type of oxidation-reduction reaction, namely, the exchange of an electron between naphthalene and its negative ion

$$C_{10}H_8^- + C_{10}H_8 \rightarrow C_{10}H_8 + C_{10}H_8^-,$$

for which S. I. Weissman *et al.* found a second-order rate-constant of $10^{-8}$ l.mole$^{-1}$ sec.$^{-1}$ at 30° C. from electron resonance experiments.

This covers the major divisions of chemistry with the exception of preparative work, and even R. A. Ogg's postulate of $Al_2B_4H_{18}$ formed reversibly on heating $Al(BH_4)_3$ might be classed in this field. For the botanist and biologist, G. E. Pake *et al.* have shown that germinated foxglove seedlings (digitalis) contain free radicals which were absent in the ungerminated material, and that free radicals are also present in metabolically active liver and kidney tissues. D. J. E. Ingram and J. E. Bennett have investigated phthalocyanine and hæmoglobin metal ion resonances and showed these to be sensitive to structure. Finally, as regards this account, there was a description of a molecular oscillator by N. G. Basov and A. M. Prokhorov which should be stable to better than 1 in $10^9$, that is, 30 msec./year. Such an oscillator coupled to a clock mechanism should be a useful tool for astronomers; C. H. Townes reported that initial experiments have approached this figure for the stability.

Thus it can be seen that not only must the Faraday Society be congratulated on a most successful meeting worthy of ranking beside the best of its predecessors, but also that it must be congratulated on a brave and opportune choice of subject.

D. H. WHIFFEN

# SCIENCE AND BRITISH RAILWAYS

THE part that science can play in the improvement of railways is not so much in the production of, say, better locomotives, as in the impartial study of a great variety of problems arising in the railway business as a whole. Some of these problems and the way they are approached were described by T. M. Herbert, director of research, British Railways, in a recent lecture to the Manchester Literary and Philosophical Society (*Manchester Memoirs*, 95, No. 8). Of the two hundred scientific staff who make up the research department of British Railways, not more than a quarter are engaged on definite research projects, the others being concerned with some form of scientific service requiring the employment of staff with a scientific training and outlook.

The true function of a railway is to provide a transport service for passengers and freight, and to move them from point to point as safely, as efficiently and as cheaply as possible. It is only an incidental to providing such service that the railways need conduct a vast engineering business in the manufacture of such things as locomotive and rolling stock. Only about one-third of the annual expenditure is devoted to the engineering side of the business, that is, the construction and maintenance of locomotives and rolling stock, the maintenance of buildings, structures and track, etc.

It has been suggested that research on equipment and materials used by railways could probably and perhaps better be carried out by the industry concerned with the manufacture of such equipment and materials. There is some truth in this belief. A railway is so much concerned with the subsequent performance, reliability and maintenance of its physical equipment, however, that much of its research and study can only be carried out by railway staff on the equipment and material during its actual life.

Another argument for the existence of a scientific service within the railways is that it ensures that the results of scientific development in the universities, other industries and other fields are not ignored.

The varied nature of the activities and problems of the railways provide for a scientific service employing chemists, engineers, metallurgists, physicists, mathematicians, as well as those trained in economics and statistical methods. British Railways are almost unique among railway administrations in having grouped their scientific resources into a single department; it has made possible the formation of a sizable unit in place of a number of small groups which would probably have been less effectively staffed and equipped.

The Research Department of the Railways comprises three main groups, the first consisting of the engineering, metallurgical and physical laboratories which are at Derby, the second consisting of a group known as Chemical Services, and the third a small group known as the Operational Research Division. The first group is almost entirely concerned with research proper, some of it carried out in the laboratory but a good deal of it in the field; the second group provides chemical service from a number of laboratories located throughout the country at important railway centres, with specialized laboratories dealing with protective coatings, corrosion, building materials and textiles. The Operational Research Division is centred in London; but its staff operates wherever required. The annual budget amounts to about a quarter of a million pounds. There is a smaller but similar unit within the London Transport Executive, and the Docks and Inland Waterways Board of Management.

The work of the chemist consists of the examination of materials used by the railways; the laying down of specifications; the examination of new materials offered by industry and services of a more specialized nature like the chemical and bacteriological control of water supplies. There is also a de-infestation service, in respect of premises, vehicles, and stored products such as foodstuffs, tobacco, hides and skins, wool and other fibres. The chemists also perform important and essential advisory work in connexion with the classification of rail traffics for charging purposes, on safeguards in their conveyance and storage, and in the investigation of alleged damage to goods in transit. Other typical examples of chemical investigations are those into the materials used in the making of railway detonators and into the suspected deterioration in old brickwork.

Problems arise in the physical study of the ventilation and heating of passenger vehicles. The fully air-conditioned coach with sealed windows is scarcely justified in our climate, and the tradition of the open window dies hard. Nevertheless, the present type of sliding ventilator seems to be a reasonable compromise, and extensive air-flow explorations and wind-tunnel tests were conducted when it was adopted. The heating problem is closely associated with a proper knowledge of the air-flow within a compartment or coach; but there is an inherent difficulty in heating the end of a long train. The passage of steam through a long, and by no means straight, pipe from the engine to the fifteenth coach involves the study of a rather complicated heat-balance problem.

The Physics Division is concerned with a very diverse series of problems. Some of these have been concerned with the analysis of data obtained in the course of engineering investigations, including locomotive testing and train resistance studies. Others have formed a direct or an alternative attack on problems involving vibration, elasticity and heat transfer. Among the vibration problems was the study of the behaviour of a machine for carrying out fatigue tests on full-size rails, in which the rail carried a number of attached masses on one of which acts a harmonically varying force.

During the past few years, the investigation of the relative merits of the vacuum and air brake for freight trains has occupied much attention from the research engineer. The fitting of continuous brakes would greatly speed up the whole tempo of railways operating, by closing the gap between the speed of passenger and freight trains, thus reducing delay and increasing line capacity. With very long trains, which may be either empty or loaded, there are serious technical problems in ensuring that the brakes are applied to each wagon as simultaneously as possible, and in releasing the brakes quickly after a full brake application.

The largest single group of engineering research studies relate to the track. One large-scale experiment is in hand to try to assess the optimum depth of ballast, and important work is also in hand to determine the lateral resistance of ballast, which becomes of special moment in the case of long-welded rails. The behaviour of concrete sleepers of various designs and methods of attaching the rails to them are also being continually studied at the present time.

There is also the problem of the rails themselves. Rails in Britain fail primarily by fatigue in the top fillets or at the bolt holes at the joints, and laboratory equipment has been developed for fatigue testing complete rails.

The other aspect of the rail problem is more of a metallurgical character. In course of time rails are replaced because the section, and therefore the strength, has been reduced by wear and corrosion. On the running surface of the rail these two influences combine in producing loss of metal from the rail head. In Britain, with its relatively humid climate, corrosion occurs at the initial corrosion-rate between the passage of successive trains, and by improved methods of wear measurement and axle counting much new data are being accumulated on the problem.

The operational research teams have studied such subjects as the logical basis for bonus payment systems, the present-day facilities for conveying passengers' luggage, and the proper quarter on which to place responsibility for the issue of station stores. Other work of great importance has been the study of the use of locomotive coal, both in hauling trains and during standby periods.

# ROYAL TECHNICAL COLLEGE, GLASGOW

## REPORT FOR 1953–54

THE report on research during the session 1953–54 at the Royal Technical College, Glasgow*, gives a brief conspectus of research pursued in the various departments which conduct research programmes. Under each of these departments is given a list of theses submitted for higher degrees and a list of publications in which the titles are amplified by brief abstracts or annotations.

Research in the Department of Mathematics has been concerned with gas dynamics, the applications of blanket transforms in statistics, and the applications of new complex-variable techniques in problems arising in elasticity. In the Department of Natural Philosophy, work has continued in collaboration with the Technical Chemistry Department on the effects of polishing and annealing on the surface structure of finely ground quartz and vitreosil. In geophysics reasons have been sought for the sudden increase in electrical conductivity, to metallic character, within the earth's mantle at a depth of about 700 km. Research continued on the properties of both metallic and non-metallic evaporated films, and an electron-microscopic study was made of the hydrochlorination of natural (*Hevea*) rubber and various synthetic polyisoprene lattices covering a tenfold range of particle size. In the Department of Chemistry research on natural products continued as a major activity in the organic laboratories, while in the physical and inorganic laboratories the study of the photochemical properties of solutions of ferric iron continued and the critical micelle concentrations of some long-chain detergents were being measured by colorimetric and fluorimetric methods.

Research in the Department of Technical Chemistry was concerned with three main fields: the properties and processing, particularly dyeing, of natural and synthetic high polymers; the pyrolysis of organic substances; and the surface chemistry of finely divided solids and of liquid/gas and gas/liquid dispersions. The research programme of the Department of Metallurgy continued to be concerned chiefly with slag/metal relations; but interest in powder metallurgy was extending.

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The Department of Civil and Mechanical Engineering undertook, as in previous years, a wide range of short-term investigations for local industries, while in the Department of Electrical Engineering, besides the main work on high-voltage and heavy-current phenomena, postgraduate work in electronics has developed and a new line of research on non-linear servo-mechanisms was commenced. The Department of Mining Engineering has investigated the resistance to airflow of different roadway linings and tubs at varying spacings, and in the Department of Architecture, Town Planning and Building investigations related to timber structure have been made, in addition to postgraduate studies and planning reports on the history, present condition and development of Campsie, Cumbernauld, Galston, Kilmacolm, Uddingston and St. Andrew's Square, Glasgow. Research activities of the School of Pharmacy and School of Bakery fall into five main groups: pharmaceutical and pharmacological; pharmaceutical chemistry; microbiological; biological; and biochemical.

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* Royal Technical College, Glasgow: Report on Research, Session 1953–54. Pp. 40. (Glasgow Royal Technical College, 1954.)

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# NEW MATERIALS AND PROCEDURES FOR GENETIC STUDIES OF YEASTS*

## By Dr. LYNFERD J. WICKERHAM

Fermentation Section, Northern Utilization Research Branch, Agricultural Research Service, U.S. Department of Agriculture, Peoria, Illinois

UP to the present, the only species of *Saccharomyces* which have been hybridized are a few that are closely related to *S. cerevisiae*, the type species of the genus. *Saccharomyces*, as defined by Lodder and Kreger-van Rij[1], is composed of several groups of species, some being very different from *S. cerevisiae*. One group consists of *S. lactis*, *S. fragilis* and *S. marxianus*, and species which have been described under the names of *Zygosaccharomyces ashbyi* and *Z. dobzhanskii*. I intend to place these species and several others in a new genus called *Dekkeromyces*, named in honour of Dr. N. M. Stelling-Dekker.

The low average germination of ascospores in strains of *Dekkeromyces* precludes the usual micromanipulator procedures; but hybridization by a very simple procedure has been successful. Cells of the two species to be hybridized are mixed on a slant of malt-extract sporulation medium (for composition of media, see ref. 2) and incubated for ten days at 25° C. Cells on the lower part of the ten-day-old agar-slant culture are mixed thereon and streaked on a second slant. A total of four similar serial transfers is sufficient to produce hybrids if the strains are compatible.

Two methods are used for separating the hybrids from the parent cells. The first is based on the fact that, in most species of the anticipated genus *Dekkeromyces*, strains vary widely in the amount of red pigment which they produce on malt extract–yeast extract agar and on morphology medium. When weakly chromogenic strains are mated, strongly pigmented hybrids are produced. The red pigment is related to pulcherrimin[3], and I have found it to have antibiotic activity. The pigmentation of the hybrids permits their ready recognition.

In the second method, species differing in the carbon sources which they assimilate are hybridized. For example, one parent may assimilate maltose, the other lactose, and some of the hybrids will assimilate both. The mixture of hybrids and parents are grown in a series of shaken flasks containing maltose as the only source of carbon (except for a trace in the vitamins of the medium), thus eliminating the parent which cannot assimilate maltose. Then cells from the last maltose flask are transferred serially in lactose medium, which eliminates the parent that does not assimilate lactose, thus yielding a culture of the hybrids.

Species have been hybridized which are very different in their sexual characteristics. For example, *S. lactis*, which is heterothallic and completely haploid, has been hybridized with *Z. ashbyi*, which is homothallic and predominantly diploid, to yield hybrids some of which are exclusively diploid (or possibly triploid). Some of the hybrids are homothallic, some are heterothallic, and others produce only a few, infertile ascospores.

Physiologically, a maltose fermenter (*Z. dobzhanskii*) has been mated with a lactose fermenter (*S. fragilis*) to produce the first ascosporogenous yeasts known to ferment both these sugars. *Saccharomyces fragilis* is unable to attack the alpha-glucosides maltose, melezitose or alpha-methylglucoside; but it ferments lactose. *Zygosaccharomyces dobzhanskii* ferments alpha-glucosides but has no action on lactose. Hybrids produced by these two species ferment the alpha-glucosides less actively than does *Z. dobzhanskii*, and the hybrids produce variants which range downward in activity, with some having no ability to ferment and almost no ability to assimilate alpha-glucosides. Yet all the hybrids and their variants ferment lactose.

Persons interested in studying genetics of these species may obtain appropriate strains from the Northern Utilization Research Branch, Agricultural Research Service, U.S. Department of Agriculture, Peoria, Illinois.

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[*] Substance of a paper presented at the annual meeting of the Mycological Society of America, September 8–9, 1954.

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# LONG-DISTANCE PLANT DISPERSAL IN THE NORTH POLAR REGIONS

## By Dr. NICHOLAS POLUNIN

ONE of the most familiar and provocative phenomena in plant geography is the occurrence of some species at far-flung points between which they are, or at least appear to be, wanting. Sometimes there are no suitable habitats in the intermediate positions, sometimes the habitats are there but the plants are lacking, and all too often careful exploration has shown that the plants in question occur in intermediate situations after all—that the supposed disruption in their range was exaggerated or even non-existent. This is especially the case with diminutive plants and minor taxa that are easily overlooked.

Such range-disruption, whether actual or only supposed, has engendered some of the most active theorizing, and has stimulated much of the most

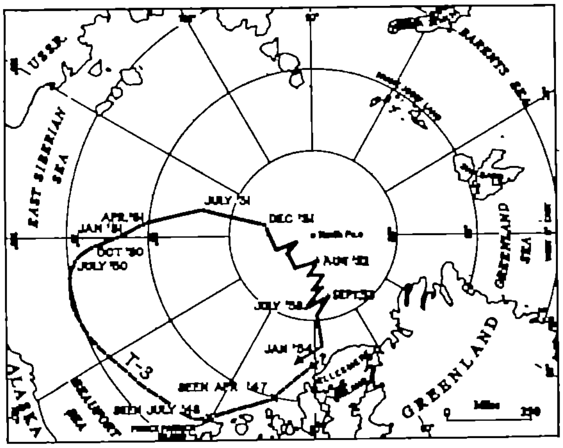

Fig. 1. Drifting of *T*-3 in the North Polar Basin

lively discussion, in all biogeography. It has been brought with particular force into arguments concerning such hypotheses as those of continental drift, perglacial persistence, and land-bridges. Indeed, there can scarcely be a major ocean that has not been hypothetically bridged by some enthusiastic biogeographer on the basis of the present-day disrupted range of the biota inhabiting its peripheral land-masses. To those who favour such hypotheses, long-distance dispersal is, of course, anathema, as it is apt to remove the very bases of their contentions.

Without denying the possible validity at some times and places of one or more of these hypotheses seeking to explain disrupted ranges in terms of 'historical' situations or events, it may be pointed out that our evidence for long-distance dispersal taking place in various regions and circumstances is mounting considerably in diversity and weight. Moreover, it should be remembered that the dispersal at any time of even a single disseminule of a hermaphrodite species to a new spot may, if it is followed by successful germination and ecesis, lead to the full establishment of the species at that new spot, which may in its turn become a centre for further colonization. Such 'saltatory' migrations over great distances of what are naturally pure strains may actually be the origin of the supposedly 'relict' populations 'depleted in biotypes' which advocates of persistence have called 'conservative'.

Whereas there are various ways in which plants are known to be dispersed in the Arctic, the case which has engendered the present communication is of a very special nature. In July 1953, Mr. A. P. Crary, of the Geophysics Research Directorate, Air Force Cambridge Research Center, found on the ice-island *T*-3 an almost flat, mat-like 'tussock' of moss about 24 cm. in diameter which he gave to me. Although dry and upside down when found, "lying near the edge of a melt stream on bare ice" (Crary *in litt.*), the tussock was greenish on its morphologically upper surface. It proved to be made up exclusively of the predominantly arctic species *Hygrohypnum polare* (Lindb.) Broth., being identified by Prof. William C. Steere, of Stanford University. Unlike all the other macroscopic botanical material collected on *T*-3, this specimen turned out to be alive[1]. Thus a portion of it, when moistened and kept under a bell-jar, soon lost its green colour and after ten days still gave no evident sign of life, being soggy and brown; yet after eighteen days the younger shoots were observed to be putting out tender laterals, and after less than four weeks the whole was a vivid green with new growth. It survived in this vegetative condition for several months, until the early summer of 1954, but then became lost in a move of my main laboratory from Harvard to Yale. Later attempts to revive other pieces of the same tussock have so far proved unavailing.

At the time when this moss was found, *T*-3 was floating in lat. 85° 41′ N. and long. 96° 20′ W., far out in the Polar Basin. So this seems to be much the most northerly collection of a living macroscopic plant ever made, being indeed from far north of the northernmost land in the world; and whereas it might be argued that its chances of ever reaching land, if it had been left alone, and of becoming re-established, would have been infinitesimally small, nevertheless they cannot be entirely ignored, having regard to the manner in which ice-islands are now known to float about the Arctic and, at least when smaller, even come so near to land that it is quite conceivable such a light and dry tussock might be blown back to effect migration. Thus, for example, it is computed that *T*-3 must have floated, ignoring minor lateral movements, at least some three thousand miles (4,800 km.) since becoming separated from the remaining shelf-ice of northernmost Ellesmere Island. There it apparently originated, and there the tussock of *Hygrohypnum polare* was presumably blown or washed from the land on to the adjacent shelf-ice before part of this last broke away to form *T*-3. It is even possible that the ice-island, and with it the moss, may have floated twice that distance around the Arctic Ocean since breaking loose—probably in 1936 or one of the ten subsequent years[2].

The possibility has been considered that this moss might have grown on *T*-3, for example from an air-borne spore which alighted on it when it was floating far out in the Arctic Ocean. But although moss spores are well known to be transported in the atmosphere to remote regions, and some protonemal growth has been observed on snow and ice[3], there is no evidence that development can proceed to leafy plants in such circumstances, much less reach the considerable dimensions of this specimen. Moreover, no macroscopic form of life has been found on the mixed morainic or dirt or other deposits on the island, and the crumbs of inorganic material enclosed

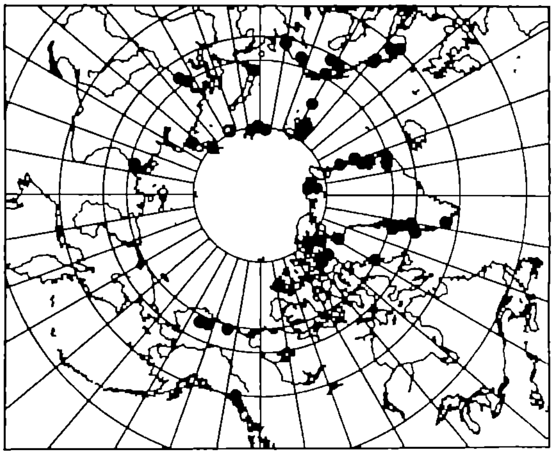

Fig. 2. Known geographical distribution of *Hygrohypnum polare* (Lindb.) Broth.

in the tussock appeared to be of alluvial origin, so there seem to be good reasons for discounting such a suggestion. Finally, Mr. A. P. Crary, who has lived for considerable periods on *T*-3, making all manner of scientific observations, considers it inconceivable that this moss tussock could have grown on *T*-3 or that it could have reached the island after its separation from the land. For, on one hand, on *T*-3 the temperature scarcely rises above 0° C. even in the warmest month and not even *small* growths of mosses are to be found, and, on the other, the jammed-up ice skirting the northernmost coasts commonly prevents a close approach to land and its roughness impedes travel of at all heavy objects by blowing. Nevertheless, other ice-islands—and this could in time apply to *T*-3—have been observed very close to land in the channels of the Canadian Arctic Archipelago[4], making it by no means inconceivable that this tussock of moss might ultimately have reached land and effected migration if it had been left alone and had remained viable.

Fig. 1 shows the presumed (broken line) and known (solid line) route of *T*-3 in the North Polar Basin since observations commenced in 1947, the 'July '53' spot in lat. 85° 41′ N. and long. 96° 20′ W. indicating where the living moss was gathered. Data for this sketch-map were kindly supplied by the Geophysics Research Directorate of the Air Force Cambridge Research Center. The known distribution of *Hygrohypnum polare* is shown in Fig. 2, prepared principally from data supplied by Dr. Steere and Mag. Kjeld Holmen, of Copenhagen, to both of whom warm acknowledgment is due. Whether or not the polar basin 'spot' should be added is a question rather for the philosophers of our subject to decide. At least they would not ignore the statisticians' contention that, even if the likelihood of some member of a population crossing a barrier is virtually nil in any one year, in the course of a million years such an event becomes probable, and in ten million years practically certain.

Work reported in this article has been sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, under Contract *AF* 19(604)–1144, with the author as Project Director.

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# EARTH TILTS IN THE BRITISH ISLES CONNECTED WITH FAR DISTANT EARTHQUAKES

By PROF. R. TOMASCHEK

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THE phenomenon of earthquakes being preceded by characteristic tilting movements of the ground in the same seismic region has been frequently observed[1]. In a recent paper Nishimura[2] has published observations on tilt movements in Japan which can be correlated with very far distant earthquakes. As such movements have also previously been observed in Europe[3] it seemed worth while investigating the possible existence of a world-wide influence of this type. This was readily possible as very sensitive tiltmeters have been in operation[4] in Winsford, Cheshire, since 1950, and records from them could be compared with all the cases given by Nishimura. The comparison shows generally a much steadier behaviour of the Earth's crust in Great Britain than in Japan. This is not merely an apparent effect due to the very stable position of the Winsford tiltmeters at a depth of 143 m. below surface (116 m. below sea-level) so that they are sheltered against the movements of the upper strata the tilts of which are known to be sometimes fairly large. Although many of the Japanese stations are situated at only shallow depths and some of the deeper stations are located in hills, so that they are above sea-level, there are several like Makimina (depth below surface 165 m.; below sea-level 35 m.), Bessi (750 m.; 90 m.), Ikuno (719 m.; 279 m.), Ogoya (300 m.; 90 m.), Hosokura (160 m.; 30 m.), which reach below sea-level. These stations show stronger general drift and tilt movements than are observed at Winsford, indicating that there exists a genuine difference in stability of the ground. It is therefore not surprising to find that most of the tilts connected with distant earthquakes, as observed in Japan at several stations simultaneously, have no characteristic corresponding tilt movements in Winsford, although the epicentric regions may be as different as Tibet, East Indies, Kuriles, Costa Rica. But a definite and extremely strong correspondence occurred on October 22, 1951 (Formosa earthquake).

The upper part of Fig. 1 shows the Winsford record of the north–south pendulum of August 17–19, 1952, containing among others the earthquake in Tibet (91·5° E., 30·5° N.), of magnitude 7 the tilt influence of which in Japan has been discussed by Nishimura. This record indicates that no special tilting was caused at Winsford, and it is an example of the normal behaviour of the tiltmeters showing only the tidal movements. The lower part of Fig. 1 shows the behaviour between $11^h$, October 21, 1951, and $9^h$, October 24, 1951. A heavy earthquake of magnitude 7 occurred in Formosa (122° E., 24° N.) at about $21^h34$ G.M.T. on October 21, 1951. In Japan (distance from the epicentre about 1,800 km.) special ground tilts of about 0·1 second of arc preceded the earthquake for about 20 hr. These tilts are not shown in the Winsford graphs, which are practically smooth (except for the tidal tilts) up to the first arrival of the earthquake movement. But a definite tilt is started by this earthquake, and this fairly steady tilt amounts to about 0·04 second of arc and lasts about 5 hr. after the first arrival of the earthquake. In Japan at the same time at Ikuno, Makinine, Ogoya and Kamigamo a heavy sudden tilt was observed which must have amounted to the order of seconds of arc. This is quite unusual even in the Japanese records and is not shown in any others published. In Winsford a slow, steady but very small tilt continues (partly due to tidal movements) up to about $20^h$, October 22. It is interrupted

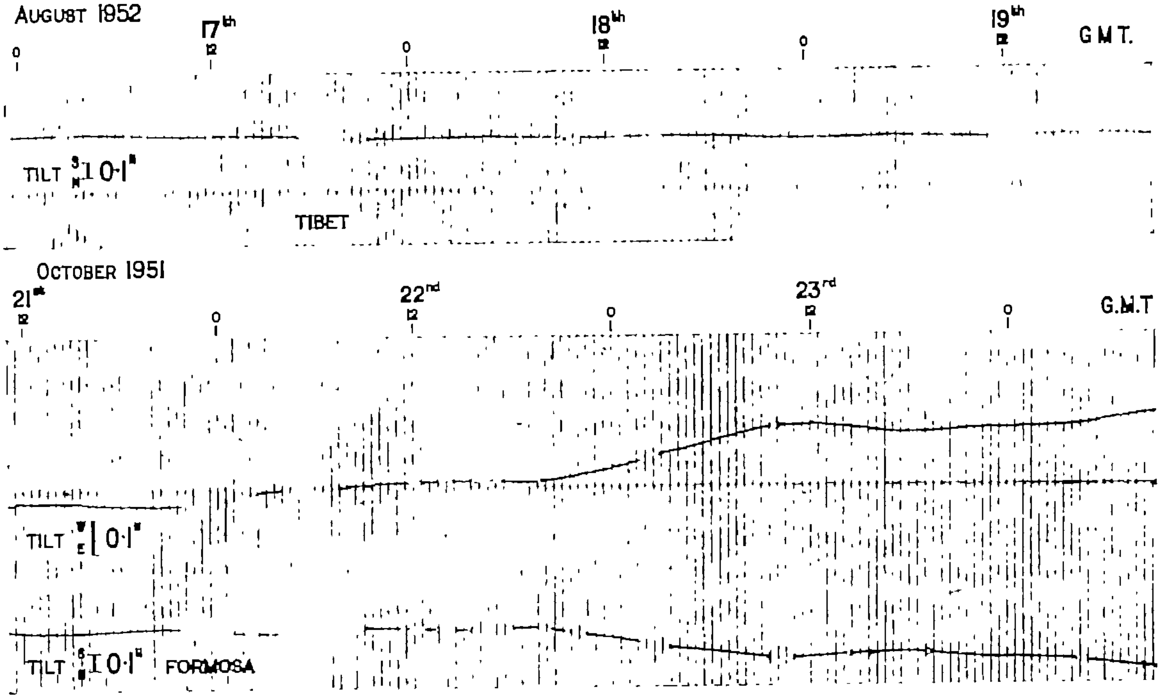

Fig. 1. Tilt records at Winsford, Cheshire

by several earthquakes which have no influence on this movement. Then, with an earthquake at about 20h, October 22, a strong tilt movement starts which lasts until about 9h30, October 23 (13½ hr.), and with an earthquake at this time the tilt movements slow down, but retain a certain drift for the next twenty-four hours. The total tilt within 36 hr. amounts to about 0·2 second of arc. In the Japanese records at Ikuno a progressive tilt very similar to the first short stronger tilt at Winsford can also be observed in one component. The tilt records taken by Dr. Doodson and the late R. H. Corkan at the Tidal Institute at Bidston also show the disturbance very clearly. (I should like to thank Dr. Doodson for showing me the Bidston records.) One has the impression that, initiated by the Formosa earthquake, a large world-wide readjustment of the Earth's crust must have taken place which was fairly rapid and strong in Japan and slower and later in Europe, and lasted here nearly 38 hr., showing even later after-effects.

That strong stresses accumulate in the Earth's crust at this time of the year has also been shown by previous experience[5]. The Winsford records show, furthermore, that a spectacular readjustment took place on October 24, 1950. The title of a lecture by Prof. Benioff[6]: "Evidence for World Strain Re-adjustment following the Kamtshatka Earthquake of November 4, 1952", seems to indicate the observation of a similar readjustment at very nearly the same date in autumn 1952.

These readjustments seem not to be connected with a considerable change in the distance of the masses from the centre of the Earth. No significant change in the rotational speed of the Earth (±0·1 thousandth of a second) was connected with the adjustment described in the present note (I thank Sir Harold Spencer Jones for this information).

However, the seasonal recurrence of these readjustments, which indicate the periodic accumulation of stresses in the mantle, shows that a certain connexion with the change of rotational speed of the Earth may exist in the following way. The annual change of rotational speed is due to meteorological factors on the Earth's surface, where the dislocation of masses (air, water, precipitation) takes place. The braking or accelerating effect of the change of moment of inertia has to be transferred to the deeper layers of the Earth. The transition of the Northern hemisphere from summer to winter condition puts, therefore, a heavy stress on these transferring layers. Its release might be observed in the readjustment mentioned above.

Another additive factor can be found in the direct action of the seasonal change of the temperature distribution over the northern hemisphere. It is surprising how deep into the earth these temperature influences penetrate in the form of stresses and strains, as shown by the solar semidiurnal and diurnal variations observed in the course of gravity and tilt measurements in deep mines, where temperature itself is constant in certain cases within a few thousandths of a degree. The change of temperature on a global scale[7] may add up to considerable strains in tectonically coherent areas. [Feb. 23

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Mechanical Properties of Degraded Gelatins

FRACTIONATION[1] of commercial gelatins has shown that the rigidity of gelatin gels is not solely dependent on the distribution of molecular weights but also depends on another factor—the 'rigidity factor'. Scatchard's results[2] show that the mean molecular weight of gelatin, and also its viscosity in aqueous solution, are decreased by thermal degradation. Ferry[3] measured the reduction in the rigidity of gels of these degraded gelatins, and related the changes to the molecular weights. The present investigation shows that while in certain conditions (for example, low *p*H) Ferry's assumption is correct, in other conditions (for example, neutral or high *p*H) the 'rigidity factor' is also reduced as degradation proceeds.

A lime-processed hide gelatin, isoionic point *p*H 5·05 (commercially characterized by its viscosity of 8·7 cp. in aqueous solution at 5·8 per cent w/w gelatin concentration and Bloom jelly strength, 225 *g*), was degraded in 5·8 per cent w/w solution at various temperatures and *p*H's for selected times. The viscosity of the 5·8 per cent solutions at *p*H 6·5 were measured at 40° C. and the rigidities[4] of the corresponding gels were measured at 0° C., after maturing for 18 hr. at 0° C. The results are illustrated in Fig. 1, where each curve represents constant degradation conditions (*p*H, temperature, etc.) and each point represents a given stage in the degradation.

The results may be summarized as follows. (1) At 90° C. and *p*H 5·5, both viscosity and rigidity decreased as the degradation proceeded, the rigidity tending rapidly to zero at the stage when the average molecular weight of the gelatin became too small to permit gel formation, corresponding approximately to a viscosity of 3 cp.; (2) at 60° C. and *p*H 11·2, the rigidity decreased more for a given fall in viscosity than in (1); (3) at 60° C. and *p*H 1·7, the rigidity actually increased slightly as the viscosity decreased, and then fell rapidly as the viscosity approached 3 cp.; (4) at 10° C. and *p*H > 13 in the gel form, the rigidity remained almost constant during the initial stages of degradation and then fell to zero.

These results suggest that for experiments (3) and (4) the 'rigidity factor' is unchanged. Only when a sufficient proportion of very short chains has been formed does the rigidity show a marked decrease. In contrast, the decreased rigidities for the degraded gelatins obtained in (1) and (2) may be explained by a reduction in 'rigidity factor' together with the effect of production of short chains especially in the latter stages.

Table 1

| Gelatin | Conditions of degradation<br>Temp. (° C.) | <br>*p*H | <br>Duration (hr.) | Rigidity* (in $10^4$ dynes/cm.$^2$) | 'Rigidity factor' (% of initial value) | Average logarithmic viscosity number (% of initial value) |
|---|---|---|---|---|---|---|
| *A* | Undegraded | | | 112 | 100 | 100 |
| *B* | 60 | 1·7 | 3 | 106 | 110 | 45 |
| *C* | 60 | 11·2 | 3 | 50·5 | 60 | 50 |
| *D* | 90 | 6·5 | 7·5 | 68·5 | 70 | 65 |
| *E* | 90 | 6·5 | 19 | 36 | 50 | 40 |
| *F* | 10 | >13 | 24 | 49·5 | 90 | 40 |

* 5·8 per cent gelatin concentration. Measured at 0° C. after maturing for 18 hr. at 0° C.

In order to investigate any change in the 'rigidity factor' during degradation, a number of degraded gelatins (Table 1) were fractionated by the alcohol[5] co-acervation method. The logarithmic viscosity numbers ($\frac{1}{c} \ln \frac{\eta}{\eta_0}$ at $c = 0\cdot002$ gm./ml.) of the fractions were measured[6] in molar NaCl at 40° C. and *p*H 6·5, and the rigidities of the 5·8 per cent gels of the fractions were measured at 0° C. In this way, certain fractions free of low-molecular weight non-gelling gelatin were obtained, which would show the effect of a change in 'rigidity factor' free from molecular weight complications.

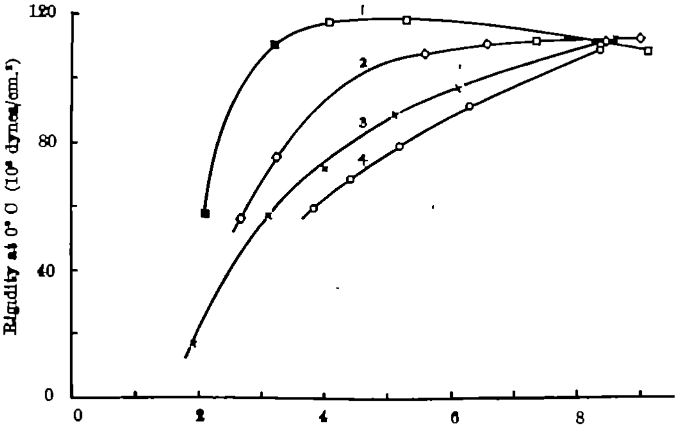

Fig. 1. Thermal degradation of a high-viscosity alkali-processed gelatin: (1) ⊡—⊡—, 60° C., *p*H 1·7; (2) ◈—◈—, 10° C., *p*H > 13; (3) ×—×—, 90° C., *p*H 5·5; (4) ○—○—, 60° C., *p*H 11·2

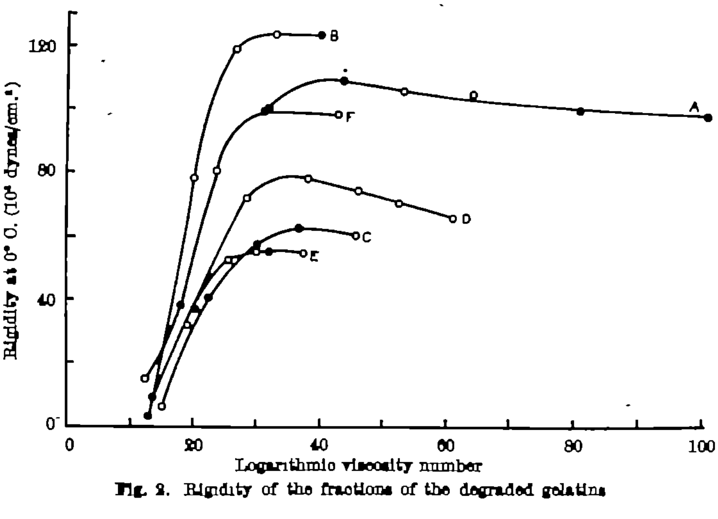

Fig. 2. Rigidity of the fractions of the degraded gelatins

The properties of the fractions of the degraded gelatins and of the original gelatin are shown in Fig. 2. The 'rigidity factors' of the degraded gelatins have been evaluated as a percentage of the undegraded values, by comparing the maximum values of rigidity on the rigidity – logarithmic viscosity number curves for the fractions.

Fig. 2 and Table 1 show clearly that, in neutral or alkaline conditions, not only is the average molecular weight of the gelatin reduced but also the 'rigidity factor' is seriously affected. In acid solutions, in contrast, there is even an apparent increase in 'rigidity factor'. This increase is not considered to be genuine, but to be related to limitations in the fractionation technique. Corrections for fraction homogeneity and degradation during fractionation reduce the discrepancy between the rigidities of the fractions of acid-degraded and undegraded gelatins of equal logarithmic viscosity numbers to zero within experimental error. A full account of this work will be published elsewhere.

P. R. Saunders
A. G. Ward

British Gelatine and Glue Research Association,
2*a* Dalmeny Avenue,
London, N.7.
Feb. 25.

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## Ultra High-speed Skew-ray Tracing

Several electronic digital computors in Britain and the United States are now being used for tracing skew-rays through optical systems. The speed of calculation varies from machine to machine; but in general the fastest time is probably slightly less than ½ sec. per ray surface, while the slower machines require 1–2 sec. per ray surface.

Some work has been carried out recently using the new experimental Manchester *MK* II Machine (*MEG*) in this connexion. This machine has been programmed to trace single skew-rays through systems at a speed of 0·1 sec. per ray surface. The machine has been described in detail in two publications[1]. As the name implies, the machine has a pulse repetition-frequency of one megacycle, a speed faster by ten times than the Manchester *MK* I, which has already been used for optical work[2,3].

There is at present no magnetic storage for this machine, although provision has been made for this facility. The electronic storage consists of ten cathode-ray tubes operating in the parallel mode. Each tube stores 1,024 binary digits, so that the present full storage capacity is 1,024 ten-digit words. An important feature of this machine is that no attention need be paid to number-ranges, the arithmetical units having been arranged to perform floating-point arithmetic. In optical work this is a valuable feature, for systems of any focal length can be calculated as they stand, a facility which obviates the necessity, using fixed-point machines, for scaling systems up or down to a constant focal length.

All working routines must be stored in the electronic store, although it is possible to use punched tape as an auxiliary store, provided that the original input instructions are not written over. In this case, fresh orders can be read in from tape and the calculation can continue.

The placing of routines 'nose to tail' throughout the electronic store with the necessary alterations due to changes in position is carried out by an input routine due to R. A. Brooker. The method of skew-ray tracing described by me[3] has been strictly adhered to, and provision has been made for the extraction and summation of optical path differences, as it is proposed to use this programme for the evaluation of complete wave-front data.

At a ray-trace speed of 0·1 sec. per surface, it is possible to obtain a very full account of emergent wave-fronts at the exit pupils of systems in a quite reasonable time; and the examination of regions of stationary phase can be conducted in a time comparable with that required for the calculation of a few rays using conventional desk machines.

This work forms part of the programme of the British Scientific Instrument Research Association, carried out under contract to the Ministry of Supply.

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## Determination of Elastic Constants of Solids by Ultrasonic Diffraction Methods

Elastic constants of a number of polycrystalline materials such as aluminium, silver, copper, steel, nickel, glass, zinc and brass have been determined using ultrasonic diffraction techniques. The results compare well with the values obtained by other methods.

The experimental arrangement consists of the usual Debye–Sears equipment for observing ultrasonic diffraction patterns. The material in the form of a thin plate, of which the elastic constants are to be determined, is placed in the cell interrupting the ultrasonic radiation from the quartz transducer. Rotation of the plate about the vertical axis causes total internal reflexion, and the transmitted wave disappears, which can be detected by the absence of diffraction pattern.

Since shear waves cannot be transmitted through a liquid, only longitudinal waves incident on the material are considered. When the longitudinal wave is incident in the normal direction, it is transmitted through the plate entirely as a longitudinal wave. As the angle is rotated from 90°, a point comes when there is no transmission of longitudinal waves. This is the first critical angle. As the plate continues to rotate, a second critical angle is obtained at which shear waves in the plate also cease to be transmitted. For points lying beyond this second critical angle there will be no transmission.

Snell's law for angular transmission gives:

$$\frac{\sin\theta}{V_L} = \frac{\sin\theta_L}{V'_L} = \frac{\sin\theta_S}{V'_S}$$

Table 1

| Material | Thickness (mm.) | $V'_L$ (m./sec.) | $V'_S$ (m./sec.) | $K$ | $\mu$ | $\rho$ | $F$ $\times 10^{11}$ dyne/cm.$^2$ | $E$ $\times 10^{11}$ dyne/cm.$^2$ |
|---|---|---|---|---|---|---|---|---|
| Aluminium | 1·32 | 6,686 | 3,626 | 1·84 | 0·29 | 2·68 | 3·52 | 9·08 |
| Silver | 1·66 | 3,181 | 1,671 | 2·1 | 0·35 | 10·4 | 2·90 | 7·85 |
| Copper | 3·26 | 5,958 | 2,703 | 2·2 | 0·37 | 8·7 | 6·34 | 17·37 |
| Steel | 3·09 | 6,301 | 3,221 | 1·96 | 0·32 | 7·8 | 8·1 | 21·44 |
| Nickel | 0·96 | 4,480 | 2,394 | 1·87 | 0·299 | 8·9 | 5·1 | 13·25 |
| Glass | 2·11 | 5,697 | 3,221 | 1·77 | 0·27 | 2·58 | 2·68 | 6·81 |
| Zinc | 1·51 | 6,686 | 2,441 | 2·73 | 0·42 | 7·1 | 4·23 | 12·01 |
| Brass | 1·67 | 4,480 | 2,540 | 1·76 | 0·26 | 8·4 | 5·41 | 13·67 |

where θ is angle of incidence of longitudinal waves in the liquid, $\theta_L$ is angle of transmission of $L$ waves in solid, $\theta_S$ is angle of transmission of $S$ waves in solid, $V_L$ is velocity of $L$ waves in liquid, $V'_L$ is velocity of $L$ waves in solid, and $V'_S$ is velocity of $S$ waves in solid.

At the two critical angles,

$$V'_L = \frac{V_L}{\sin \theta_I} \quad \text{and} \quad V'_S = \frac{V_L}{\sin \theta_{II}}$$

Also

$$V'_L = \sqrt{\frac{(1-\mu)E}{\rho(1+\mu)(1-2\mu)}}$$

where ρ is the density, μ is Poisson's ratio and $E$ is Young's modulus, and

$$V'_S = \sqrt{\frac{F}{\rho}} = \sqrt{\frac{2(1+\mu)(1-\mu)}{(1+\mu)(1-2\mu)}}$$

where $F$ is the shear modulus.

$$\text{Hence,} \quad K = \frac{V'_L}{V'_S} = \sqrt{\frac{2(1+\mu)(1-\mu)}{(1+\mu)(1-2\mu)}}$$

$$\text{or} \quad K^2 = \frac{2(1-\mu)}{1-2\mu}$$

$$\text{Hence,} \quad \mu = \frac{K^2-2}{2(K^2-1)}$$

$$\text{Also,} \quad F = V'^2_S\rho \text{ and } E = 2(1+\mu)F.$$

The results are given in Table 1.

I thank Dr. K. Bannerji for his valuable suggestions and advice during this work.

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## High-Pressure Glow-to-Arc Transitions with Tungsten and Copper Cathodes

FURTHER experiments on high-pressure glow-to-arc transitions using the technique described in a previous communication[1] indicate that, with both tungsten and copper cathodes, transitions may be initiated by either low ionization cathode impurities or surface irregularities. It has been found that a stable glow discharge may be operated in oxygen and on either thin or thick oxide layers provided the layers are smooth; but with the same experimental conditions the presence of an irregular oxide layer was found to cause transitions. Transitions were similarly obtained with unoxidized irregular surfaces and surfaces contaminated with irregular semi-conductor layers. In all cases the transitions were observed to take place at the points of irregularity. While it is clear, for example, from the work of Llewellyn Jones[2] and his collaborators, that enhanced emission is obtained from oxide surfaces, our work indicates that a more important factor affecting glow-to-arc transitions appears to be the presence of surface irregularities. An examination of the work of the many previous investigators who conclude that oxides or oxygen produce transitions shows that the transitions which they obtained may well have been produced by the presence of oxide irregularities rather than by the oxide itself. It may be concluded that such irregularities lead to an enhanced field and the consequent rapid formation of a field-emission arc.

It is of interest to consider the formation of arcs from glow discharges when the cathode is free both from surface impurities and irregularities. By careful polishing followed by prolonged cleaning of the cathode in a hydrogen discharge, experiments of this nature are possible. With tungsten electrodes in hydrogen at atmospheric pressure, it was found possible to obtain almost continuous glow-to-arc transitions with a range of electrode diameters from 1/32 in. to 1/8 in. As the diameter is increased, the current at which the transition begins (shown by the rapid fall in the voltage-current characteristic) also increases; but in all cases the overall cathode temperature was found to be ~ 1,800° C. at the commencement of the transition. This clearly indicates, in agreement with previous investigations, that the transition is explicable on the basis of the growth of cathode thermionic emission. A small discontinuity in the falling voltage-current characteristics was found to coincide with the sudden constriction of the discharge plasma into the bright red column normally associated with the hydrogen arc. This column transition is no doubt the cause of one of the transitions reported by Suits[3], although we have found no evidence of the further transitions which he reported.

In the case of a clean smooth copper cathode in hydrogen at atmospheric pressure when commencing with a glow discharge, increase in current caused a continuous concentration of the column until a final and sudden contraction took place, producing the bright red column observed with a tungsten cathode. This form of column has been noted previously by Fan[4] and Bruce[5], and its production may well be explained by the shape of the thermal conductivity curve as proposed by Hocker and Finkelnburg[6] and King[7] for the constriction of the carbon arc in air. Despite the formation of this constricted column, the cathode still possessed the normal negative glow and cathode dark space characteristic of a glow discharge. Attempts to increase the current further produced in some experiments a completely molten cathode surface with the production of cathode vapour bursts. Although the cathode surface was molten, the cathodic part of the discharge remained in the glow form. It appears, therefore, in contradiction to the work of Plesse[8] and others, that the presence of metal vapour at the cathode does not necessarily result in the formation of an arc. Further experiments at higher currents with the cathodes cooled to prevent melting produced uncontrolled discontinuous transitions. It may be that in these cases local melting and solidification take place with subsequent transitions at the points of irregularity thus produced. Should it be possible to avoid the formation of such irregularities, it is considered that an arc may well be finally formed on copper and mercury cathodes when the cathode current density is such as to produce field emission as calculated, for example, by Mackeown[9].

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## Secondary Expansion of Perlite Concrete and Plaster

EXPANDED perlite, which is made by rapidly heating small particles of suitable volcanic glass, has recently been used extensively as a lightweight aggregate for gypsum plaster and concrete in the United States, and to a lesser extent in Australia and Europe. The phenomena described below are therefore of some concern to the building industry in those countries.

Unrestrained specimens of perlite plaster show at first a setting expansion followed by a short-term shrinkage, as does normal plaster. At an age of about three weeks, however, a relatively slow secondary expansion at a rate of about 0·1 per cent length increase per annum commences, and under normal atmospheric conditions this expansion continues at a slightly decreasing rate over a long period. The oldest specimens under test in this Division are still expanding at about half the initial rate after 600 days. Perlite concrete shows a similar, though much slower, expansion following an initial shrinkage period of some months[1].

Work which I have done indicates that a slow ion-exchange reaction is the cause of the secondary expansion. Expanded perlite is a glass which contains some exchangeable alkali and alkaline earth ions. In the presence of water, the main process which occurs is that hydrogen ions from the solution are exchanged with sodium ions, and to a lesser extent potassium and calcium ions from the glass. The rate of exchange for a given perlite depends, among other factors, upon the temperature and *p*H of the solution, being greatest at high temperature and low *p*H. Such exchanges taking place in perlite plaster and concrete lead to the formation in the matrix of alkaline hydroxides which may then react with carbon dioxide and moisture from the air, causing the matrix to expand. The quantity which may be exchanged is about 8 m.equiv. per 100 gm. after 60 days and is sufficient to account for the observed expansion. There is evidence that a further cause of the expansion in perlite plaster is the exchange of calcium ions in the plaster for sodium ions from the glass; the hydrated sodium sulphate which would form in the matrix has a greater volume than the gypsum it replaces. The rates of expansion of perlite plaster and concrete increase with increasing temperature, humidity and proportion of perlite in the mix, and vary considerably for different perlites.

Although some degree of control of expansion may be achieved in the laboratory, it appears that control in job conditions is impracticable. However, preliminary tests on restrained specimens of perlite plaster have shown that all but a small part of the stress caused by expansion is relieved by internal creep. The secondary expansion is therefore not likely to cause failure of perlite plaster provided the rate of expansion of unrestrained specimens at 70° F. and 60 per cent relative humidity is less than 0·1 per cent per annum, and provided suitable construction methods are used. Similar considerations apply to the use of perlite concrete, in which the expansion is usually more than offset by the high initial shrinkage.

A more detailed account of this work is to be published at a later date.

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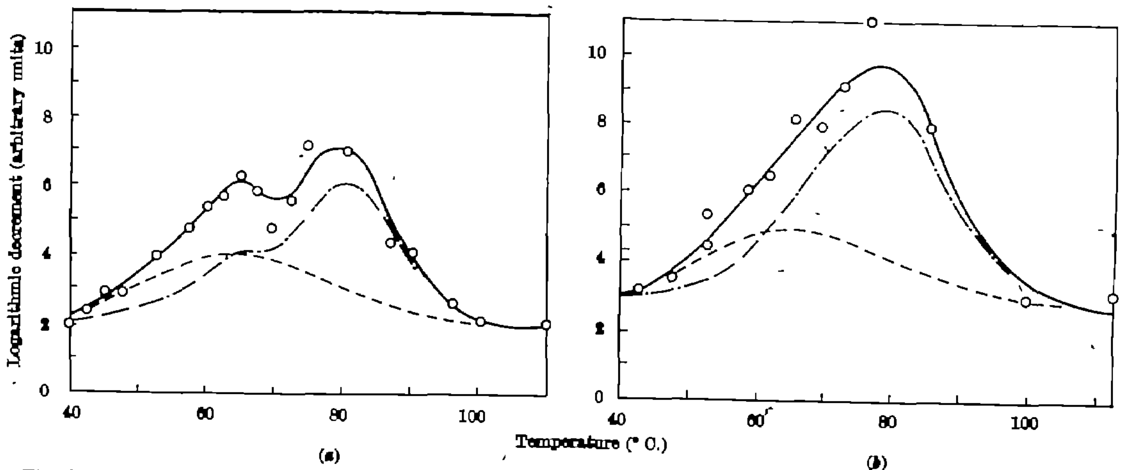
## Condition of Boron in Alpha Iron

THE question as to whether boron forms an interstitial or a substitutional solid solution in α-iron is of considerable theoretical and practical interest. Recently measurements have been made, by orthodox methods, of the solubility and diffusivity of boron in both α- and γ-iron[1-3]. These gave the maximum solubility of boron in α-iron as about 0·008 weight per cent at 900° C. The data on the diffusion in α-iron[4] were not precise but indicated an activation energy of 62 kcal. per mole and a $D_0$ of $10^{4}$ cm.$^{2}$ sec.$^{-1}$. This suggests that boron behaves substitutionally. Some calculations based on estimates of the atomic radius of boron[5] also suggest that boron may be substitutional in α-iron. However, we felt that this evidence was somewhat speculative and not sufficiently conclusive. Obviously, if boron were interstitial, it should be possible to observe an internal friction peak similar to that caused by carbon and nitrogen in α-iron[5,6]. The purpose of the present communication is to describe some exploratory measurements on internal friction which suggest that boron is in interstitial solution in α-iron.

The internal friction technique has been described in detail elsewhere[7]. Essentially a wire specimen forms the torsional suspension of a freely oscillating system. When the logarithmic decrement is plotted against temperature of measurement, the presence of an interstitial solute gives rise to a peak in the curve. The diffusion coefficient is calculated from the frequency of vibration for the temperature at which the peak occurs. The height of the peak is proportional to the amount of interstitial solute in free solution.



(a) (b)

Fig. 1. (a) Specimen quenched from 700° C. Frequency of vibration 15·5 per sec.; (b) specimen quenched from 900° C. Frequency of vibration 14 per sec. 1 unit of logarithmic decrement is approximately equivalent to 0·001 weight per cent carbon. ———, Experimental curve; – – –, relaxation peak due to 0·002 weight per cent carbon; — . —, difference between observed curve and carbon peak

Internal friction peaks have now been observed in specimens containing boron (Fig. 1). Specimens were produced in the following way. Pure iron wires (0·04 and 0·08 in. diameter) were decarburized and denitrided in flowing wet hydrogen (about seven days at 800° C.). Boron was introduced by annealing the wires, with powdered boron, in an atmosphere of dry hydrogen at 1,000° C. in a closed system. The purest boron that could be obtained contained about 1 per cent carbon. The resulting specimens contained (weight per cent) about 0·05 boron, 0·002 carbon and 0·001 nitrogen (by chemical analysis). Consequently, the only possible controversial point in ascribing the peaks of Fig. 1 to interstitial boron is the fact that carbon was also present in the specimens.

Previous work with wire specimens of similar texture to that used in this investigation gave the proportionality constant between peak height and carbon content in solution. In Fig. 1 one unit of logarithmic decrement is roughly equivalent to 0·001 weight per cent carbon. The curves in Fig. 1 represent specimens quenched from 700° and 900° C. The latter peak height is greater than that for 0·002 weight per cent. It is also at a temperature higher than that corresponding to the peak for carbon, for a frequency of vibration of 14 c./s. Experimental error is greatest at high levels of damping. The curve in Fig. 1b has been drawn purposely below the highest observed point because of this. The resultant component curves are then of the form to be expected from theoretical calculation. The specimen quenched from 700° C. gave two resolved peaks corresponding in height to about 0·002 carbon and 0·004 boron (weight per cent). The lower temperature peak corresponds, for the frequency of vibration, to that for carbon[4]. The higher-temperature peak must thus correspond to interstitial boron. A relaxation peak due to substitutional boron would not be observed for such a low concentration of boron, nor at such a low temperature.

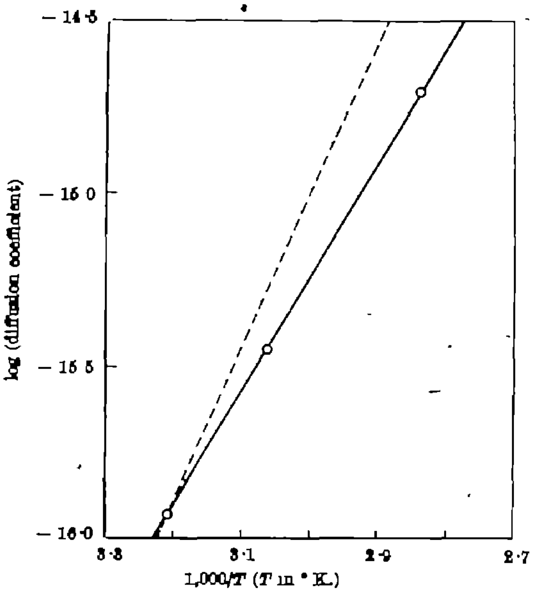


Fig. 2. Variation of diffusion coefficient with temperature. ———, Boron; – – –, carbon

Two further points arise from this present exploratory work. Assuming that the proportionality constant between peak height and boron content is the same as that for carbon, the solubility of boron in α-iron can be determined. This solubility is that in equilibrium with precipitated iron boride, presumably $Fe_2B$. At 900° C. it is 0·005 weight per cent and at 700° C. about 0·004 weight per cent. The assumption is probably untrue; it is more likely that boron strains the iron lattice to a greater extent than does carbon. This would lead to a bigger proportionality constant, and consequently the boron solubility will be less than quoted above.

Secondly, an estimate can be made of the diffusion coefficient, $D$, of boron in α-iron,

$$D = \frac{a^2 \omega}{36}$$

where $a$ is the lattice parameter of α-iron and $\omega$ the angular frequency of vibration.

Measurements carried out at various frequencies are reported in Table 1 and plotted in Fig. 2 in the form $-\log D$ versus $1/T$, where $T$ is the absolute

Table 1

| Frequency of oscillation (sec.$^{-1}$) | Temperature of peak (° C.) | Diffusion coefficient $\times 10^{16}$ cm.$^2$ sec.$^{-1}$ |
|---|---|---|
| 0·8 | 39 | 1·18 |
| 2·5 | 54 | 3·55 |
| 14 | 79 | 20 |

temperature at which the internal friction peak occurs.

The corresponding curve for carbon is also plotted in Fig. 2. In view of the results of Fig. 1, however, the evidence for considering boron to constitute an interstitial solid solution is considered satisfactory. The activation energy for diffusion, estimated from Fig. 2, is 15 kcal. per mole, with a $D_0$ of about $10^{-3}$ cm.$^2$ sec.$^{-1}$. It is not proposed, at this stage, to discuss the differences between the present results and those of previous workers. A more complete report will be given elsewhere.

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## Bed-width and Wave-length in Meandering Valleys

IN a previous communication[1] it was stated that the alluvium of six winding valleys occupies large channels which meander around the valley bends. Subsequent work in other valleys has provided similar evidence[2], and confirms the view that the valleys were eroded by streams larger than those which now flow in them.

When the width of the alluvium-filled channels is plotted against the size of the drainage basins, it is clear that a relationship exists. A connexion is also observed between the size of catchment and the wave-length of valley meanders (Fig. 1). Equations of best fit have been calculated both for width of channel and for wave-length of meander, with the following results:

$$W = 43\,M^{0.43}$$
$$L = 560\,M^{0.43},$$

where $W$ and $L$ are respectively the minimum width of the filled channel and the wave-length of valley meanders, in feet, and $M$ is the size of catchment in square miles. The close interdependence of the three variables is further illustrated in Fig. 2. The coefficient of correlation between $W$ and $M$ is $+0{\cdot}791 \pm 0{\cdot}067$, while that between $L$ and $M$ is $+0{\cdot}856 \pm 0{\cdot}048$.

The closeness of the connexions is all the more impressive in view of the natural irregularities of development both of the channels and of the valley meanders. The channels are laterally enlarged at bends, and for this reason measurements were taken at the points of inflexion where lateral cutting has been at a minimum and the channel width is least. The effects of distortion of meanders during incision, with or without shift downstream, has been partly offset by taking as a value for wave-length the mean wave-length of a series of bends, some upstream and some downstream of the point at which the channel width was measured.

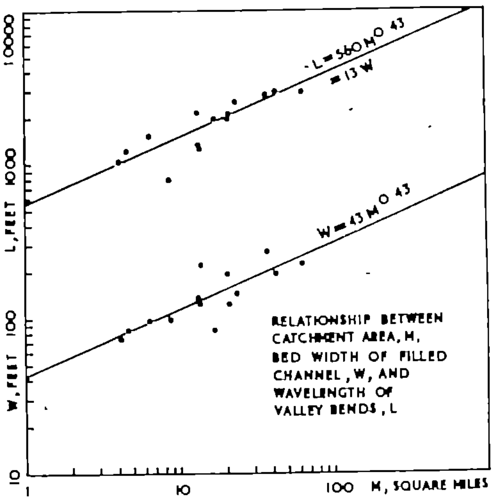

Fig. 1

It is known that the channels of natural meandering streams are shaped at bank-full discharge conditions. It has also been shown that the dimensions of meanders depend mainly on discharge[3], and that discharge is the principal control of bed-width in natural streams[4]. It follows therefore that, when the valley meanders and large channels now under discussion were being cut, bank-full discharge varied proportionally to catchment area. The circumstance is not surprising, since the catchments dealt with are all small (see Table 1). Even to-day, heavy rainfall or the melting of snow is rapidly followed by a swiftly increasing discharge.

The twelve basins represent a considerable range of hydrographic environments and of relations to former glacial and periglacial conditions. Some of them have been reduced in size, either by river capture or by-divide migration, within the Pleistocene. In view of these facts the inferred connexion between size of catchment and amount of former discharge is all the more impressive. It is evident from the contrast in size between the present stream beds and the filled channels, and between the present river meanders and the valley meanders, that all the

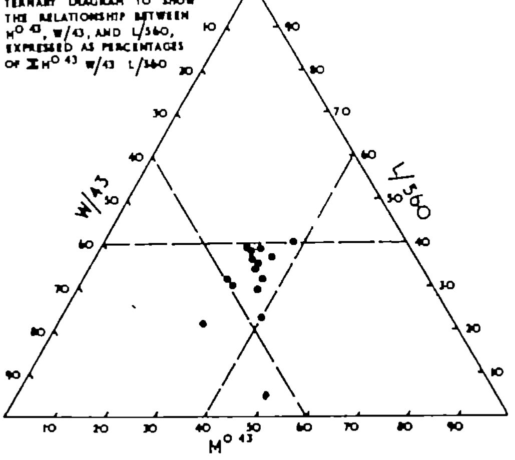

Fig. 2

Table 1. VALLEYS MEASURED

| River | Size of catchment above measured section of channel (sq. miles) |
|---|---|
| *Thames Basin* | |
| Cherwell | 12·3 |
| Coln | 13·2 |
| Dikler | 4·65 |
| Dorn | 13·9 |
| Evenlode | 63·2 |
| Glyme | 16·85 |
| Leach | 21·0 |
| Windrush | 6·4 |
| *Warwickshire Avon Basin* | |
| Itchen (i) | 8·7 |
| Itchen (ii) | 23·3 |
| Itchen (iii) | 42·3 |
| *Herefordshire Wye Basin* | |
| Garren Brook | 4·1 |
| *Sussex Arun Basin* | |
| Dunsfold Brook | 37·0 |
| Kirdford Brook | 20·8 |

streams have suffered a marked reduction of discharge at bank-full stage. The analysis of the results indicates that the reduction has taken place within the limits of the basins as at present defined. River capture is seen to be irrelevant to the question of stream shrinkage. The problem is one of changes in the rate or amount of precipitation, or in both, and possibly also of high surface-discharge from melting snow. This conclusion, already reached on other grounds, is amply supported by the figures analysed here.

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## New Zealand Crustal Structure

A SEISMIC refraction profile 170 km. in length has been recorded in the Wellington Province of the North Island by officers of the Geophysics Division, N.Z. Department of Scientific and Industrial Research. The shot point and all recording stations were sited on basement greywacke. A formal solution of the results shows four layers with thicknesses of 0·6, 1·7, 7·2 and 8·8 km. in which the velocities of longitudinal waves are $3{\cdot}5_0$, $5{\cdot}5_2$, $6{\cdot}0_7$ and $6{\cdot}2_3$ km./sec. respectively. The Mohorovičić discontinuity is at a depth of slightly more than 18 km., and the velocity below it is $8{\cdot}0_3$ km./sec. No reverse shot was possible, and gravity data indicate that the discontinuity may be slightly deeper at the northern end. The true velocities could therefore be a little greater than those given by the formal solution. The Mohorovičić discontinuity and possibly the $6{\cdot}0_7/6{\cdot}2_3$ boundary are confirmed by reflexions.

The 3·5 km./sec. velocity is not considered to indicate a separate layer, but to represent the weathered and shattered upper portion of the greywacke with which the 5·5 km./sec. velocity is associated. There is probably no sharp transition between these 'layers'. The earlier conclusion of Bullen[1] from earthquake studies that the 'granitic' layer is thin or absent in New Zealand is not accepted, since the 6·0 km./sec. velocity is that conventionally assigned to this layer. Bullen's results can be reinterpreted to conform with this view. It is uncertain whether the velocity of 6·2 km./sec. is high enough to allow the associated layer to be identified as 'intermediate'.

A detailed account of the observations and discussion of the results will be published later this year as a Memoir of the Geophysics Division of this Department.

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Feb. 22.

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## The Nocturnal Heat Balance

IT is implicit, in the generally accepted theory of the heat balance on clear nights[1-3] that the cooling of the air near the ground is a direct consequence of heat loss to the surface by convection and conduction; ultimately the latter. However, Ramdas and Atmanathan[4] have shown that, in India, under very stable atmospheric conditions, the lowest air temperature is not reached at the surface but at some height above it. This observation is inconsistent with the classical theory. The phenomenon has been observed by workers in other places, notably Brawand and Kohnke[5] in Indiana, and Jenny[6] in Lausanne; but apparently its theoretical implications have not been appreciated. Ramanathan and Ramdas[7], and more recently Rider and Robinson[8], have suggested that under stable conditions certain air layers near the ground may be in radiative rather than conductive equilibrium with their surroundings, the eddy conductivity approaching the molecular value. Sutton[9] and others have stated that the part of the atmosphere mainly concerned in nocturnal radiation exchange is a relatively thin layer near the ground. Now if this layer is considered to be at the same initial temperature as the surface it must be a net radiative loser of heat, and will therefore tend to cool to a temperature below that of the surface; a process more or less retarded by heat gained by convection and conduction from the ground and from the upper air layers. On the basis of this theory, the temperature reached by the surface continues to play an important part in determining that reached by the air near it, but for reasons quite different from those given in the classical theory.

The present investigation confirms the observation of Ramdas[4]. Fig. 1 shows the temperature profile observed over the centre of a thirteen-acre field of entirely bare soil. The temperature of the 'surface' was obtained by taking the mean reading of two spirit-in-glass minimum thermometers resting upon it. It is inconceivable, especially in view of Robinson's observations[8], that the temperature indicated could have been greater than the effective surface temperature under these conditions. The other temperatures were measured with a single type *U* 2361 thermistor, of diameter about 0·01 in., without aspiration or screening. So small an element indicates closely the behaviour of the air temperature. Moreover, the observed profiles could not be adequately explained in terms of errors due to radiation, evaporation or thermal lag, even if these were appreciable. The shape of the profile was confirmed qualitatively by observations with pairs of fully exposed minimum thermometers. A sensitive wind-direction recorder (vane-centre at 14 in. above the surface) remained

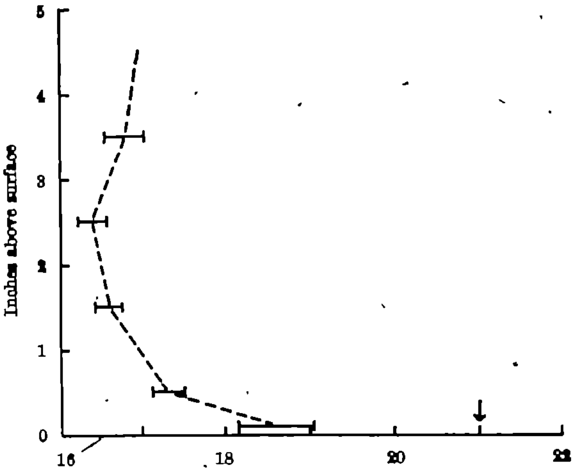

Fig. 1. Mean temperature profile on March 22 for the period 05.42–06.11 G.M.T. (before local sunrise). Sky entirely clear. The mean temperature at 54 in. was 18·4° F. Standard deviations (52 observations) indicated by ⊢⊣. Arrow indicates surface temperature

practically motionless throughout the half-hour period of observation.

From these results, and from similar observations made on the two preceding nights, the following conclusions were drawn: (1) the lowest temperature occurred at about 2·5 in. above the surface; (2) the profile of standard deviation of temperature fluctuations about the mean showed a minimum value at about the same level; (3) the negative difference between the surface temperature and that at any height up to 54 in. increased with time, so long as conditions remained stable.

The curious density distribution indicated by this profile has already been noted by Ramanathan and Ramdas[7], and conclusion (2) above supports their view that at the level of the lowest temperature heat exchange must be at a minimum.

Although on less-stable nights the discontinuity in the temperature profile may well disappear, direct radiation loss from the air will presumably continue to be of considerable importance in determining the temperature distribution. This result may be of both theoretical and practical interest, particularly in relation to the frost problem, and a fuller discussion, together with a description of the experimental methods used, will be published elsewhere.

Thanks are due to the Ministry of Agriculture, Fisheries and Food for the postgraduate scholarship, during the tenure of which this work was carried out.

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## Accuracy and Reproducibility of Paper Protein Electrophoresis

THE analysis of the protein composition of blood serum or plasma by means of zone electrophoresis on filter paper has stimulated interest in clinical laboratories throughout the world. In addition to numerous publications dealing with the applications of the technique in various pathological conditions, critical assessments of its validity and accuracy have appeared[1–4], in which attention is properly directed to the limitations of the method from the point of view of the numerical evaluation of the separated protein fractions. It has seemed desirable to undertake a study of the accuracy and reproducibility of this method of protein analysis, using two of the most commonly employed protein-dyeing techniques.

Protein-free plasma was obtained by heating pooled human plasma in a boiling water-bath for 30 min., and then centrifuging at 3,000 r.p.m. for 2 hr. In this solution, bovine serum albumin (Armour), and bovine globulin (Armour—Fraction V) were dissolved to a concentration of 6 gm. protein per 100 ml. in each case. These stock solutions were diluted with protein-free plasma to give a final concentration of 4 gm. and 2 gm. of albumin and globulin respectively, and then mixed in the proportions shown in Table 1. The mixtures were applied to strips of Whatman No. 1 filter paper in a modification of the method described by Hardwicke[4]. The estimations were carried out in duplicate. 2·5 mm.$^3$ of solution was applied to each of five spots along a line at right-angles to the axis of the paper strips and 6 cm. from one end.

Table 1

| Protein conc. (gm./100 ml.) | Albumin – globulin ratio in mixture | Ratios obtained by electrophoresis | | | |
|---|---|---|---|---|---|
| | | Naphthalene black 12 *B* | | Bromphenol blue | |
| | | Albumin – globulin ratio duplicate | | Albumin – globulin ratio duplicate | |
| 2 | 1 | 1·1 | 1·2 | 1·04 | 0·82 |
| 2 | 3 | 2·3 | 2·2 | 1·1 | 2 |
| 2 | 0·33 | 0·23 | 0·14 | — | — |
| 4 | 1 | 0·94 | 1 | 1·06 | 1·3 |
| 4 | 3 | 2·6 | 2·7 | 2·9 | 3·4 |
| 4 | 0·33 | 0·38 | 0·43 | 0·35 | 0·43 |
| 6 | 1 | 1·15 | 1·25 | 0·96 | 0·79 |
| 6 | 3 | 3·3 | 3 | 1·85 | 1·63 |
| 6 | 0·33 | 0·51 | 0·64 | 0·42 | 0·57 |

Electrophoresis was carried out by the method of Grassmann *et al.*[5] using veronal–acetate buffer *p*H 8·6, $\mu$, $\mu = 0·05$. The serum-bearing end of the paper was placed at the cathode side of the tank and migration was permitted to continue for 16 hr. at 110 volts.

After drying rapidly in a hot-air oven at 125° C., representative strips were dyed, either for 10 min. in saturated naphthalene black 12*B* in methyl alcohol containing 10 per cent glacial acetic acid; or for 30 min. in 0·1 per cent bromphenol blue in absolute alcohol saturated with mercuric chloride. To avoid uneven dyeing due to air bubbles in the paper strips, it was found necessary to do this in an evacuated desiccator. The strips dyed in naphthalene black 12*B* were washed in 90 per cent methanol – 10 per cent glacial acetic acid until elution of dye had almost ceased, and then in 60 per cent methanol – 6·6 per cent water, 1·2 per cent glacial acetic acid and 0·2 per cent normal hydrochloric acid, until elution was complete. Strips dyed in bromphenol blue were

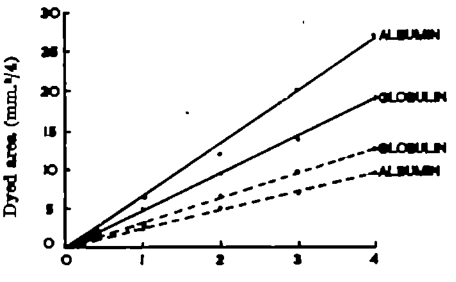

Fig. 1. Relationship between intensity of dyeing and protein concentration. — — — —, bromphenol blue; ———, naphthalene black

washed for 40 min. in four changes of 0·5 per cent acetic acid in water, followed by rinsing in dioxan and ether.

Evaluation of the strips was carried out using the strip densitometer manufactured by Messrs. Bender and Hobein, Munich, the strips being rendered translucent by immersion in a mixture of liquid paraffin and α-bromonaphthalene (6 : 1). Densitometer readings, made at 1-mm. intervals along the strips, were plotted graphically to produce a curve in which each peak corresponded to a protein component. The peaks were drawn as Gaussian curves and the areas beneath the curves measured by planimeter. In order to establish a direct relationship between the areas so measured and the protein concentration on the paper, stepwise increases in concentration of albumin and globulin applied as bands to paper strips were dyed as described, but without preliminary electrophoresis, and evaluated. The results are shown graphically in Fig. 1 and illustrate the rectilinear relationship between dyed area and protein concentration for albumin and globulin for both dye substances used. These findings have been confirmed by D. J. R. Laurence (personal communication). Also shown by Fig. 1 is the difference between the dye-binding capacity of albumin and globulin for both dye substances, together with the considerable reduction in dyeing intensity achieved with bromphenol blue.

The albumin to globulin ratios determined after electrophoresis are shown in Table 1, and from these results the following conclusions may be drawn:

(*a*) Using this particular technique, the concentration of the applied protein solution must be of such an order that the concentration of the minor component, particularly where this is albumin, is adequate to prevent significant loss or reduction by 'tailing', while the concentration of the major component is below that at which understaining or 'packing' is liable to occur[4]. Using bromphenol blue and employing an elution technique, Hardwicke[4] found that the relationship between protein concentration and optical density was lost if the concentration of any one fraction exceeded 1·0 gm. per 100 ml., whereas Martin and Franglen[1], on the basis of a scanning technique and using bromcresol green as dye solution, found that the uptake of dye by unit area of protein varied directly with protein concentration only when that concentration lay between 2 and 3 gm. per 100 ml. In the present experiment a total concentration of 4 gm. per 100 ml. was found to be optimal for accuracy and reproducibility for both the dyes investigated, thus giving a maximum component concentration of 3 gm. per 100 ml. and a minimum component concentration of 1 gm. per 100 ml.

(*b*) When used under the above conditions, and at all concentrations of protein, naphthalene black gives the more correct and reproducible evaluation of protein composition.

(*c*) With either dye, and using the optimum protein concentration, recovery of the protein fractions is only possible to within about ± 5 per cent, and while such a degree of accuracy is not impressive, it is adequate when used as an aid to clinical diagnosis. Such use with pathological sera or plasma will involve an evaluation of the minor globulin components, where concentration must inevitably fall below the optimum necessary for accuracy, and thus small numerical variations must not be regarded as being unduly significant.

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## Mode of Action of *iso*Nicotinic Hydrazide

The high specific activity of *iso*nicotinic hydrazide (isoniazid; I) against *Myco. tuberculosis* suggests interference with an essential metabolite.

It is known[1] that hydrazides form stable complexes with copper. The structures (II*a* and II*b*) have been suggested[2,3] for the copper complex of (I), and the anti-tuberculous activity of isoniazid has been attributed[4], without direct experimental evidence, to the ability of the hydrazide structure (—CO—NH—N=) to form such copper (or iron) complexes. We have now obtained the following evidence relevant to this problem:

(i) Formation of the copper complex of (I) is accompanied by a marked fall in *p*H, due to the reaction of isoniazid in the tautomeric enolic form, via salt formation of the pseudo-acid (III), to give the complex (II*a* or II*b*).

(ii) Schiff's bases of type (IV) have activity equal to that of isoniazid itself[5], and have been found to form copper complexes of type (II) also.

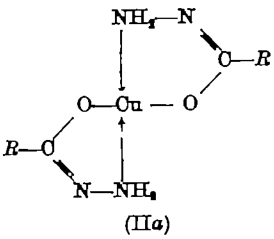
(iii) Alkyl derivatives of isoniazid of type (V) are also able to form copper complexes of type (II), and have been shown[5] to retain, either wholly or partially, the activity of the parent compound.

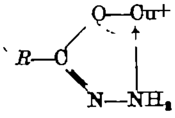
(iv) It is therefore clear that the ability to form chelate complexes of type (II) depends on the asterisked hydrogen atom in (I), and that substitution of this hydrogen, for example by methyl, will produce compounds unable to form such complexes.

We have now prepared three such compounds: 1-*iso*nicotinoyl-1-methylhydrazine (VI) and two Schiff's bases of type (VII). These three compounds give, with cupric ion, neither a colour change nor a precipitate. When tested against *Myco. tuberculosis* H37*Rv. in vitro* by the technique previously described[6], side by side with their analogues of structure (IV) and with isoniazid itself, it was found that whereas (I) and (IV) were highly active (this activity is specific for *Myco. tuberculosis*), the corresponding methyl-

$R—CO—NH^{*}—NH_2$
(I)

$R—C(OH)=N—NH_2$
(III)


(IIa)

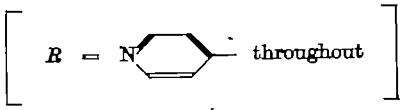

(IIb)

$R—CO—NH—N=CR'R''$
(IV)

$R—CO—NH—NHR'$
(V)

$R—CO—NCH_3—NH_2$
(VI)

$R—CO—NCH_3—N=CR'R''$
(VII)



substituted compounds (VI and VII) were, by comparison, inactive (Table 1).

Experimental evidence is thus presented that the anti-tuberculous action of isoniazid compounds may be correlated with their ability to form chelate complexes of type (II), and that inability to form such complexes results in disappearance of activity. The action of isoniazid therefore appears to include an essential chelation step.

In view of the fact that the anti-tuberculous action of isoniazid is inhibited by pyridoxal, pyridoxine and pyridoxamine[7], and by α-ketoglutarate and pyruvate[7], it is possible that the metabolic block caused by the isoniazid–metal complex involves interference with transamination, a reaction catalysed by pyridoxal in the presence of heavy metal ions. It is worth noting that the postulated complex formed from pyridoxal, amino-acid and cupric ion[8] bears a marked resemblance to the metal–isoniazid complex (IIa).

Further work on this problem is in progress, and full details will be published elsewhere. We wish to thank the National Health and Medical Research Council and the Rockefeller Foundation for partial financial support.

Table 1. TUBERCULOSTATIC ACTIVITY IN SERUM–SYNTHETIC MEDIUM

| Compound | Chelation with copper at pH 7 | Highest dilution completely inhibiting growth of *Myco. tuberculosis* H37*Rv.* after 14 days at 37° C. |
|---|---|---|
| Isoniazid (I) | + | *M*/2,400,000 |
| 1-*iso*Nicotinoyl-1-methylhydrazine (VI) | – | *M*/250 |
| 1-*iso*Nicotinoyl-2-(*p*-nitrobenzylidene)hydrazine (IV; $R'$ = H; $R''$ = $4\text{-}NO_2C_6H_4\text{-}$) | + | *M*/1,200,000 |
| 1-*iso*Nicotinoyl-1-methyl-2-(*p*-nitrobenzylidene)hydrazine (VII; $R'$ = H; $R''$ = $4\text{-}NO_2C_6H_4\text{-}$) | – | < *M*/32,000* |
| 1-*iso*Nicotinoyl-2-(3′ : 4′-dimethoxybenzylidene)hydrazine (IV; $R'$ = H; $R''$ = $3:4(CH_3O)_2C_6H_3\text{-}$) | + | *M*/4,800,000 |
| 1-*iso*Nicotinoyl-1-methyl-2-(3′ : 4′-dimethoxybenzylidene)hydrazine (VII; $R'$ = H; $R''$ = $3:4(CH_3O)_2C_6H_3\text{-}$) | – | *M*/2,000 |

* Strongest solution obtainable

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## Liberation of Amino-Acids by Oat Seedlings

IN a recent communication[1], the excretion of amino-acids by roots in relation to desiccation was discussed, and an indication given that plants grown under sterile conditions excreted ninhydrin-positive substances from their roots. In view of the importance of such root exudates in rhizosphere microbiology, the following preliminary report on the excretion of amino-acids by oat seedlings grown under sterile conditions may be of interest.

The method of obtaining material exuded by oat seedlings was by means of a perfusing system (a modification of the Lees–Quastel perfusion apparatus[2] was utilized). Surface-sterilized oat grains were placed on the surface of a column of sterile sand which could be irrigated with a sterile inorganic mineral nutrient solution (the total volume of perfusate being initially 150 ml.). The perfusion system was a closed one, sterile air being pumped into the system to effect perfusion of the sand column. Regular tests on the perfusate were made to check the sterility of this liquid. Sterility tests were effected by drawing off 1-ml. samples of the perfusate at four-day intervals, incorporating such samples with cooled molten Czapek–Dox agar (at pH 7), which was then dispensed into Petri dishes. The plates, thus prepared, were incubated and observed daily for the development of micro-organisms, the development of which would indicate a loss of sterility by the perfusing system.

Rapid germination of the oat grain ensured the formation of a dense root mass in the sand column. Perfusion was effected for three half-hour periods daily until the seedlings were twenty-eight days old. The perfusate was then collected and concentrated *in vacuo*, the residue being taken up in 5 ml. alcohol. This resulting solution was utilized (*a*) for colorimetric tests for the presence of amino-acids, and (*b*) for the chromatographic analysis of the amino-acids present.

A positive colorimetric reaction for amino-acids was given, and the chromatographic analysis demonstrated the presence of several amino-acids in the exudate preparation, among which cystine, glycine, alanine and aspartic acid have been identified.

Tests on concentrated perfusates from sterile sand columns in which no oats were grown showed no amino-acids present.

With the results given here, it is not possible to ascertain the relative roles of the grain and the roots in the excretion of amino-acids into the growing-medium; investigations are in progress to attempt to elucidate this. The work is being carried out as part of a study on the metabolism of soil micro-fungi with particular reference to forms inhabiting the rhizosphere and root surface.

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## Action of Ribonuclease on Two Solid Tumours *in vivo*

THE effects of ribonuclease on ascites tumours have been described recently[1]. The present communication gives preliminary results obtained on two solid tumours, namely, the spontaneous mammary tumour in *C3H* or *C*+ mice and the Crocker 180 sarcoma in *C*+ mice.

The enzyme used in these experiments was the commercial product produced by Armour from beef pancreas (the preparations used were sterilized by Seitz filtration). It has been mentioned elsewhere[2] that this enzyme preparation differed in some respects from that described in the literature[3,4] and from other commercial sources. It may suffice to state here that the Armour product as used contained about 25–30 per cent of fully active ribonuclease, the remaining 70–75 per cent being inactive ribonuclease and material of low molecular weight. The results obtained with the ascites tumours gave an indication that the inactive portion of the enzyme preparation could, to some extent, inhibit the action of the active one. It is suggested, therefore, that the results obtained on solid tumours represent thus a minimum effect with the concentrations used.

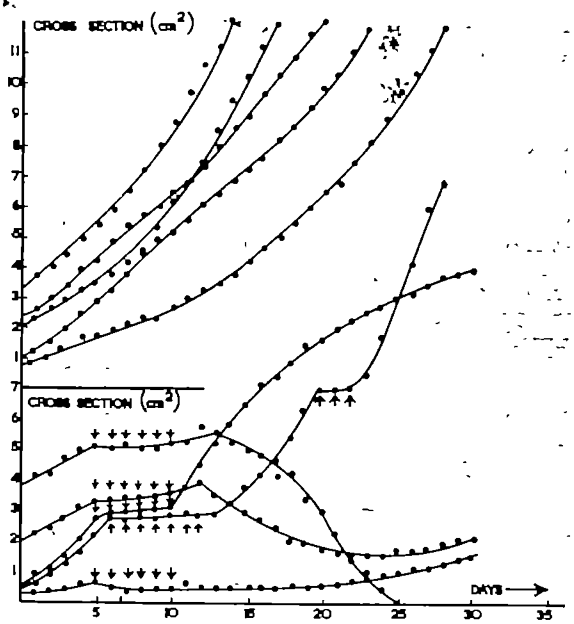

Fig. 2. Sarcoma 180. Treated animals received daily injections of: ↓ 25 mgm. ribonuclease, or † 12 mgm. ribonuclease, dissolved in 0·5 ml. saline. Controls were injected with equal volumes of saline

Fig. 1 shows the growth-curves of untreated and treated spontaneous mammary tumours in *C3H* or *C*+ mice. The size of the tumours was estimated either directly on the animal by measuring two perpendicular diameters and using their product as an expression of the size of their cross-section, or by determining with a planimeter the area of the tumours on photographs taken under standard conditions. This estimation was carried out daily for a period of seven to fifteen days prior to the commencement of the treatment, and this initial curve can serve as an additive control of the effects achieved. Controls were selected from animals showing approximately the same growth-rate as the treated ones, and while the enzyme preparation was administered to the latter by intraperitoneal or subcutaneous injections (*I* and *S* respectively on the graph) the former were given injections of saline solutions. This would exclude the possibility of injection effects in the treated series.

The mammary tumours used are known to regress spontaneously only very rarely[5], and although not always giving the same results in certain cases[6], they are certainly among the most resistant tumours to any drug used. In consequence, the effect of the treatment by ribonuclease as shown in Fig. 1 appears to be really significant: in a number of treated animals, regression occurs, and in

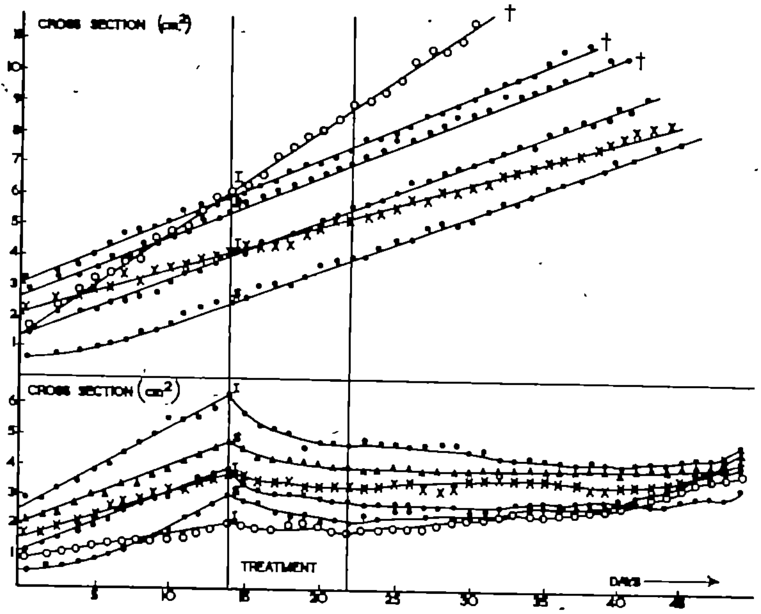

Fig. 1. Spontaneous mammary carcinoma. Treated animals received daily injections of 25 mgm. of ribonuclease dissolved in 0·5 ml. saline. Controls received daily injections of saline (0·5 ml.)

ll of them the growth of the tumour was arrested hile the treatment lasted. The regression in ize of the tumours is a transient one with the doses sed; but it lasts for some time after the treatnent has ceased. It should be emphasized that he doses used are probably not optimal ones. n fact, it was impossible to establish any toxicityevels of ribonuclease at doses up to 200 mgm./nouse. The only side-effect of the enzyme preparaion seems to be loss of hair. The hair starts falling out a few weeks after the beginning of the injections, but grows again when tumour-growth recommences; otherwise, the animals continue to take their food normally.

In Fig. 2, the results obtained on animals with sarcoma 180 (Crocker) are given. In this case, ribonuclease was administered by intraperitoneal injections only. The animals for this experiment were selected from the best of a group with implantations. In each of the animals the growth of the tumour was inhibited during treatment but continued after the cessation of the injections. In some animals a regression was noticed, and in one animal the tumour disappeared. However, none of the control animals showed any regression in tumour growth. In treated animals in which regression was observed, this was usually accompanied by necrosis of the tumour, not observed in the control series.

These preliminary results clearly reveal that ribonuclease can influence the growth of certain solid tumours, and they also indicate that it should be possible to interfere with the nucleic acid metabolism of tumour cells by enzymic means, possibly similar to the action described by Haddow *et al.*[7] for xanthine oxidase from cows' milk, another nucleolytic enzyme.

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## Variations in the Direction of Venous Blood-flow in the Mammary Region of the Sheep and Goat

IT is commonly held that the udder of the cow, sheep and goat is drained by three main veins on each side[1]. These are: (*a*) the external pudic, running with the main artery through the inguinal canal; (*b*) the perineal, running up behind the udder to the perineum; (*c*) the caudal superficial epigastric (subcutaneous abdominal or 'milk vein'), running forward along the abdomen (Fig. 1). We have made observations which are at variance with this generally accepted scheme.

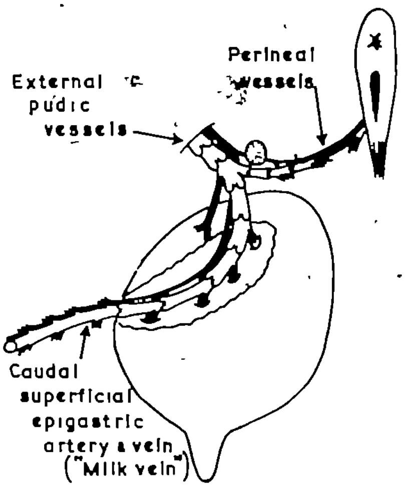

Fig. 1. Main vessels of the udder of the sheep and goat, indicating the position of the venous valves (left lateral aspect). Arteries black; veins white

At the end of an experiment involving the measurement of blood-flow through the udder of a lactating sheep, it was of great interest to find that the intramammary portion of the 'milk vein' contained valves directed caudally, although, during the experiment, blood had been flowing freely in a cranial direction through the same vein. In view of the fact that the 'milk vein', cranial to the udder, is always used as the source of mammary venous blood in milk secretion studies, we have examined a number of animals for the presence of valves and determined the direction of flow in anæsthetized and conscious animals by visual inspection, after intravenous injections of coloured solutions (milk or Evans blue) or by fluoroscopic examination after injections of iodoxyl.

In all animals examined anatomically (ten goats and ten sheep), nulliparous and multiparous, valves have been found in all three main veins in approximately the positions indicated in Fig. 1. In virgin animals all the valves were quite competent; but in pregnant or lactating animals, the valves in the 'milk vein' were often completely incompetent and allowed fluids to pass in either direction or broke down under slight fluid pressure. The angle of junction of the tributaries with the veins agreed with the orientation of the valves as regards the expected direction of flow (Fig. 1).

In some of the animals examined anatomically (five sheep and two goats) the direction of flow in the mammary veins was determined previously under anæsthesia. It was found that in the virgin sheep and goat the flow was towards the external pudic in the direction of the valves in the 'milk vein' and in the perineal vein, in both the supine and prone (standing, supported in a frame) positions. In pregnant and lactating animals the flows were also towards the external pudic in the supine position. In the prone position, however, the main perineal flow remained craniad, towards the udder (except in one animal where it was craniad near the udder and caudad near the perineum); but the flow in the 'milk vein' was reversed and carried blood cranially, away from the udder against the valves. In one lactating sheep (first lamb), in the prone position, the flow in the back half of the intramammary part of the 'milk vein' was caudad (with the valves) and that in the front half craniad. However, in a multiparous pregnant sheep and in a multiparous lactating goat the flow was craniad in the prone position along the entire vein. No blood was leaving via the external pudic vein and the 'milk vein' contained a mixture of perineal and mammary blood.

These findings have been confirmed in four conscious goats in which the 'milk vein' on one side had been exteriorized as a vein loop just in front of the udder. The animals were examined standing quietly in a stand without restraint (generally eating). In the two multiparous animals examined, the 'milk vein' flow was craniad towards the end of one lactation, when completely dry and when pregnant again. However, in two virgin kids, the flow in the umbilical region was craniad, but farther back near the udder it was quite clearly caudad.

The occurrence of valves in the perineal vein of the cow has been previously reported by Becker[2], and Becker and Arnold[3] have also described them in the other veins of the cow (which we confirm), but the actual directions of flow were not determined. However, Gracev[4] described valves in the perineal vein of goats and found the flow to be towards the udder (craniad) in eighteen of twenty-one animals, presumably supine and anæsthetized.

Our preliminary findings would indicate that the direction of flow in the veins draining the area of skin in which the mammary glands develop in the ruminant is determined by the state and history of the animal. In the virgin the inguinal and perineal areas are drained by the caudal superficial epigastric and perineal veins into the external pudic. We suggest that the great increase in mammary blood-flow consequent on pregnancy and lactation is associated with a physiological dilatation of the veins, and consequent valvular incompetence, so that the flow in the 'milk vein' is apparently reversed in the standing position and may carry mammary and perineal venous blood. Whether the flow in the perineal and external pudic veins is ever reversed in any circumstances, and whether these results apply to the dairy and beef cow, remain to be determined.

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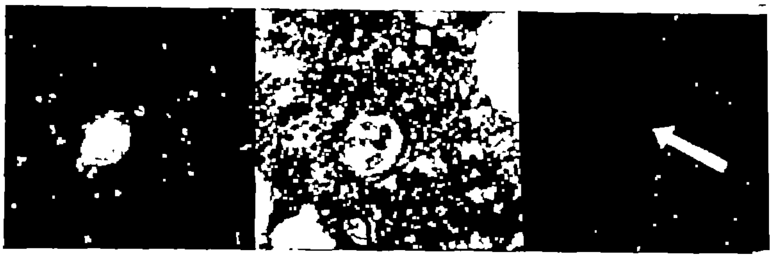
## Origin of Blood Platelets

The conclusion of J. H. Wright[1] that blood platelets are detached portions of the cytoplasm of megakaryocytes has been supported by much circumstantial evidence, and is generally accepted[2], although unequivocal direct evidence is lacking.

In the course of other experiments[3], an antiserum against guinea pig platelets was prepared in rabbits, which was rendered specific for platelets by repeate absorption with other cells and tissues, and whic upon injection into guinea pigs caused complete dir appearance of platelets from the blood withou affecting the numbers of other cells. The globuli fraction of this serum was conjugated with fluorescei isocyanate by the method of Coons and Kaplan[4] absorbed well with liver powder and used for stainin impression smears of guinea pig spleen and bon marrow, which had been fixed by immersion i 95 per cent ethanol at 37° for 15 min. After thoroug washing in saline buffered at pH 7·5, the slide were mounted in glycerol and were examined b ultra-violet illumination at 3650 A. (using a 80-W. 'Osira' lamp and a quartz cone dark-groun illuminator).



(1) Megakaryocyte stained by conjugated anti-platelet globulins (× 180); (2) same field as (1), stained with hæmatoxylin and eosin (× 180); (3) megakaryocyte (arrow) treated with conjugated normal globulins (× 180)

Apart from polymorphonuclear leucocytes, whic had a bluish-grey fluorescence, the only cells in th smears which fluoresced were megakaryocytes, and these had the apple-green colour of the fluorescein-coupled proteins. In smears treated with norma rabbit globulin conjugated with fluorescein, th polymorphonuclear leucocytes appeared the same, but megakaryocytes were unstained (Figs. 1–3).

Megakaryocytes must therefore share with platelets some characteristic unique antigenic structure, and this fact may be regarded as direct evidence o their relationship.

I wish to thank Mr. M. R. Young for carrying out the optical side of this work and for preparing the photographs.

J. H. Humphrey

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London, N.W.7.
March 8.

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[1] Wright, J. H., *J. Morphol.*, 21, 263 (1910).

[2] Tocantins, L. M., *Medicine*, 17, 175 (1938).

[3] Humphrey, J. H., and Jaques, R., *J. Physiol.*, 128, 9 (1955).

[4] Coons, A. H., and Kaplan, M. H., *J. Exp. Med.*, 91, 1 (1950).

## Microfilaræmia in Rock Rabbits

During the course of studies on transmission of Bancroftial filariasis on Ukara Island in Tanganyika, domestic and wild animals were examined for microfilarial infections. Among those infected were rock rabbits, *Heterohyrax syriacus diesneri* Brauer. Of 28 specimens of mixed sexes, 57 per cent were infected. Records of the number of microfilariæ in thin blood films, prepared by a standardized technique, are compared with body-lengths of the individual hyrax in Table 1. The results may be of interest because they show a general positive correla-

Table 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Males | Body length (mm.) | 325 | 328 | 358 | 364 | 374 | 379 | 416 | 418 |
| | No. microfilariae | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | Body length (mm.) | 443 | 458 | 462 | 465 | 468 | 475 | 493 | |
| | No. microfilariae | 129 | 66 | 7 | 7 | 48 | 60 | 98 | |
| Females | Body length (mm.) | 368 | 410 | 425 | 455 | 457 | 458 | 465 | 465 |
| | No. microfilariae | 0 | 0 | 0 | 0 | 3 | 3 | 5 | 1 |
| | Body length (mm.) | 466 | 471 | 473 | 475 | 491 | | | |
| | No. microfilariae | 26 | 88 | 4 | 54 | 0 | | | |

on between size of host and intensity of a micro-arial infection in a species of wild mammal taken rectly from the field.

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Same,
Tanganyika.
Jan. 22.

## Correlation between Cloud Shade and Shedding in Cotton

THE cotton plant is well known to shed some of its ruiting-points following periods of cloudy weather, and *such shade-induced* losses are often in excess f the natural shedding normally associated with healthy cotton plants growing in a cloudless environment. Dunlap[1] was able definitely to show that phases of excess shedding followed two to eight days after a particular cloud event. Confirmation of Dunlap's work was recently published[2], and it was further demonstrated graphically that a series of loud changes was followed by corresponding variations in the number of fruit-points lost daily from plants at Tokar in the Anglo-Egyptian Sudan. For some of the varieties tested, however, prolonged periods of cloudy weather were not associated with ustained heavy shedding.

The varieties examined at Tokar show a lag of two to four days between cloud event and the associated shedding. A direct comparison between cloudiness, as measured on the octant scale, and numbers of fruit-points shed is possible by correlating shedding with cloud events which occurred two to four days earlier. For four of the six varieties in Table 1, it was possible to demonstrate (method *A*) a direct correlation between the fruit-points lost and the highest daily cloud amount as assessed at 0600 and 1200 hr. G.M.T. Varieties *BLR* 14/25 and *X* 1730*A* failed to show a significant correlation when tested by this method; both these varieties were unable to sustain shedding at an increased rate during two or three days of continued cloudy weather. For these varieties an arbitrary method (*B*) was used in which shedding was compared with the first only of a series of cloud changes, in excess of six-eighths amount. By this method *BLR* 14/25 showed a high degree of correlation, whereas *X 1730A* just failed to reach significance level of correlation between shedding and cloud amount at probability $P = 0{\cdot}05$.

Table 1. CORRELATION COEFFICIENTS LINKING SHEDDING OF FRUITING-POINTS WITH MAXIMUM DAILY CLOUD AMOUNTS

| Variety | Method | Period examined | Calculated value of $r$ | $r$ value at $P=0{\cdot}05$ | Shedding advancement |
|---|---|---|---|---|---|
| Coker-Wilds 11 | *A* | Dec. 4–31 | 0·514 | 0·381 | 2 days |
| *BAR* 12/9 | *A* | Dec. 4–31 | 0·446 | 0·349 | 3 ,, |
| *NT* 96/40 | *A* | Dec. 19–30 | 0·735 | 0·576 | 4 ,, |
| Domains-Sakel | *A* | Dec. 14–28 | 0·587 | 0·532 | 3 ,, |
| *BLR* 14/25 | *B* | Dec. 4–Jan. 31 | 0·671 | 0·325 | 3 ,, |
| *X* 1730*A* | *B* | ,, | 0·324 | 0·325 | 2 ,, |

The varieties tested by method *B* might be considered as having become adapted to cloud-shade following the first of a series of cloud events over six-eighths amount. These varieties at Tokar developed slowly, and during December at least carried only a small boll load. The more sensitive varieties listed against method *A*, which were able to respond to most of the cloud events, had developed more rapidly and carried a heavier boll load. It is possible that this inability of some varieties to respond to all cloud events may provide evidence in favour of the usually postulated mechanism of temporary carbohydrate shortage within the plant as being the fundamental cause of shedding during periods of cloudy weather. In this way it is possible that the plants nearest maturity and with the heaviest boll loads were the most likely to be unable to tolerate temporary or continued internal shortages of available photosynthesates.

I am grateful to the Chief of Research Division, Ministry of Agriculture and Forests, for permission to publish this communication.

ALAN GOODMAN

Research Division,
Gezira Research Farm,
Ministry of Agriculture and Forests,
Sudan Government.
Jan. 19.

[1] Dunlap, A. A., *Tex. Agric. Exp. Stat.* Bull. No. 677 (1945).

[2] Goodman, A., *Emp. Cott. Grow. Rev.*, 32, (1), 24 (1955).

## Protoplasts in 'Mature' Wood Elements

IN a recent communication[1], Mia reports the presence of nuclei and cytoplasm in mature vessel elements and fibre tracheids, and states that his findings are contrary to the observations of Esau and of Eames and MacDaniels in their text-books of plant anatomy. Mia's interpretations of the statements are very loose. He quotes Esau[2]: "in the mature state, tracheids and vessel members . . . with lignified walls" are "devoid of protoplasts", and "after the secondary wall is fully formed and lignified, the swollen parts of the primary wall break down and finally the protoplasts break down and disappear". Esau's statements certainly cover the possible existence of a protoplast in a vessel element after the primary wall of the perforation plate breaks down. She does not state that disappearance of pore wall and protoplast coincide.

Mia's sketch of a vessel element is in itself proof that the protoplast is disintegrating: it is a shrunken mass restricted to a small area on one side of the cell. This is the characteristic appearance of the dying protoplast in such cells, as frequently seen in maturing xylem.

Mia does not quote directly from Eames and MacDaniels's text-book[3], but indirectly from Shah[4], with the words "the disappearance of the protoplasts usually synchronizes with the formation of perforation plates". This is not a correct quotation. Eames and MacDaniels state (ref. 3, p. 101) that when the "secondary wall is partly, perhaps even fully formed, the perforation of the end wall and loss of the protoplast begin". They make no statement as to which process is completed first, but state only that "as the cytoplasm gradually goes to pieces, it (the perforation plate) also disintegrates". Probably no critical study of the very last stages of vessel-element maturation has been made; but the protoplast must control the dissolution of the plate and therefore persist at least until the completion of the perforation. Mia has apparently described the last stage in the maturation of the vessel segment. He remarks that "the protoplasts disappear after the deposition of the secondary thickening matter"; Eames and MacDaniels stated this in 1925.

Mia also claims and figures the presence, in one species of *Corchorus*, of abundant fibre tracheids with protoplasts. His figures of these cells do not illustrate fibre tracheids but probably substitute fibres, because the pits shown are simple, as in these fibres, not bordered, as in fibre tracheids. Substitute fibres are characteristic of woody herbs, such as *Corchorus*, and fibre tracheids are usually absent.

Further, Mia finds the protoplast-containing fibre tracheids in only some varieties of jute, and vessel elements with cytoplasm only rarely. It is evident that he is dealing either with immature cells or abnormal tissues.

Shah[4], in also claiming the "rather remarkable" presence of protoplasts in "mature" wood cells of the tendrils of *Vitis*, is likewise apparently misinterpreting maturity of the cells in question. He describes vessel elements and fibre tracheids as mature because their walls are lignified. This is not proof of maturity, for it is well known that lignification of the cell wall characteristically begins long before the cell is mature. The cells figured came from immature tendril tips where there were doubtless only immature cells.

A. J. EAMES
L. H. MACDANIELS

Cornell University,
Ithaca, New York.
March 12.

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[1] Mia, A. J., *Nature*, 175, 177 (1955).

[2] Esau, K., "Plant Anatomy" (New York, 1953).

[3] Eames, A. J., and MacDaniels, L. H., "An Introduction to Plant Anatomy" (2nd edit., New York, 1947).

[4] Shah, J. J. *Curr. Sci.*, 23, 65 (1954).

## Random Association of Points on a Lattice

FOR a lattice of rectangular array of points each of which takes any one of $k$ characters or colours with probabilities $p_1, p_2 \ldots p_k$, Moran[1] and Iyer[2] have considered the distributions for the number of joins between adjacent points of the same or different characters. The distributions for joins between points which are adjacent or not are more complicated and therefore do not seem to have been considered. The present communication gives the first and the second moments and also the nature of the higher cumulants for the distributions of the number of joins between adjacent and alternate points including diagonals of $2 \times 2$, $2 \times 3$, $3 \times 2$ and $3 \times 3$ sub-lattices, no join being counted more than once, for two- and three-dimensional lattices.

(1) *Joins between points of the same charac*

(a) $m \times n$ : *two-dimensional lattice.*

$$\mu_1' = (12b - 15a + 18)p_r^2.$$
$$\mu_2 = (12b - 15a + 18)p_r^2 + 8(69b - 145a + 299)$$
$$- (564b - 1175a + 2410)p_r^4.$$

(b) $l \times m \times n$ : *three-dimensional lattice.*

$$\mu'_1 = (62e - 75d + 90c - 108)p_r^2$$
$$\mu_2 = (62e - 75d + 90c - 108)p_r^2$$
$$+ 4(3813e - 7700d + 15490c - 31088)p_r^3$$
$$- (15314e - 30875d + 62050c - 124460)p_r^4$$

(2) *Total number of joins between points of differ colours.*

(a) $m \times n$ : *two-dimensional lattice.*

$$\mu'_1 = 2(12b - 15a + 18) \Sigma p_r p_s.$$
$$\mu_2 = 2(288b - 595a + 1214) \Sigma p_r p_s$$
$$- 2(1428b - 2960a + 6052) \Sigma p_r p_s p_t$$
$$- 4(564b - 1175a + 2410) \Sigma p_r^2 p_s^2$$
$$+ 8(564b - 1175a + 2410) \Sigma p_r p_s p_t p_u$$

(b) $l \times m \times n$ : *three-dimensional lattice.*

$$\mu'_1 = 2(62e - 75d + 90c - 108) \Sigma p_r p_s$$
$$\mu_2 = 2(7688e - 15475d + 31070c - 62284) \Sigma p_r p_s$$
$$- 2(38378e - 77300d + 155260c - 311312) \Sigma p_r p_t$$
$$- 4(15314e - 30875d + 62050c - 124460) \Sigma p_r^2 p_s$$
$$+ 8(15314e - 30875d + 62050c - 124460) \Sigma p_r p_s p_t$$

In the above expressions, $a = m + n$, $b = m$ $c = l + m + n$, $d = lm + mn + nl$ and $e = lm$ The summations extend to values of $r$, $s$, $t$ and such that $1 \leqslant r < s < t < u \leqslant k$.

The higher cumulants are linear functions of $a$ and or $c$, $d$ and $e$, and therefore as $l$, $m$ and $n$ tend t infinity all these distributions tend to the norm form so long as the $p$'s are finite. If some of the $p$' are very small, the distribution for joins betwee points of the same kind tends to the Poisson form

Similar results have also been obtained for the distributions between points separated by $h$ or les points, $h$ taking values 3, 4 etc. When joins betwee any two points of the lattice are considered, $\mu'_1$ an $\mu_2$ for the total number of joins between points o different colours reduce to the following expressions

$m \times n$ *lattice.*

$$\mu'_1 = b(b - 1) \Sigma p_r p_s$$
$$\mu_2 = b(b - 1) \{ (b - 1) \Sigma p_r p_s - (5b - 6) \Sigma p_r p_s p_t$$
$$- 2(2b - 3) (\Sigma p_r^2 p_s^2 - 2 \Sigma p_r p_s p_t p_u) \}$$

For the three-dimensional lattice also the above ex pressions give $\mu'_1$ and $\mu_2$ provided we replace $b$ by The $r$th cumulant will be of degree $(r + 1)$ in $b$ or Hence the limiting form of this distribution for larg $l$, $m$ and $n$ is normal. It may be further added tha when the points of the lattice take quantitativ values, say, $\theta_1, \theta_2, \ldots \theta_k$ with probabilities $p_1, p_2, \ldots$ $p_k$, respectively, the nature of the distribution obtained by considering the sums of the moduli or squares of the differences between observation situated on a sub-lattice similar to those discussed in this communication have also been worked out. These distributions also tend to the normal form as $l$, $m$ and $n$ tend to infinity.

Full details of these investigations will be published shortly elsewhere.

P. V. KRISHNA IYER

Defence Science Laboratory,
New Delhi.
Jan. 25.

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[1] Moran, P. A., *Nature*, 158, 521 (1946).

[2] Krishna Iyer, P. V., *Nature*, 160, 714 (1947); 162, 333 (1948): *Biometrika*, 36, 135 (1949).

# FORTHCOMING EVENTS

### Monday, July 4

British Society for the History of Science (in the Lecture eatre of the Science Museum, South Kensington, London, S.W.7), 5.30 p.m.—Dr. L. G. A. Sims: "The History of the Determination the Ohm".

### Monday, July 4—Wednesday, July 6

Society for Applied Bacteriology (at Cambridge)—Summer onference and Annual Meeting.

oday, July 4—Tuesday, July 5

Symposium on "Food Microbiology and Public Health".

### Monday, July 4—Saturday, July 9

Museums Association (at the Barber Institute of Fine Arts, The niversity, Birmingham 15)—Annual Conference.

### Tuesday, July 5—Wednesday, July 6

Physical Society (in the Lecture Theatre of the George Holt ysics Laboratory, The University, Liverpool)—Summer Meeting—igh Energy Nuclear Physics".

### Tuesday, July 5—Thursday, July 7

Institute of Physics, Electron Microscopy Group (in the emistry Department, The University, Glasgow)—Annual Conference

### Wednesday, July 6

Royal Meteorological Society (at the College of Aeronautics, anfield, Bedfordshire)—Summer Meeting.

### Saturday, July 9—Wednesday, July 13

European Association for Animal Production (at the Univerty, Reading)—Fifth Study Meeting—"Animal Production from rass".

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or efore the dates mentioned:

Senior Scientific Officer (with a first- or second-class honours egree in metallurgy, or in physics or chemistry, if with metallurgical xperience, and at least two years works or laboratory experience, referably in the non-ferrous industry) at the Royal Mint, for duties which include the supervision of production from the metallurgical oint of view; investigation of problems of material and manuacture; examination and assay of coins suspected to be counterfeit; nd research into the properties of alloys to decide their suitability or coinage—The Secretary, Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S 4479/55 July 7).

Assistant Lecturer in Physics—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (July 9).

Lecturer or Assistant Lecturer in Botany—The Registrar, The University, Hull (July 9).

Lecturer (with a good degree in zoology, and preferably with some esearch, industrial or other relevant experience) in Biology—The Principal, Acton Technical College, High Street, Acton, London, W.3 July 9).

Research Fellow (physicist or engineer with experience of high-vacuum and high-voltage apparatus) in the Nuclear Particle Laboratory, to investigate the production of short duration, high intensity pulses of electrons with energies up to 2 MeV—The Registrar, Queen Mary College, Mile End Road, London, E.1 (July 15).

Chemical Engineer (with a first- or second-class honours degree, plus a professional qualification in chemical engineering, and experience in the chemical industry), to carry out development work to the pilot plant stage, for the Chemical Division of the Rubber Research Institute of Malaya, Kuala Lumpur, and at the R.R.I. Experiment Station, Sungei Buloh—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (July 30).

Reader in the Department of Anthropology, and a Reader in the Department of Psychology—The Registrar, Rajshahi University, Rajshahi, East Pakistan, and the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (July 31).

Research Assistant (with a good honours degree in physics and some research experience, preferably in low temperature physics) to work on the design and operation of a liquid hydrogen bubble chamber —The Head of the Department of Physics, Imperial College, London, S.W.7 (July 31).

Lecturer in Philosophy at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 1).

Lecturer (with industrial and research experience) in Engineering—The Secretary, The University, Edinburgh (August 1).

Senior Lecturer in Botany at the University of Sydney, Australia —The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Sydney, August 1).

Lecturer in Bacteriology at the University College of the West Indies—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (August 2).

Biochemist (with an appropriate science degree or A.R.I.C.)—The Group Secretary, The Royal Infirmary, Bolton.

Chemist or Metallurgist (with an honours degree in chemistry or metallurgy) to carry out research on high temperature slag-metal-gas reactions—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Reactions".

Geologist (with a first- or second-class honours degree of a British university in geology, preferably with subsidiary geography) at the Ministry of Housing and Local Government in London, mainly to prepare memoranda on the distribution throughout the country of minerals of economic importance—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G.206/5A (July 2[illegible]).

Lecturer (Grade B) in General Science in the Department of Hygiene and Public Health—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

Lecturer in Education to specialize in the teaching of psychology —Prof. E. A. Peel, Education Department, The University, Birmingham 15.

Lecturer (with a degree or A.M.I.Mech.E., or higher national certificate) in Mechanical Engineering—The Principal, Faraday House College, Southampton Row, London, W.C.1.

*Nuffield Research Fellow in the Department of Zoology*, to work on reagents which will increase contrast in electron microscopy *of biological objects*—Prof. J. F. Danielli, King's College, London, W.C.2.

Physical Chemist, Experimental Officer grade (preferably with a pass degree in chemistry, or at least H.S.C. (science) or equivalent), to assist in a group engaged in the production and filling of initiation explosives and to undertake development work in this field—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 666/WJB/34.

Physical Chemist, Scientific Officer grade, in the Pedology Department, for work on ageing of oxides and the synthesis of clay minerals—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting "107".

Physicist (male, with a good honours degree or A.Inst.P.) for research on servo control mechanisms—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

Scientific Officer (with a first- or second-class honours degree in physics or electrical engineering, or equivalent) at a Royal Air Force Station near Maidenhead, Berks, for operational research duties, theoretical studies and development work in the field of communications and general electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.113/5A.

Senior Experimental Officer (with at least H.S.C. in science subjects or equivalent qualifications, and with considerable experience of electronics and solid state physics), for research on the solid state with particular reference to the application of magnetic resonance techniques—The Establishment Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/354.

*Senior Experimental Officers and Experimental Officers* (with at least H.S.C. in science subjects or equivalent qualifications, and with training in *radio*, electronics *or* physics, and preferably several years experience in the design and development of electronic equipment) *in the Geological Instrument Group, for duties concerned* with the design, development and servicing of electronic radiation *measuring equipment for use in geological prospecting for radio*-active minerals—The Establishment Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/355.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Modern Solders. Third edition. Pp. 22. (Hemel Hempstead: Multicore Solders, Ltd., 1955.) [55

British Electrical and Allied Industries Research Association. Thirty-Fourth Annual Report, 1st January, 1954, to 31st December, 1954. Pp. 154. (Leatherhead: British Electrical and Allied Industries Research Association, 1955.) [55

West of Scotland Agricultural College. Bulletin No. 153: The Establishment of Grass Seeds in South West Scotland. By L. V. Hunt. Pp. 16. (Glasgow: West of Scotland Agricultural College, 1955.) 1s. [55

Polarography with Tinsley Polarographs. (Instruction Book No. ETP 460.) Pp. 20. (London: Evershed and Vignoles Limited, 1955.) [55

Mushroom Research Association Limited. Final Report, 1954. Pp. 36. (Yaxley, Peterborough: Mushroom Research Association, Ltd., 1955. 5s. Distributed by the M.G.A., 45 Bedford Square, London, W.C.1.) [105

John Innes Leaflet No. 14: Balanced Steaming of Glasshouse Soil. Pp. 8. (Edinburgh and London: Oliver and Boyd, Ltd., 1955. 1s. Published for the John Innes Horticultural Institution.) [105

Murphy Fruit Growers' Booklet, 1955. Pp. 92. (Wheathampstead: Murphy Chemical Company, Ltd., 1955.) [105

*Lancashire Dynamo Holdings, Ltd.* Report 1954. *Pp.* 12. (London: Lancashire Dynamo Holdings, Ltd., 1955.) [105

*Report of the Rugby School Natural History Society for the year* 1954. Pp. 28. (Rugby: George Over, Ltd., 1955.) [115

*Department of Scientific and Industrial Research. Report of the* Building Research Board, with the Report of the Director of Building Research *for the year* 1954. Pp. iv+72+12 plates. (London: H.M. Stationery Office, 1955.) 4s. net. [115

Discovery Reports. (Issued by the National Institute of Oceanography.) Vol. 27: The Distribution of *Sagitta Gazellae* Ritter-Zahony. By P. M. David. Pp. 235–278+plate 13. (Cambridge: At the University Press, 1955.) 15s. net. [115

Department of Scientific and Industrial Research. Report of the Radio Research Board, with the Report of the Director of Radio Research for the year 1954. Pp. iv+48+2 plates. (London: H.M. Stationery Office, 1955.) 2s. 6d. net. [165

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 18, No 9: Estimation of Growth and Mortality in Commercial Fish Populations. By J. A. Gulland. Pp. 46. (London: H.M. Stationery Office, 1955.) 6s. net. [165

Wye College (University of London). Report on Hop Picking by Machine By G. P. Chater and Miss C. L. Jary. Pp. 26. (Wye, Ashford: Wye College, 1955.) 1s. [165

Forty-second Annual Report of the University of Leeds for the Academic year 1952–1953. Pp. 100. Forty-third Annual Report of the University of Leeds for the Academic year 1953–1954. Pp. 91. (Leeds: The University, 1953 and 1955.) [165

The Registrar General's Statistical Review of England and Wales for the year 1953. Tables, Part 2, Civil. Pp. viii+174. (London: H.M. Stationery Office, 1955.) 5s. net. [165

Ministry of Agriculture and Fisheries. Bulletin No. 123: Diseases of Vegetables. By Lawrence Ogilvie. Fourth edition. Pp. iv+80+12 plates. (London: H.M. Stationery Office, 1954.) 4s. net. [165

British Drug Houses Limited. Report and Accounts, 1954. Pp. 12. (London: British Drug Houses Limited, 1955.) [165

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 958, Vol. 248 (12 May 1955): A New High Precision Calorimeter for the Measurement of Heats of Combustion: and the Heat of Combustion of Succinic Acid. By G. Pilcher and Dr L. E. Sutton Pp. 23–44. 7s. No. 959, Vol. 248 (12 May 1955): The Numerical Solution of the Differential Equations Governing the Reflexion of Long Radio Waves from the Ionosphere, 2. By K. G. Budden. Pp. 45–72. 8s 6d. (London: Royal Society, 1955.) [165

Report of the Department of Technology, City and Guilds of London Institute, for the year 1st October, 1953, to 30th September, 1954. Pp. 28. (London: City and Guilds of London Institute, 1955.) 2s. [165

Department of Scientific and Industrial Research. National Physical Laboratory. Notes on Applied Science, No. 10: Noise Measurement Techniques Pp. iv+40+3 plates. 2s. net. No. 11: Wind Effects on Bridges and other Flexible Structures. Pp iv+14+7 plates. 1s. 6d. net. No. 12: Calibration of Temperature Measuring Instruments. Pp. iv+47+2 plates. 2s. net. (London: H.M. Stationery Office, 1955.) [175

National Physical Laboratory. Precision Electrical Instruments: Proceedings of a Symposium held at the National Physical Laboratory on November 17, 18, 19 and 20, 1954. Pp. ix+388. (London: H.M. Stationery Office, 1955.) 27s. 6d. net. [175

Department of Scientific and Industrial Research. Forest Products Research. Special Report No. 9: The Strength of Timber Struts. By J. G. Sunley. Pp. iv+28+2 plates 1s. 6d. net. Special Report No. 10: Laminated Beams from Two Species of Timber. By W. T. Curry. Pp. iv+28+2 plates. 1s. 6d. net. (London: H.M. Stationery Office, 1955.) [185

Aero Research Technical Notes. Bulletin 147 (March, 1955): Hardeners—Some Notes on the Composition, Function and Mode of Operation of Hardeners for use with "Aerolite" Urea-Formaldehyde Adhesives. Pp 4. (Duxford: Aero Research, Ltd., 1955.) [185

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Thirty-fifth Annual Report of the Board of the Institute of Physics, 1954. Pp. 25. (London: Institute of Physics, 1955.) [196

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# RESEARCH IN MAN-POWER

ALTHOUGH the recommendations of the National Manpower Council in "A Policy for Skilled anpower"* are too closely concerned with contions in the United States to be of more than very direct interest in Great Britain and elsewhere, the atement prepared by the Council has implications hich deserve close attention from all concerned ith the use and training of skilled man-power. They bear on the development of technical and echnological education; for example, the shortage of cience teachers and the differentials between skilled and unskilled workers. Moreover, in spite of the greater difficulty which the Federal State structure of the United States places in the way of a national policy, the report should bring home to any reader he imperative importance of viewing these related problems as a whole and of insisting that the ational interest should over-ride sectional interests r prejudices.

Of the five major long-range objectives which the National Manpower Council suggests should be pursued if the United States resources of skilled workers and technicians are to be strengthened, he first—strengthening the contributions made by econdary education to the acquisition of skill—consorts well with the policy of increasing the number of technical school, as well as of grammar school, places announced by Sir David Eccles on April 26, as does Sir David's intention of seeing that no area fails to provide fifteen to twenty-five per cent of such places with the third objective of more equal opporunities for all individuals to acquire skill. It will be noted that in the United States this latter objective is more concerned with the elimination of discriminations of race, creed or sex which prevent the utilization of existing opportunities. In Britain, the problem is rather one of increasing the opportunities available, of seeing that they are fully utilized and that they are related quantitatively to the country's needs for skilled man-power and to the resources from which those needs can be met.

Speaking at the opening of the new Technical College at Devonport and Plymouth, Dr. (now Sir) Alexander Fleck said that Britain has only 64,000 scientists and needs 90,000, and that the shortage is greatest in technologists. He also added that we need people at all levels with the powers of leadership combined with a scientific background. On its production side, industry, for example, needs three types of leaders—scientists, technologists and technicians—as well as a great body of skilled craftsmen. Competent judges, however, have expressed the opinion that the universities, which, since 1931, have increased the number of students reading science and technology by about 14,000, in spite of a decrease of about 1,500,000 in the age-group from which the student element in the population is drawn, are already absorbing very nearly all those who are inclined to take a university degree and have the ability to acquire entrance qualifications to a university. More people can accordingly only be attracted into science and applied science courses by diverting them from other fields of university study.

If, therefore, we are to expand our facilities for scientific, technological and technical training and they are to be used effectively, it is not so much vocational guidance that is needed as more accurate knowledge about our man-power resources and the needs they are called upon to meet. To acquire such knowledge is the first step towards formulating a national policy, and the importance of such reports as that of the Appleton Committee on the Supply of Teachers of Mathematics and Science in Scotland, of Sir Philip Morris's Committee on Graduate Teachers of Mathematics and Science, of the Federation of British Industries on the Shortage of Science Teachers, or of the Central Advisory Council for Education on Early Leaving is to be assessed in this perspective. It can then be seen how much more knowledge is still required and how urgent it is that the Technical Personnel Committee of the Ministry of Labour and National Service and the Scientific Manpower Committee of the Advisory Council on Scientific Policy should expedite their inquiries. Apart from this, the University Appointments Board and such bodies as the Federation of British Industries could possibly help to expedite compilation of the data essential for sound decisions both as to the scale on which new facilities should be provided and as to the balance between them.

Such decisions involve, moreover, consideration of the methods used for training skilled and technical man-power and where that training, in its varied types, is best given, not only as between the university, the college of technology, the technical college or technical school, but as before or after entry to industry. It means that industry must be clear in its mind as to the types and quality of the recruits it requires and the prospects it can offer them. Such questions in themselves affect both the number of science and technical teachers required and the extent of the scientific and technical teaching as well as its nature and the general education to be given. Moreover, as the survey of vocational and non-vocational further education and training carried out for the National Institute of Adult Education by a Committee of which Sir Robert Wood was chairman and Dr. P. F. R. Venables vice-chairman shows, the professional institutions have a major responsibility here.

The Committee reached the firm conclusion that the present narrowness of technical studies is largely due to the framing by some professional and examining bodies of their syllabuses and papers so as to put a premium on the memorizing of facts rather than on the discussion of underlying principles. The Committee suggests that such bodies should re-examine the purpose and nature of their examinations, and it also makes the sound suggestion that students should be allowed to use in the examination room the kind of reference books without which they would not dream of practising their profession.

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* National Manpower Council. A Policy for Skilled Manpower: a Statement by the Council, with Facts and Issues prepared by the Research Staff. Pp. xxvi+200. (New York: Columbia University Press, 1954.) 4.50 dollars.

That is one handicap which technical institutions encounter in trying to introduce liberal values into vocational studies. It is clear, however, from this survey that many principals and teachers in such institutions already hold a generous view of vocational education and that, examination requirements apart, the hindrances due to unsatisfactory physical requirements, inadequate library provision and the like, would easily be overcome if industry demonstrated its desire for a more liberal education both by insisting on it in its requirements and by generous support in the provision of new and improved facilities at the technical institutions. The responsibility of industry is fully recognized by the National Manpower Council, particularly in connexion with the fourth of the five long-range objectives which its policy for skilled man-power stipulates—the improvement of the facilities and methods used for training skilled and technical man-power. Indeed, it states frankly that its objectives can be achieved only through a continued and many-sided effort sustained by an informed public opinion and the co-operation of the schools, employers, labour organizations, voluntary groups, the Armed Services and local, State and Federal Governments.

Industry will not, in fact, discharge its major responsibility for the development of the nation's skilled and technical man-power merely by closer attention to training within industry. The very fact that so large a proportion of workers acquire their skill on the job should make industry consider very carefully what technical training it requires of those entering industry. Even where the university graduate is concerned it is at least possible that the arts graduate could be employed in some positions for which it is customary to stipulate the engagement of a science graduate. Such possibilities would be considerably extended if the universities made it their business to see that the arts graduate left the university with at least that understanding of what science is and how it works which should be an essential part of the equipment of every educated man and woman in this technological age.

That bears on the question of general education which in the United States in the technical institute, the vocational high school and the engineering college is now as live an issue as it is in Britain in the colleges of technology, the grammar schools and elsewhere. Although the line between vocational and general education is admittedly blurred to a certain extent, the study made by the research staff of the National Manpower Council brings little fresh information to light that bears on the problem of general education in Britain, other than to indicate the value of general education in developing the versatility and adaptability demanded by an era of rapid technological change with its attendant changes in the types of skill demanded. This is a factor which was emphasized at the recent Conference on Education in a Changing World, as well as at th of the Institution of Production Engineers on aut matic methods in industry at Margate during Ju 16–18. It is clearly one of which close account mu be taken both qualitatively in relation to gener education and quantitatively in planning the expa sion of technical and technological education. Som agreement must be reached as to the nature ar extent of the industrial contribution to be give within industry, whether by industrial firms through the research associations, before any soun assessment can be made of the number, the locatio and the nature of the courses which the technic colleges and technical schools as well as the college of technology should provide.

What needs to be emphasized here is that, so fa as the Government is concerned, the division c responsibility between the Minister of Educatio and the Lord President of the Council offers possibilities of overlapping and waste of effort if eithe Minister fails to take a broad view of his responsibilities. The Advisory Council for Scientific Polic should be well aware of the danger, and the Parliamentary and Scientific Committee could help to se that there is full co-ordination of effort at a poin where it is essential if serious waste of one of ou scarcest resources is to be avoided.

The National Manpower Council places a large share of responsibility for the necessary research on man-power resources on the universities and foundations, specifying particularly the desirability of more knowledge as to the complex process of occupational choice, the role of skilled and technical man-power in economic development, the impact of government policy upon the supply of skilled man-power resources and the relation between how people are trained and their subsequent performance at work. In the United States the National Science Foundation is already engaged in some of this fact-finding either directly, or by arrangement with the National Bureau of Economic Research or other bodies, as Dr. A. T. Waterman, its director, indicated at the sixth Annual Conference on Industrial Research on June 6. In Britain, apart from the work of the Technical Personnel Committee of the Ministry of Labour and the Scientific Manpower Committee of the Advisory Council on Scientific Policy and certain inquiries pursued by Political and Economic Planning, some of the investigations under the two Committees on Human Relations in Industry and on Industrial Efficiency in Industry should throw light on the problems indicated by the National Manpower Council; but the technical study which the National Science Foundation is sponsoring of methods for determining the demand and supply of specialized personnel should be of particular interest to Britain.

As to how the training of skilled and technical man-power could be improved the present study gives little indication; but this aspect of the man-power problem should be engaging the close attention of professional institutions and of the trade unions. Without their full co-operation and understanding it will be impossible to frame, let alone execute, a man-power policy adequate to the country's needs, even if the estimates s to the numbers of skilled workers which the oming of the automatic factory and the adoption of lectronic computation will require prove to be exaggerated. When the secondary schools, the technical colleges and the universities have dealt satisfactorily with the problem of general education and secured the increased number of science teachers required to provide both an adequate number of graduates in science and technology but also arts graduates and school-leavers in general with an understanding of what science is which enables them to play an effective part in an industrial world based on science and technology, the increased supply of educated and trained workers will not be used efficiently and flexibly without relaxation of craft rules and trade union practices.

Moreover, besides the character of professional examinations stressed by the National Institute of Adult Education, there are other hindrances to the recruitment of more technical workers. Although their number is increasing, it is not increasing in proportion to the demand for their services which arises from advances in science and technology, particularly when an existing shortage of more highly trained scientists makes it necessary to use less highly trained technicians wherever possible. The automatic factory of the future threatens to displace the semi-skilled operative and thus to accentuate the demand for skilled- and flexible-workers parallel with the tendency for technicians to carry out tasks formerly entrusted to professional workers, and the study made by the National Manpower Council reiterates accordingly the importance of workers possessing a broad foundation of basic knowledge and skills together with attitudes which will facilitate their learning new tasks as the need and opportunity arise.

That, as already indicated, consorts ill with rigid apprenticeship systems or trade union rules and practices. Another difficulty is the decreasing differential between the wages of skilled and semi-skilled workers. Although on the evidence presented to it the National Manpower Council concluded that in the United States at present the long-term decline in the relative wage advantage of skilled workers had not produced and was unlikely to produce a general shortage of skilled workers, it appears to be a factor which should not be disregarded. In Britain, quite apart from repercussions of which the economy has recently been made unpleasantly aware, it could be a serious factor against obtaining a supply of those ready to assume the increased responsibilities as well as acquire the greater skill that the advent of the automatic factory would demand.

Apart, however, from its demonstration of the importance of a carefully thought-out and co-ordinated national policy for scientific and technical man-power and its demonstration of the many factors that enter into the formulation of such a policy, the statement of the National Manpower Council is of interest to British readers for its emphatic indication of the observations in the recent Appleton Report on the crucial importance of an adequate supply of suitably qualified teachers. In the United States, as in Britain, any inadequacy in the teaching of mathematics and science is a national problem which, if unsolved, may endanger the whole national economy, if not indeed the national safety. This is the first and most urgent matter to which our attention should be given, and it is to be hoped that the statement and the evidence on which it is based will receive careful study, above all by those who, like the Parliamentary and Scientific Committee, which has already discussed the expansion of colleges of technology with the Minister of Education, are best placed to further an impartial, all-party approach and to foster the concerted and fully co-ordinated action required.

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# MEDIEVAL COSMOLOGY

## Le Système du Monde

Histoire des Doctrines Cosmologiques de Platon à Copernic. Par Prof. Pierre Duhem. Tome 6. Pp. viii+740. (Paris: Librairie Scientifique Hermann et Cie., 1954.) 2,900 francs.

THE first five volumes of Duhem's "Le Système du Monde" appeared in 1913. The author then hoped that the work would be completed in eight volumes; but already, at his death in 1916, ten had been written, and still the task which he had set himself was unfinished. The distractions of war and the economic difficulties that followed, however, prevented any further publication, and for many years copies of the published volumes have been eagerly looked for from second-hand sources. A second edition has now been issued, and with it appears, for the first time, Vol. 6.

This happy event, for which all interested in these subjects will be grateful, has been made possible by the patronage of the Paris Academy of Sciences, to the care of which Mme. Hélène Pierre-Duhem, the author's daughter, long ago committed the manuscript. The co-operation of the Centre National de la Recherche Scientifique was secured and has been promised for the gradual issue of the succeeding volumes. Mme. Pierre-Duhem introduces the sixth volume with a short note explaining these circumstances.

Duhem's "Le Système du Monde", by virtue of its scope, its wealth of detail, and the number of previously unexamined manuscripts on which it is based, is unique among the histories of early cosmological thought. Whereas such a valuable work as Dreyer's "History of the Planetary Systems from Thales to Kepler", for example, is confined strictly to the purely astronomical problem of the structure of the mechanism of the heavens, Duhem treats cosmology in a far wider sense and includes the whole system of philosophy of which astronomy was but one aspect. It is thus at the same time a history of philosophy and a history of science for the periods with which it deals. Though the author's treatment of the subject-matter has not escaped criticism, the work is by common consent an indispensable source of information to all who would form a true idea of the heritage of modern science.

The sixth volume is chiefly concerned with the ebbing of Aristotelianism during the few decades following the death of Thomas Aquinas in 1274. The best-known figures of this period, Duns

Scotus and William of Ockham, as well as those of lesser note such as Henry of Ghent, Richard of Middleton, Giles of Rome and others still less familiar, are presented in the manner characteristic of the author's earlier work, and the story is carried up to Jean Buridan and the beginning of the Paris School of the fourteenth century which, in kinematics in particular, anticipated Galileo in so interesting a manner. For the full treatment of this movement, however, we must wait for the next volume.

The great value of these detailed discussions of the minor, as well as the major, thinkers of those days is that they enable us, as nothing else can, to recover the intellectual atmosphere of the times and to view the problems faced as they then appeared and not as they present themselves in the light of modern knowledge. What now often appears as mere idle verbiage is thus seen to have had a real and vital content, and sometimes to be simply a translation into an outworn language of problems with which we still wrestle. There is a story of an examining body which set the same questions every year, but prevented automatic passing by varying the answers. Whatever may be said for this as an examination device, it is certainly closer to the history of thought than the common practice. The fundamental problems of philosophy remain the same; but each age, seeing them in its own light, gives its own answers. That is not to say that progress is not discernible in the answers.

The appearance of the remainder of this great work will be awaited with feelings of the liveliest expectation.

HERBERT DINGLE

## BIOLOGICAL GROWTH

### Dynamics of Growth Processes

Edited by Edgar J. Boell. (A symposium of the Society for the Study of Development and Growth.) Pp. vii+304+21 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1954.) 60s. net.

THIS volume represents the proceedings of the symposium on growth held in Williams College, Williamstown, Mass., in June 1952, under the joint sponsorship of the Society for the Study of Development and Growth and the National Research Council's Committee on Developmental Biology. Although the eleventh symposium of its kind, it is the first to have been published in book form: its predecessors appeared as supplements to the journal *Growth*. Inasmuch as publication did not take place until 1954, and some of the articles deal with lively and quick-moving subjects, one cannot but reflect upon the wisdom of the change.

The symposium is an altogether crisper and more down-to-earth affair than its title might suggest. (What would be the 'statics' of a process which is, of its nature, one of transformation?) A certain order is imposed on what would otherwise be a miscellany by arranging the articles in ascending order of the size of their subject-matter, starting with viruses and protein molecules and ending with the growth of whole organisms and their populations. It is inevitable that the articles on the more rapidly growing subjects should be the first to 'date'. One must not overestimate the danger: new hypotheses on the nature of molecular 'replication' have appeare since the preparation of the present article on viruse but its general conclusions remain essentially soun Other articles deal with amino-acid and protei synthesis, the interrelation of nucleus and cytoplasm and cellular differentiation in animals and plants with the physical, chemical and endocrine control growth; with hereditary mechanisms, and with th growth-curves of individuals and populations. All ar by scientific workers distinguished for their contr butions to these several fields; none is a mer inventory of information, and some are written wit a real sense of style.

We are left with a useful synoptic picture of th problems of growth that are most insistent at each level of the hierarchy of sizes and complexity; w learn how little in growth can be usefully thought o as merely scalar and quantitative, and how much at every level of complexity, depends upon vecto properties—organization and form.

## CLASSIFICATION OF INSECTS

### Classification of Insects

Keys to the Living and Extinct Families of Insects, and to the Living Families of Other Terrestrial Arthropods. By Prof. Charles T. Brues, Prof. A. L. Melander and Prof. Frank M. Carpenter. (Bulletin of the Museum of Comparative Zoology at Harvard College—Vol. 108. New edition.) Pp. v+917. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) 9 dollars.

THE previous and first edition of this well-known work appeared in 1932. The present revised edition contains half again as many pages. Most of these additional pages are due to greatly extended lists of references to the different orders of insects, the references to the Diptera, for example, occupying a hundred and twenty-four pages instead of twenty-seven. Another important and useful addition is a section of fifty pages on fossil insects. More than a hundred new illustrations have been added. There are scarcely any typographical errors, and the print is easy to read.

The extended lists of references will be useful to students; but the selection of some of these has not been done with sufficient care. References to the Tipulidae include six pages devoted entirely to listing the papers by Alexander. Some of these should be cited; but the great mass are small papers not relevant to the purpose of the book, as each is concerned with describing a few new species, and no keys are given. Sometimes the same paper is listed as a reference for two quite different groups of insects. For example, Brown's revision of the North American Aegialidae is listed in the references to both the Tenebrionoidea and Scarabaeoidea. No consistent system of abbreviation of references is used.

In a "Conspectus of the Higher Groups of Insects" (pp. 17–25), the families and higher groups are listed in the order in which they are afterwards treated. In the introduction the authors say that this list ". . . aims to present a natural classification as nearly as this can be expressed in a linear sequence". In this aim they have failed signally. The Collembola, which are not insects, are listed between apterygote and pterygote insects. One of the suborders of the Dictyoptera is given ordinal rank and the other, the antodea, is included in the Orthoptera. It is nerally accepted that the Psocoptera are closely lated to the Mallophaga and Anoplura; but the raptera, which are unrelated to these three orders, e placed between the Psocoptera and Mallophaga. ranger still, and quite inexcusable, both the orders ysanoptera and Hemiptera are entered between e Mallophaga and Anoplura.

The treatment of family relations within orders is ry unequal in quality. The beetles fare the worst. or example, no mention is made of the suborder rchostemata, and the Cupididae are placed in the border Adephaga. The Chelonariidae and Limniidae are in the Dascilloidea instead of in the ryopoidea, where they rightly belong. The families f the Cucujoidea are scattered at random between neir superfamilies Mordelloidea, Colydioidea and enebrionoidea. Of the families of the Bostrichoidea, he Ptinidae are included in the Dascilloidea; but the ery closely related Anobiidae, Bostrichidae and yctidae are placed in the Colydioidea. The Ptiliidae re included in the Colydioidea, to which they are ot remotely related. Most of these major mistakes ccur in the first edition. In the past two decades one, so far as I know, has accepted these views on he classification of beetles.

The Papilionoidea are listed by the authors as the most specialized Lepidoptera and are placed far from he groups to which they are related. The first four amilies they include in the Tineoidea are all Tineidae, nd both their *Amadryidae* and *Setomorphidae* are more closely related to *Tinea* than some of the genera included by them in the Tineidae. In the section on Diptera, the Simuliidae are said to be peripneustic, whereas in fact they are apneustic, and they have mistaken the dorsal for the ventral side of the common *Dixa*.

Throughout the work the term 'chitinization' is used when the authors mean 'sclerotization'. On a lighter note, it may be mentioned that, according to the authors, one of the characteristics of Micropterygid larvæ is that they have three-dimensional setæ.

H. E. Hinton

# SILICATE THESAURUS

## The Physical Chemistry of the Silicates

By Wilhelm Eitel. Pp. xvii+1592. (Chicago: University of Chicago Press; London: Cambridge University Press, 1954.) £11 5s. net.

In variety and ubiquity the silicates almost rival the carbon compounds, and there are indeed certain similarities between the two series. The basis of variation in the silicates, for example, is the tetravalent silica tetrahedron (compare with the carbon atom) which may link up with other silica tetrahedra, or with other ions or complex ions, to give stable three-dimensional networks. The numerous ways in which linkage can occur lead to such a variation in silicon/oxygen ratios that in pre-Bragg days a bewildering array of hypothetical 'silicic acids' was postulated; only with the application of X-ray techniques was the simplicity inherent in this apparent complexity revealed.

The compounds concerned being so numerous and varied, it is scarcely surprising that consideration of their physical chemistry has necessitated such a large volume as the one under review. Nevertheless, some idea of the growth of this subject during recent years is afforded by the fact that the volume is almost twice the size of the previous (German) edition of 1941, which in turn, despite the omission of much text-book material, was about half as large again as the original German edition of 1929. The space devoted to the various topics in each edition may also serve as some guide to the relative rates of progress in each field. The present edition is stated to be based upon a translation of a third unpublished German edition completed in 1945; but it is obvious from even a cursory glance that much later material has been added; the most recent reference noted was to a paper published early in 1953.

It is indeed refreshing in these days of symposia to encounter such a comprehensive treatise from the pen of one author, and this only serves to emphasize the vast extent of Dr. W. Eitel's knowledge; his experience of the subject, both as director of silicate research institutes and as teacher, is surely unique. It should be added that he has cast his net widely and has, indeed, made a liberal interpretation of "physical chemistry". The field covered by the book is best indicated by listing the section headings: states of silicates (crystalline; fused and glassy; colloidal); fusion and polymorphic equilibria in dry systems (general remarks; special systems); pneumatogenic and hydratogenic silicates (systems with volatile components; hydrates of the zeolite, permutite group); solid-state reactions (general; ceramics; hydraulic cements); and silicate melts (glasses; slags). In such an immense field each reader could doubtless find aspects he might feel were inadequately treated, or observe omissions; for example, a surprising omission, to the reviewer, was the absence of reference to the book "X-Ray Identification and Crystal Structures of Clay Minerals" (published early in 1951) in spite of the space devoted to this subject. Yet, considering the book as a whole and remembering that it covers the period up to late 1952, little criticism can be made on the grounds either of inadequacy or omission, and the book is indeed a valuable compendium; that it is in many respects encyclopædic rather than critical in no way detracts from its value.

The bibliography is very complete, and the multitudinous footnotes serve as an excellent medium for providing information additional to that given in the text. A special numerical system of referring to journals is employed; although the numbers of the most usual journals soon become familiar, this, at times, forms a source of irritation as one has to consult the key at the end of the book before one can trace the journal—while the possibility of typographical errors in numbering always exists. All six indexes are clear, and appear to be carefully compiled. The diagrams are, on the whole, excellent, although a very few, such as that on p. 1112, might perhaps have been better chosen; the numerous phase diagrams will delight those on whose sphere of work they impinge. A number of typographical errors and misprints were observed; but all should be obvious to the careful reader. Only one slight, and perhaps excusable, error of fact was observed in those sections of which the reviewer has most knowledge.

In general, the book is well printed and well bound, and both author and printer are to be congratulated on its expeditious production. It is a volume which in spite of its cost should find its way on to the reference book-shelf of all interested in silicate chemistry.

R. C. Mackenzie

# HISTORY OF COLE (*Brassica* sp.)

## By G. E. FUSSELL

A FEW hundred acres of cole or rape are still grown in most counties[1]. Some farmers expanded the acreage under the crop during the war years, notably in Yorkshire, but it has lost the importance it enjoyed between 1650 and 1850. The Fen farmers no longer rely upon it as a cash and forage crop, though it was once a most valuable 'vegetable' for reclaiming newly drained lands.

Like many grasses and roots that have become important in our farming, rape is indigenous, being native to our sea-shores. At the beginning of the eighteenth century the wild *Brassica oleracea* was gathered for human food; people living near the coast preferred it to cabbage. Turner had seen it long before near Dover[2]. It did not become important as a table succulent, but as a green fodder crop and an oil-producing seed crop, its residual cake proving useful as a feeding stuff and manure.

John Smith suggests that some varieties were introduced by the Romans[3]. Rape was certainly cultivated in Classical times. Several Latin works on agriculture contain references to it; but it is not easy to decide just what plant is meant. Pliny is the most definite. He knew three kinds of *rapa*: one flat and broad, the second round like a ball, the third wild with a long radish-like root, pointed rough leaves and acrid juice[4]. This suggests tankard and globe turnips and rape or cole. Pliny thought *rapa* could be sown where scarcely any other crop would succeed, being nourished by mists, hoar frosts and cold to a prodigious bulk. He had seen some of more than forty pounds weight.

Both Columella and Palladius, however, advise that the two things require different soils. The *rapa* delight in low, wet lands, the *napus* in dry sandy soils. Both believed that if grown in the opposite soils the plants would change into each other in two years[5]. The rustic Roman ate both *rapa* and *napus*; but the *rapa* was most useful for cattle. It was used in Gaul as winter feed. Pliny agreed with this. The boiled seed was excellent for fowls, and livestock flourished on the leaves.

All this must have been known to medieval scholars, but did not lead to the cultivation of either kind of *Brassica* as forage or industrial crops. Barnaby Googe, the Lincolnshire squire who translated and expounded the "Whole Art of Husbandry" (1577), was acquainted with Columella's statement and had seen rape or cole cultivated in the Principality of Cleves. He thought it valuable for green manuring, for its oil seeds and sheep fodder[6]. His remarks did not induce anyone, even himself, to grow the crop.

Rape seed was extensively grown in Belgium in the late Middle Ages, to which country it may have been brought from Holland. This was *Brassica rapa rapifera*, described by Dodoens as sown before the winter after corn harvest. It was also sown on the fallow after oats. The crop was heavily manured and was rather costly. A tenant of Hof ter Kluizen who paid 70 pound of rape seed with his corn rent in 1470 could substitute an equal quantity of wheat if rape failed.

A Belgian farmer with more rape than necessary to feed his cattle as green fodder let it run to seed in the spring and harvested the seed for sale. It wa grown on a large scale in Waes and sold in th markets of St. Nicholas in Ghent, at Louvain an Mechlin.

The name 'cole seed' first occurred in the sixteent century when Dodoens mentioned "sloren", a cabbag grown only for its seed. This Lindemans believes t have been developed from rape, though not i Belgium. After 1550 Belgian leases speak of cole seed instead of rape-seed. This was a more profitabl crop, the yield greater and the seed much riche in oil. It was *Brassica oleifera*, and became th most cultivated oil plant of West and Middl Europe.

The centre of cultivation in the Middle Ages wa perhaps in the Netherlands, most likely in the north whence it passed to Belgium, France, Artois an Picardy, and in the second half of the sixteenth century to the Rhineland and mid-Germany[7]. Thi may be a correct assumption; but the plant or some form of it was known in classical Gaul. Did it continue to be cultivated there, and how did it get to North Holland, whence it could continue its travels in the late Middle Ages?

Whatever the history of the crop in Europe, the drainers who came from the Low Countries with Vermuijden introduced it to the Fenlands of Britain. The fenmen strongly resented the activities of the drainers, and did their best to destroy the works. So early as 1639 there were riots in Lincolnshire, with great loss and damage, especially to crops on reclaimed land, which included "great crops of rape, cole-seed, corn and other grain"; while about 1646 the "Anti-Projector" (an anonymous pamphleteer) was asking scornfully, "What is cole-seed and rape? These are but Dutch commodities and but trash and trumpery"[8].

Many Walloons and French-speaking Hollanders from Picardy and North Flanders settled in Thorney after its drainage by Francis Duke of Bedford in Charles I's reign. They were expert in the cultivation of colza, from which they extracted oil.

The new crop (if it were new) immediately found its way into the text-books. Both Walter Blith and Samuel Hartlib came down heartily in favour of it. They and their successors for a century or more emphasized the importance of obtaining seed from Holland.

Blith looked at the matter both generally and particularly. Cole was most useful on marsh, fen, lands newly recovered from the sea, or any lands flat and rank. It should, as Palladius had said so long before, be sowed about midsummer. The fen-land was carefully prepared. The surface was pared off with a paring plough[10]. The turves were stacked in small heaps and burned (a process called denshiring elsewhere), the land thoroughly ploughed and ridged up. Cole-seed was then sown, and the crop harvested the following summer[11].

Blith's advice was based on practical work done in the reclaimed Fens. Vermuijden reported in 1652 that 40,000 acres of the South Level had been sown with cole, seed wheat and other grain. In the Bedford Level, "a small quantity of about 28,000a." had been cultivated. The result of the first year's crop was most profitable[12].

Hartlib optimistically estimated that 380,000 acres of the great fen of Lincoln, Cambridge and Huntingdon had been reclaimed by 1655. Its value was high. friend offered a mark an acre for 900 acres on which to sow rape, land formerly scarcely worth 12*d*. an cre.

The work went on and by the end of the seventeenth century a large area was cultivated. In 1657 it was grown between Ely and Southery; by 1696 there were great crops between Spalding and Crowland. Here were oil mills in which the seed was crushed between marble stones imported from Germany. Shipments of rape oil to London were made both from Wisbech and King's Lynn at about this time[13].

Rape was grown in Kent almost as early as in the Fens. Rochester exported thirty quarters of rapeseed to Dieppe in 1660–1—presumably the product of the county[14]. Casual shipments, too, went out of Hull between 1620 and 1670[15], although where it was grown I cannot say—perhaps in Yorkshire or in Lincolnshire; it may have been grown in Essex before the Fens.. Five quarters of rape-seed was exported from Malden in 1611, and ten quarters from Colchester in 1631, Maldon exported 353 quarters and in 1642 Colchester exported 5,000 rape seed cake[16].

By 1716 home-grown seed was nearly as good as that imported from Holland; but perhaps not so plentiful. It was still sown at a gallon or 4 lb. an acre in July on carefully prepared land, ploughed in May and again in June. As the crop became more familiar, its use as green fodder and its residue as dry feed was recognized. In Holland, rape was used for feeding oxen in winter, and that lesson was learned. English farmers used it in January, February and March "when other food is wanting". If fed one winter, it would often produce a good crop next year, and when cut the stubbs would sprout again and afford excellent nourishment for sheep.

If for seed it was reaped with the sickle in the same way as wheat, placed in small yealms or heaps to dry, gathered in large sheets and carefully threshed in the barn because very apt to shed. Lincolnshire growers threshed in the field on a sheet laid on a specially flattened piece of ground. The average yield per acre was five quarters, worth £5. Here the refuse cake was used as fuel, because the county was short of wood. Northamptonshire farmers made a better use of the cake. They fed calves from three or four days old on a mixture of powdered cake and water[17] instead of milk. The calves flourished.

The advantages of the crop were so evident that it spread to other places by the middle of the eighteenth century. In the Chiltern country it was a great success. Gloucestershire farmers were growing it on pared and burned land, though they used a breast plough to cut off the turf. Farmers near Chelmsford, Essex, were cultivating it. At Chertsey, Surrey, and Gaddesdon, Herts, the seed was sown in beds and the young plants transplanted when a few weeks old, as Palladius had recommended.

Much of this expanded acreage was for feed. Near Richmond, Surrey, and other places it was given to the ewes that suckled house lamb—a profitable business near London. If fed to cows or sheep, care must be taken not to cause hoven, or make the milk rank by giving too much at first. The animals fattened quickly on it, and a rape crop opportunely provided feed after the turnips were gone. It promoted milk yield, too.

Some farmers had begun to sow rape on one ploughing after a cereal crop, others to sow in February and feed off in midsummer—practices that developed. When sown after a cereal, ten bushels of Newbury or Hampstead peat ashes were added as fertilizer[18]. This was a novel modification of the methods introduced in the Fens.

It was not until 1756 that a hint was given that the rape- and cole-seed imported from Flanders was "not all the same kind". The plant was, said Thomas Hale, equally native of England and Flanders but did better in the latter country. Flemish seed was always to be had and always best[19]. John Mordant was sceptical about overseas seed. Home supplies were excellent. He repeated the general advice, current for a century[20].

A few years later both Nathaniel Kent and James Adam advised farmers to consider that cole occupied the ground for a whole year, and must therefore produce a profit equal to that gained from barley crop and turnip crop together. If they could make it do that, it was in addition exceedingly useful in cleaning and meliorating land.

Adam thought cabbage had begun to supersede it for feeding cattle by 1789. He quoted the Marquis of Turbilly on the Flemish method of sowing the seed in beds and transplanting it like ordinary garden cabbage. The land must be ploughed twice before winter, and again in May, harrowed two or three times, ploughed again towards the end of July, the seed sown and harrowed and rolled in. 24 lb. seed sown on three acres would provide plants to set out on twelve acres. Early in October the best plants were selected for transplanting into rows one foot apart at six-inch intervals in the rows. Harvesting was carried out as usual. Essex farmers, however, generally reaped cole and prepared frames lined with threshing cloths, each drawn by one horse, to receive the heads of the plants as fast as they were cut off. When properly managed, nothing paid better, but the product must have been sold at a high price to cover all the seed-bed preparations and careful handling[21].

Transplanting was done in two ways in Brabant. A hole was made with a special spade at the required intervals and a plant put in by a child, who pressed the soil firmly around the roots, or the plants were placed by hand at regular intervals in the furrows and covered with the earth turned upon them when the ploughman turned the next furrow. The manual method was described by the Abbé Mann. Arthur Young saw it near Cambrai on the oat stubble after one ploughing in October. Here and at Valenciennes the hole for the plant was made with a large dibble. Josiah Ringstead was the first to recommend mixing the seed with earth or sand to prevent it growing in clusters[22].

Young himself could not make cole-seed yield heavily enough to be profitable, though Philip Miller had said one acre of cole equalled two of turnips for feeding[23]. In spite of this, Young was enthusiastic about its cultivation by Essex farmers in 1807. They often grew cole on a fallow as they did turnips; but had generally found newly broken-up ground best. Three or four pints of seed were enough if grown for seed production, but for fodder five or six were often necessary. Charles Vancouver described transplanting at twelve inches square at a cost of a guinea an acre that was always profitable. The straw of rape made excellent litter. His estimate of yield was twenty-nine bushels an acre; but Mr.

Dudley, of Bradwell, an experienced grower, set it at thirty-four. Dudley thought feeding cole-seed in the county was declining, the leaves having been found better. Nevertheless, it was widely grown from Hedingham and Finchingfield to Maldon for seed. The farmers found it very profitable. In Rochford Hundred immense quantities were grown, cut with a short, strong scythe made for the purpose, and carted to the farmyard to feed bullocks. Mr. Claydon, of Audley End, and many other farmers all over the county sowed it for sheep or green manure. The crop was prohibited on the Winchelsea Estate, Foulness Island, because it exhausted the land and promoted weeds—an opinion then not widely shared[24].

By this time farmers in several counties often far removed from the Fenland grew the crop. Among these were Gloucester, Hampshire, Kent, Stafford; the farmers of Lincoln, Suffolk and Yorkshire continued their allegiance to it[25].

Sinclair was as enthusiastic as Young. In Flanders, he said, it was found to destroy the *gyrllo talpa*, so injurious in wet soils. The cake had long been used in various parts of England as manure, particularly in Yorkshire and Norfolk. It was broken up and ploughed in about six weeks before seeding. Ploughed in with wheat seed, it was particularly forcing. Flemish farmers of seventy-five acres bought as much as 5,000 rape cakes and 3,300 poppy-seed cakes, costing nearly £60 a year[26].

Twenty years later, members of the newly formed Royal Agricultural Society could read in their *Journal* how the plant was grown in Schleswig-Holstein, Lauenberg and Mecklenberg, and praise of the oil produced from the seed. When purified, it was without smell, gave a brilliant clear burning flame and was universally used all over Germany in the saloon and cottage[27].

The hint by Thomas Hale in 1756 that the seed obtained from Holland was not always the same was elaborated by the Rev. W. L. Rham, himself a Dutchman who had settled in England. *Brassica campestris* and *Brassica napus* were often confounded in Britain as rape. In the Netherlands, *B. campestris* was sown in summer and transplanted before winter and produced flowers and seed in the following year. *B. napus* was usually sown in spring, ripening its seed the same season[28].

Loudon, too, was emphatic about the distinction between the two plants for rather more botanical reasons. "Rape", he wrote, "is *Brassica Napus*, a biennial plant of the turnip kind with . . . a woody fusiform root hardly fit to be eaten", that is, the wild rape of Palladius. Von Thaer and Candolle both agree, he said, that the French or Flemish colza was a different plant from our rape, more of the cabbage kind, having a cylindrical root, cut leaves and greater hardiness. According to these authorities, it was *Brassica campestris oleifera* and the seeds produced more oil, in the ratio 955 : 700. For leaves as sheep feed and for oil this had been cultivated from time immemorial. He elaborates its use as winter forage cut green, the oil-producing qualities of its seed and the use of the residual cake for fattening livestock, and manure.

All these uses continued to be advised by the nineteenth-century didactic writers. Sussex farmers occupying 200 or 300 acres were told to sow one-tenth of their acreage to rape (*B. napus*). Sown at the latter end of May, it could be stocked about six weeks later, and would fatten and finish great quantities of sheep and lambs until near Michaelma It would then stand the winter on land not too we The following year it should be left to stand for see to make it profitable. The yield was estimated about forty bushels an acre, and the price as rath better than wheat. The profit was all the great because the cost of seed and tillage was repaid b the sheep feed. The haulm could be fed to catt and the stover after threshing used as hay. Th cake could be used as manure[30].

During the first decade of the Royal Agricultur Society many essays on this crop appeared in it *Journal*[31]. These and the references in other societie publications and the general agricultural pre indicate a widespread interest in the crop.

Most rape grown in the second half of the nin teenth century was for feed—not for seed. On th chalk and oolite, rape was often grown mixed wit vetches and turnips about 1880, but most frequentl by itself. *Brassica campestris* described by R. Scot Burn as smooth-leaved summer rape, or colza, wa suited to fen soils rich in peaty matter; *Brassic napus*, the rough-leaved winter rape or cole-seed, t clay soils. Some farmers were uneconomical enoug to burn the haulm; but this was a mistake. It mad excellent litter.

The methods of cultivation and manuring had no changed; but some farmers grew a succession o fields or patches of rape throughout the season beginning with one in April for late summer an autumn feed. The main crop was put in during June and more small areas at intervals for a few weeks This method provided a succession of growths tha could be used during winter and spring. Some continued the old practice of feeding off in autumn an letting the crop stand until the following year. It was then folded or fed green once more; but thi second growth was watery and innutritious[32].

The winter variety, still a main crop, yielded heavily on the rich fen soils in 1914. The ancient idea that neglected turnips and swedes were liable to lose their large and shapely roots and to revert, the swede to the smooth-leaved summer rape, the turnip to the rough-leaved winter rape, was then repeated[33].

With the need for economies in stock feeding between the Wars, many farmers expanded their rape acreage. The need for home-grown feed was intensified by the Second World War; the acreage under rape trebled, though it was not a major crop. In England and Wales some 52,000 acres was grown in 1935; 150,096 in 1944.

All this was grown for feed. The seed required for oil is imported; 13,419 tons during 1953 to make 4,697 tons of oil. This is not new. The quantities were 206,111 quarters in 1865; 474,667 quarters in 1866; 610,782 quarters in 1867. An experiment in making oil with home-grown seed in 1951 was not economic, insufficient oil being extracted to make seed-growing pay. In spite of this, it looks as if rape will continue to contribute substantially to feeding our livestock.

One of the main uses of the oil produced by the French, Flemish and Dutch refugees, both in their native countries and the reclaimed fens, was lighting. Condemned as it was by the irate fenmen, it provided better light than rushlights or tallow candles. Indeed, it competed with whale oil if the couplet:

"Here grows proud rape, whose price and plenty foyles
The Greenland trade and checks the Spanish oyles"

to be believed. In the early railway age it supplied ailway lamps, and later some used it in bicycle amps. In some backward countries it is still used s an illuminant. Some Asiatics cook and make margarine with it; but here and in the United States its use is for quenching steel and as a machine ubricant.

The plant, always grown more in France, Belgium, Holland and Germany than here, is to-day almost orld-wide, being grown in Hungary and the U.S.S.R., n China and India as well[34]. Here rape is now grown only for feed. Its cultivation undoubtedly owes much to the 'Dutch' settlers and to the continual reference to Low Countries' practice made in our arming text-books throughout the first two centuries f its adoption. The long-sustained trade in imported seed from Flanders and Holland, so rigidly insisted upon by a succession of writers, has helped to keep p the excellence of the crop.

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# MAN-MADE DIAMONDS

By Drs. F. P. BUNDY, H. T. HALL, H. M. STRONG and R. H. WENTORF, Jun.

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IN the 1920's it was quite widely believed that diamond had been made from carbon under conditions of high heat and great pressure. The story was indeed one to capture the imagination. It involved famous chemists, a thoroughly fascinating subject and very striking experimental techniques.

In the recent past, however, informed scientists soberly agree that there has been no certain example of diamond production in the laboratory. More than a century of claims and counterclaims for the synthesis of diamond attest to the fascination of the subject and the extreme difficulty of the experimental techniques. Henri Moissan dissolved sugar charcoal in molten iron and quenched the solution in cold water in order to crystallize the carbon under the great internal pressure supposedly generated by contraction as the mass cooled from the outside. When the metal was dissolved from the solidified melt, there remained traces of transparent material having optical properties similar to those of diamond and giving some carbon dioxide upon combustion. Moissan therefore believed he had made diamond.

In 1880, J. B. Hannay reported he had made diamonds by heating a mixture of hydrocarbons, bone oil and lithium at red heat in sealed wrought-iron tubes. The project was said to be fraught with great difficulty because of exploding tubes; only three out of eighty held. Hannay's identification of his diamonds seemed very conclusive, since it even included a density of 3·5 and a carbon analysis of 97·85 per cent.

Sir Charles Parsons tried for thirty years to synthesize diamonds, including in his experiments many attempts to duplicate the work of Moissan and Hannay. At first Parsons thought he had succeeded; but later, having some doubts, he scrupulously re-investigated all his work on the subject. Parsons's new work clearly demonstrated how he had been misled into regarding as diamond various transparent, singly refracting minerals (spinels) which were very resistant to chemical reagents and would not burn. He finally concluded that neither he nor anyone else had ever succeeded in making diamonds in the laboratory.

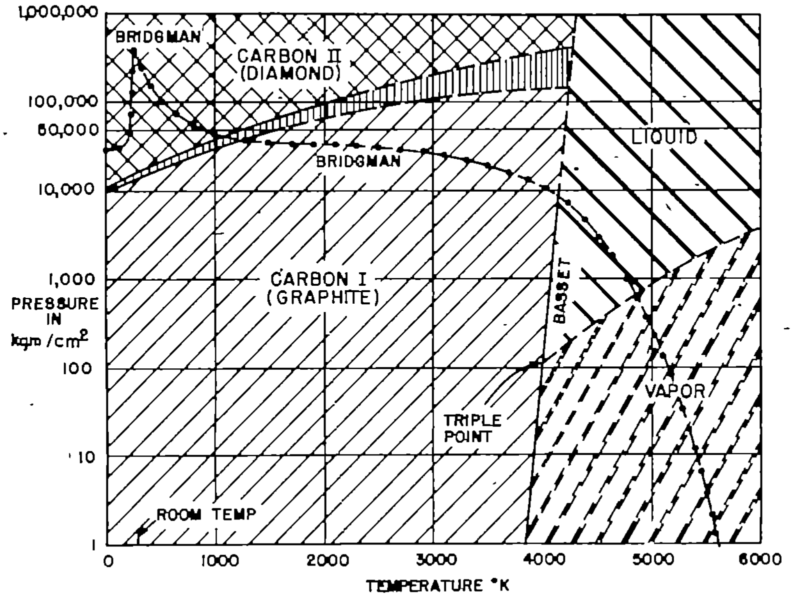

Fig. 1. Phase diagram of carbon

The early claims to diamond synthesis were again reviewed by Prof. N. V. Sidgwick, of Oxford, in 1950, and Henry Eyring, of the University of Utah, in 1952. These authorities conclude that the synthesis of diamond in the laboratory has never been shown to be a success, and that thermodynamic considerations make it seem improbable that diamonds could have been formed under the conditions used in the experiments reported.

For a full account of the arguments the reader is referred to an extensive literature on the subject, a bibliography[1–24] for which is appended.

## Suggestions from Thermodynamics

The phase diagram for carbon as now understood is plotted in Fig. 1. Only the boundary between graphite and its vapour at low pressure is accurately established by experimental measurements. The boundaries at higher pressures between graphite, vapour and liquid are based on the work of Basset, and are not fully accepted.

The location of the boundary between the graphite and diamond-stable regions has very little direct experimental evidence at present. The position of the lower temperature part of this boundary was calculated by thermodynamic methods by Rossini and Jessup[15] of the U.S. Bureau of Standards in 1938. The higher temperature part of the boundary shown by broken lines is purely extrapolated from the other part, as the physical data have never been obtained.

The chain-line running across the diagram shows the upper limits of pressure and temperature that are known to have been reached in controlled experiments (this excludes atom bombs) according to the published literature. Prof. P. W. Bridgman, of Harvard University, is the outstanding investigator in this field, working up to more than 400,000 atmospheres at room temperature. He also held temperatures near 3,000° K. at 30,000 kgm./cm.² for very short intervals of time.

The diagram shows that Bridgman has operated well up into the diamond-stable region and has tried many times to synthesi diamonds but without success. H has stated in several of his pape that the reason for his lack success is that at the relative low temperatures at which his e periments were carried out th rates of reaction were negligib He recognized the necessity going to higher temperatures; b he had not developed apparat capable of operating at these hi pressures and temperatures simu taneously. The maximum co ditions he has reported in th direction were 30,000 kgm./cm.² a 2,200°–3,000° K. for periods of o or two seconds.

Bridgman[19] attempted to esta lish a point on the diamond–graphit equilibrium curve in a series of e periments in which diamonds we heated to about 2,500° K. for a fe seconds at pressures which we increased until the diamonds faile to graphitize. This pressure wa reached at 30,000 kgm./cm.². H suggested in his paper that this point, 30,00 kgm./cm.² and 2,500° K., might lie near the diamond graphite equilibrium curve.

In Bridgman's experiment the possibility tha pressure reduced the rate of conversion of diamon to graphite cannot be ruled out. If so, the diamond would fail to graphitize at 30,000 kgm./cm.² in th few seconds at high temperature available. If this b the case, the point 30,000 kgm./cm.² and 2,500° K is still within the graphite region of stability.

The known evidence about the thermodynami stability for diamond and graphite led us to believ that diamonds could be formed in the pressure regio 30,000–100,000 kgm./cm.² at temperatures somewhere in the range of 1,000°–3,000° K.

## Pressure Vessels

Practically all known ultra-high-pressure generator are based on the principle of pushing a piston into a cylinder that encloses the substance to be subjecte

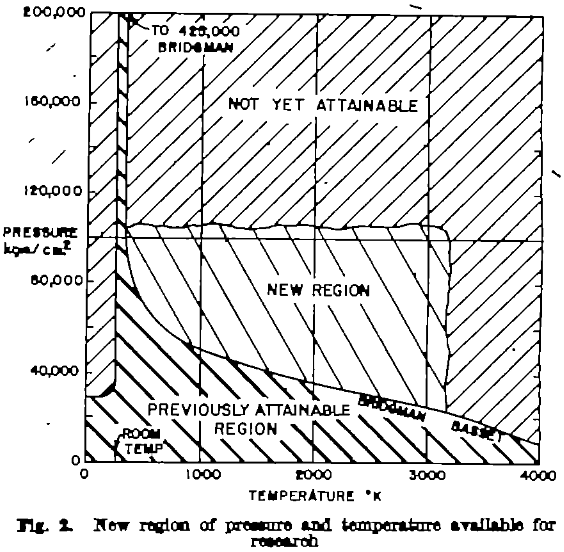

Fig. 2. New region of pressure and temperature available for research

o the pressure. The main factor which limits the maximum pressures hat can be reached within vessels is the strength of materials. The trongest steels in the most favourable form and size (piano wire, for example) have ultimate tensile strengths of the order of 14,000–21,000 kgm./cm.$^2$. Sintered carbides, such as 'Carboloy', have compressive strengths of the order of 50,000 kgm./cm.$^2$ or more. The pressure required for reasonably rapid synthesis of diamond was thought by our group to be above the compressive strength of 'Carboloy' in the range 50,000–100,000 kgm./cm.$^2$.

Merely making the walls thicker on a pressure vessel contributes very little to its pressure-holding ability after a certain wall thickness is reached. By using multiple support bands on the cylinder part (a technique used years ago in making large gun barrels), and special sealing gasket devices between

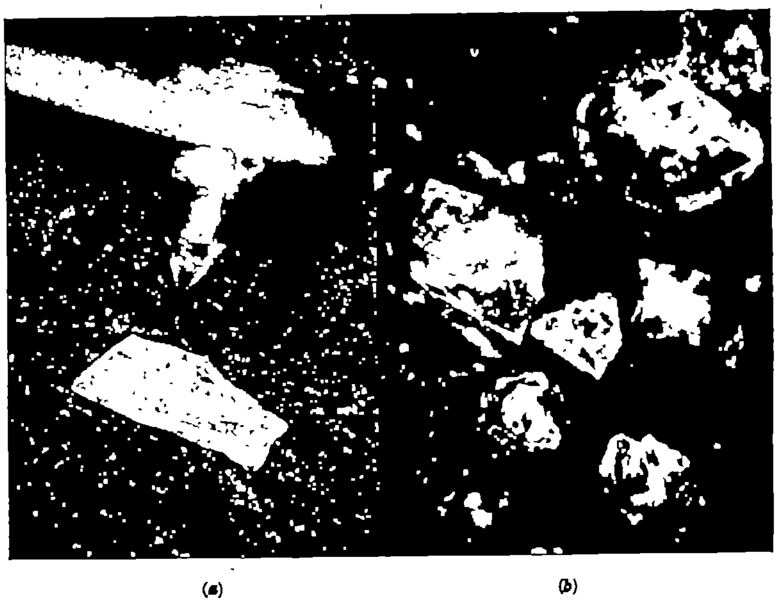

Fig. 3. Man-made diamonds. (a) 1-mm. diamond shown with phonograph needle. (b) 0·2–0·5-mm. octahedra

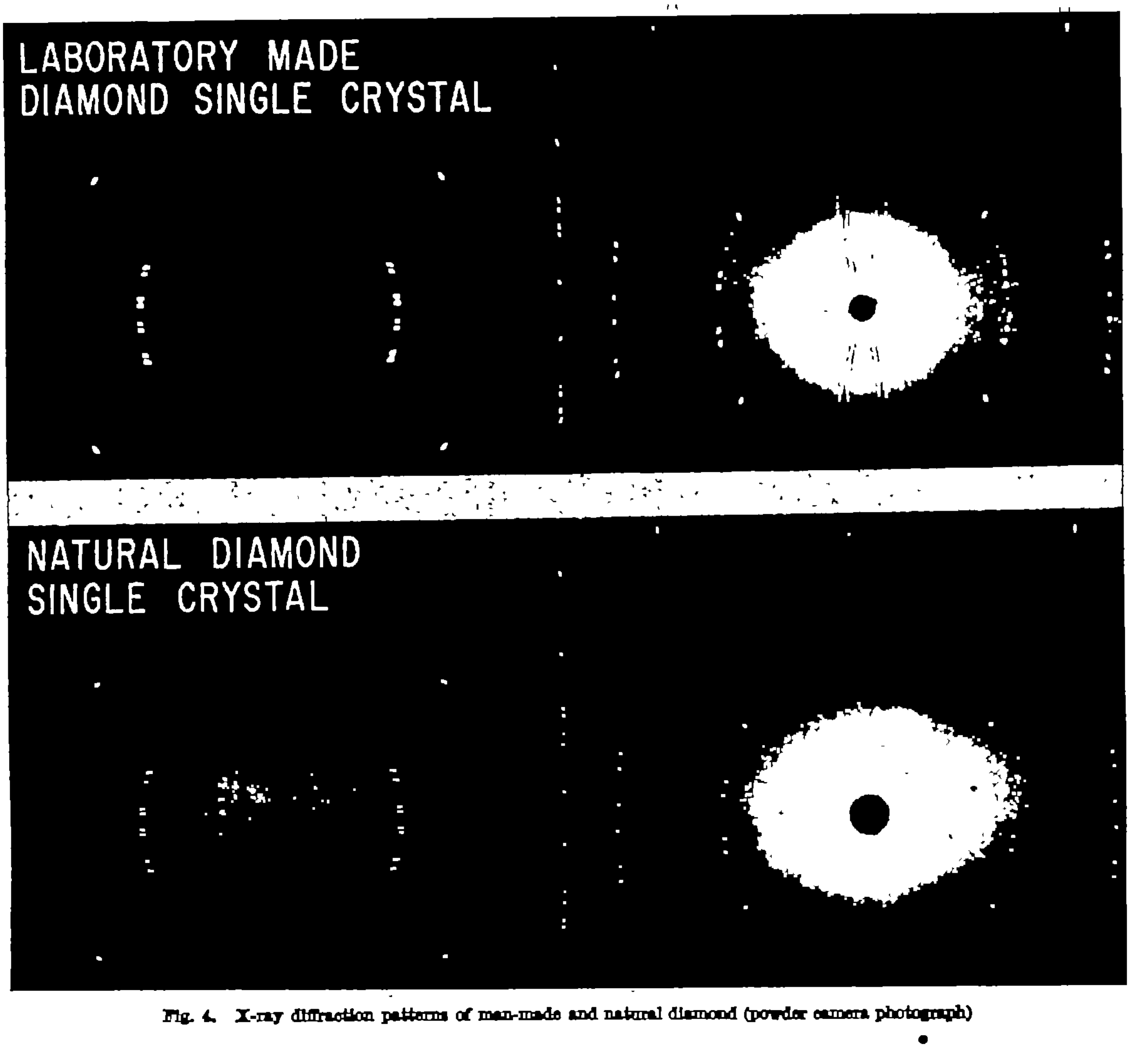

Fig. 4. X-ray diffraction patterns of man-made and natural diamond (powder camera photograph)

the piston and cylinder, Bridgman had developed pressure vessels good for 50,000 kgm./cm.$^2$ at room temperature. At high temperatures, materials get weaker and in general the attainable pressures are lower.

By developing some new ways of distributing stress and giving support to critical parts, our research group has succeeded in developing pressure vessels that operate at pressures up to at least 100,000 kgm./cm.$^2$ and temperatures in excess of 2,800° K. for hours of continuous operation.

## Calibration of Pressures and Temperatures

Pressures of this magnitude are calibrated by making use of four of the electrical resistance transitions observed by P. W. Bridgman[16] in the pressure region up to 80,000 kgm./cm.$^2$. The transitions are bismuth 25,400, thallium 45,000, cæsium 55,000 and barium at 80,000 kgm./cm.$^2$. For pressures greater than 80,000 kgm./cm.$^2$, the melting point of germanium as a function of pressure was used. It was found to decrease linearly with pressure to press loads corresponding to 100,000 kgm./cm.$^2$.

Temperatures inside the pressure cells are measured by use of thermocouples, melting points of materials, change of electrical resistance of wires, Curie points of magnetic materials, thermocolour paints, etc.

## Region now Available for Research

In Fig. 2 appears a pressure–temperature diagram, with linear scales on both axes, showing the new region of exploratory research which has been opened up by the development of our new high-pressure and high-temperature apparatus. Note that the newly attainable region covers about as much area as does all the region previously attainable.

## Diamond Synthesis

The new region of attainable pressure and temperature extended well into the diamond-stable region as defined in Fig. 1. Under these supposed diamond-stable conditions, processes were discovered which yielded diamonds ranging in size from less than 100 microns to more than 1 mm. along an edge. The various processes have been independently repeated more than one hundred times by a number of workers in this Company. Each time crystals were grown which pass the critical tests for identification with diamond. The present chamber sizes permit the synthesis of up to about ¼ carat of diamond material.

It is not necessary to introduce diamond seeds. Nucleation and growth occur spontaneously and profusely when diamond-stable conditions are reached. In some of the early successful work, diamond seeds were added; but growth occurred independently and apart from the added seed. In a few cases under special conditions, some growth has occurred on the seed crystals.

The man-made diamonds form in many of the different crystal habits found in Nature. These include octahedra, tetrahedra and dodecahedra. Some typical forms are shown in Fig. 3.

## Proof that Diamonds were Made

The proof that diamonds were made was based on the following conclusive tests:

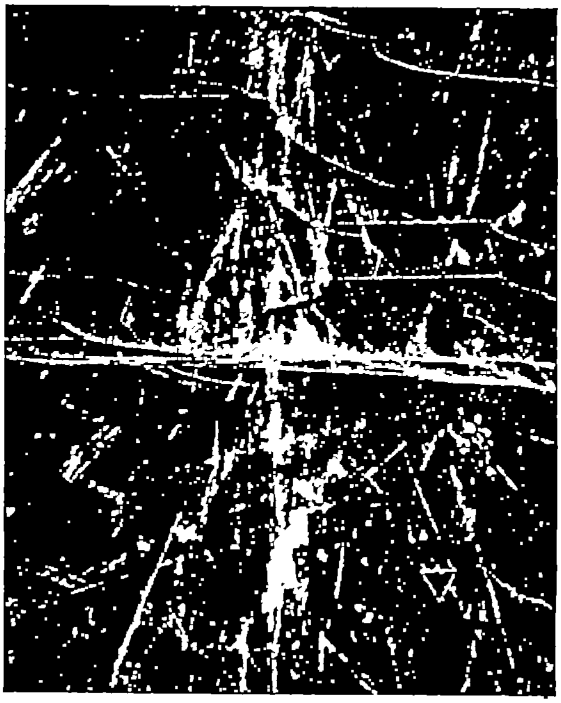

Fig. 5. Scratches made on natural diamond 111 face with man-made diamonds. A large number of scratches appear in a generally vertical direction down through the centre of the picture. The horizontal marks are growth steps on the crystal face. The triangular pit in the lower right-hand corner is also a typical growth mark found on diamond faces

(1) Identity of crystal structure of man-made diamonds to natural diamonds as determined by X-ray diffraction patterns (Fig. 4).

(2) Chemical analysis to show that crystals made were composed of carbon. Those analysed were 86 per cent carbon, 14 per cent inorganic ash identified with the growing media.

(3) Hardness tests. The laboratory-made diamonds were hard enough to scratch the hardest face, the 111 face, of natural diamond (Fig. 5).

(4) Repeatability. The synthesis of diamond has been repeated, entirely independently, by a number of workers in the General Electric Company. The diamonds so made pass the above conclusive tests for diamonds.

In addition, it was shown that the index of refraction for the man-made crystals was within the range 2·40–2·50. Mineral compilations[17] list five isotropic minerals having a refractive index near this range. Natural diamond is one of them and its value is 2·419. The other four are:

| | Index of refraction | Mohs' hardness |
|---|---|---|
| Franklinite, (Zn,Fe,Mn)O·(Fe,Mn)$_2$O$_3$ | 2·36± | 6 |
| Perovskite, CaO·TiO$_2$ | 2·38± | 5·5 |
| Sphalerite, (Zn,Fe)S | 2·428 | 3·5–4 |
| Eglestonite, Hg$_2$Cl$_2$.Hg$_2$O | 2·49± | 2·3 |

These four are ruled out as possibilities by the other critical tests.

The result of more than four years effort in this laboratory has been the development of equipment capable of holding pressures and temperatures in the diamond-stable region for hours at a time. Synthesis of diamond has been accomplished more than a hundred times. A number of people have independently repeated the various diamond-making processes successfully. These laboratory-made diamonds can scratch natural diamonds and have a crystal structure identical with natural diamonds.

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# NEWS and VIEWS

## The Astronomer Royal:

### Sir Harold Spencer Jones, K.B.E., F.R.S.

SIR HAROLD SPENCER JONES, Astronomer Royal at the Royal Greenwich Observatory, will retire on December 31. Sir Harold has had a long and distinguished career as an astronomer. Isaac Newton Student and Smith's Prizeman at Cambridge, chief assistant at the Royal Observatory during 1913–23, H.M. Astronomer at the Cape during 1923–33, and Astronomer Royal since 1933, he has left his mark on each of the institutions which he has served. His record of achievement at the Cape can only be compared with that of Sir David Gill; by their efforts and under their leadership the Cape Observatory was made a leading centre of astronomy. The tenth Astronomer Royal will always be associated with the move of the Royal Observatory from Greenwich to Herstmonceux. Conditions at Greenwich have been such that the observing instruments could with advantage have been moved half a century ago; but it required boldness to consider a move of the whole establishment to the scientific isolation of Herstmonceux. The numerous difficulties associated with this move, aggravated by post-war conditions, are known in detail only to the Astronomer Royal himself; but it is clear that they, and his far too numerous official duties outside the Observatory, have imposed an almost intolerable burden. He must be looking forward to the freedom to resume his own scientific work on the fundamental astronomical constants, just as astronomers everywhere will be looking forward to the results of this work.

### Prof. R. v. d. R. Woolley, O.B.E., F.R.S.

BRITISH astronomy is fortunate in the choice of Prof. R. v. d. R. Woolley as the eleventh Astronomer Royal. His researches on fluorescence and non-coherence in the formation of absorption lines, his investigation of convection in the solar photosphere and, with Allen, of the physical conditions in the solar chromosphere, have made him one of the leading authorities in astrophysics. As chief assistant at Greenwich during 1933–37 he became well acquainted with the older branches of astronomy and had the imagination to see how the equipment there could be used with advantage in the re-measurement of physical double stars. His skill in research is matched by his success as an organizer and administrator. Under his direction the Commonwealth Observatory at Canberra has become one of the leading observatories in the world. While carrying his own research into new fields, he has at the same time attracted and inspired a strong group of workers, and has provided modern equipment including a 74-in. reflecting telescope now in course of erection. He has been successful in securing co-operation with American astronomers, so that not only is there an active exchange between Canberra and the Pacific Coast observatories, but also the Yale–Columbia Station has been moved to Mount Stromlo.

Prof. Woolley goes to the Royal Greenwich Observatory at a critical period. The past fifty years have witnessed a dramatic revolution in astronomical knowledge and in the techniques of observation, much of it initiated on the American continent. In the same period, Greenwich has continued conscientiously to amass observations, though often with obsolescent equipment and methods and on programmes some of which stem from Airy. It is right and proper that the older methods and problems should not be lightly abandoned; but the time is more than ripe for a fundamental re-assessment of the functions of the Royal Observatory, its equipment and method of staffing.

## College of Aeronautics: Principal A. J. Murphy

PROF. A. J. MURPHY has been appointed principal of the College of Aeronautics, Cranfield, as from October 1. Prof. Murphy graduated at the University of Manchester with first-class honours in chemistry and later was awarded an M.Sc. of the same University. After a period as research assistant to Prof. C. A. Edwards in the Metallurgy Department at University College, Swansea, and later on the staff of the Metallurgy Department at the National Physical Laboratory, in 1931 he joined the firm of J. Stone and Co., Ltd., as chief metallurgist, and in 1946 became a director of that Company and also of Light-Metal Forgings, Ltd., and chairman of Stone-Fry Magnesium, Ltd. For the past five years Prof. Murphy has been professor of industrial metallurgy in the University of Birmingham, and, since 1953, director of the Departments of Physical Metallurgy and Industrial Metallurgy. He is a past-president of the Institute of Metals, and for the past six years has been chairman of the Inter-Services Metallurgical Council, and is also a member of a number of research associations and committees, including committees of the Aeronautical Research Council.

## Gold Medal of the Institute of Navigation: Captain P. van H. Weems

The Gold Medal for 1955 of the Institute of Navigation has been awarded to Captain P. van H. Weems, of the United States Navy (retired), for "his outstanding contributions to the general advancement of air and surface navigation over a period of more than thirty years". Captain Weems's "Star Altitude Curves" are still, after nearly thirty years, the leading form of graphical presentation of star data, and used in conjunction with a second-setting navigational watch, preferably adjusted to keep sidereal time, they provide the quickest way to a navigational fix. By his efforts the Greenwich hour angle, which he advocated as long ago as 1928, was eventually adopted for both air and surface navigation and is now a standard feature of most nautical almanacs. His text-book on "Air Navigation", which was first published in 1931, was awarded the Gold Medal of the Aero Club of France, and he has also written a standard text-book on marine navigation. These three examples represent only a small part of Captain Weems's contributions to a subject which has been, and still is, his life's work; but they serve to show his worthiness to receive the premier British award in the field of navigation.

## Royal Society of Edinburgh: Honorary Fellows

The following have been elected Honorary Fellows of the Royal Society of Edinburgh: Prof. Giorgio Abetti, formerly director of the Astrophysical Observatory, Arcetri, Florence; the Abbé Henri Breuil, prehistorian and archæologist, formerly of the Collège de France, Paris; Prof. L. E. J. Brouwer, Department of Mathematics, University of Amsterdam; Dr. Anton Bruun, University Zoological Museum, Copenhagen; Prof. M. Florkin, Biochemical Laboratories, University of Liège; Prof. N. E. Svedelius, Department of Botany, University of Uppsala; Prof. H. Yukawa, Department of Physics, University of Kyoto.

## Committee on Colonial Road Research

After consultation with the Department of Scientific and Industrial Research, the Secretary of State for the Colonies has appointed a committee to advise on matters of road research for the benefit of the Colonies. Dr. W. H. Glanville, director of road research, will be chairman, and the United Kingdom membership is as follows: Sir George Burt (Messrs. J. Mowlem and Co., Ltd.); Mr. R. L. Fitt (Sir Alexander Gibb and Partners); Mr. G. H. Hargreaves, deputy chief engineer (civil), Ministry of Transport and Civil Aviation; Mr. R. U. Law (Messrs. George Wimpey and Co., Ltd.); Mr. S. Mehew (Derbyshire County Council); Mr. F. W. Parker (Frederick Parker, Ltd.); Mr. J. L. Phipps (Bitumen Department, Shell Co.); Mr. J. Rawlinson (London County Council); Mr. R. W. Taylor (Crown Agents for Oversea Governments and Administrations); Prof. Gilbert Walker, Faculty of Commerce and Social Science, University of Birmingham; Sir Hubert Walker (Colonial Office); Mr. F. H. P. Williams, Colonial Road Research Liaison Officer, Road Research Laboratory (*ex officio* member). Representatives of Colonial Governments will also serve as members of the Committee.

Colonial Governments have indicated support for the establishment of a Colonial Road Research Section at the Road Research Laboratory to deal full-time with road problems peculiar to tropical and rapidly developing Colonial territories. A Colonial Development and Welfare Research grant has accordingly been made providing funds to meet the cost of the establishment and maintenance of the Section during the financial years 1955–57. Staff for the Section is being recruited, and it is hoped to commence work shortly.

## *Virology*

With the appearance of a new journal, *Virology* (pp. 140. New York: Academic Press, Inc.; 9 dollars per vol.), this useful, but ugly, word of doubtful parentage presumably takes its place as the official designation of the study of viruses. The journal has an impressive editorial board consisting of an editor-in-chief, two editors, and twenty associate editors. Among them are most of the leading virologists of the day; but it is, perhaps, a pity, if it is to be an international journal, that no European plant virologists are included. This new journal is to be welcomed for two reasons: first, since it deals with all viruses, it tends to counteract an unfortunate tendency to keep the different types of viruses in water-tight compartments and to regard plant viruses as something entirely unrelated to animal viruses; secondly, it will help to bring together the many contributions which, at present, owing partly to the extensive background of virus research, are widely scattered in journals often quite unconnected with the study of viruses. It is another step towards the building up of a separate status for the science of virology. The contents of the first number indicate the scope of the journal; there are three papers on plant viruses, three on virus diseases of the higher animals, and three dealing with bacteriophages and cognate subjects. The printing and appearance are of the high standard which we associate with the publications of the Academic Press. There is little doubt that *Virology* fills a definite gap in the literature of the subject, and we wish it every success.

## *Country-side*

To mark the golden jubilee of *Country-side*, the journal of the British Naturalists' Association, it is fitting that special tributes should be paid to the founder, E. Kay Robinson, and to Richard Morse. The journal first appeared in May 1905 as a penny weekly, and, despite vicissitudes, has regularly appeared since that time despite all the difficulties caused by war and lack of finance. Richard Morse took over the editorship in 1928 and has only recently given it up; he has been the main cause of its growth into the substantial journal it now is. Besides tributes, the jubilee number contains articles by H. N. Southern on British mammals; C. B. Williams on phenology; M. B. B. Heath on the night skies of summer; and Bernard C. Pickard on British grasshoppers and crickets. There are also a number of shorter sections describing recent observations by naturalists.

### Collected Papers of the Rowett Research Institute

As already noted (*Nature*, 173, 1124; 1954), summaries of the collected papers of the Rowett Institute became available last year for general distribution, beginning with the volume for 1953. The volume for 1954 has now been published as "Rowett Research Institute: Collected Papers, Summary and Subject Reviews", Vol. 11 (pp. 44, obtainable from the Reid Library, Rowett Research Institute, Bucksburn, Aberdeenshire; 5*s*.). The larger number of papers, seventy-six in 1954 against sixty-seven in the year before, reflects the growth of the Institute. The scope and diversity of its problems may be gauged from the following sub-titles of the summary, again written by the director, Dr. D. P. Cuthbertson: methods; microbiology of digestion; absorption; movements of ruminant stomach; animal behaviour; imbalance of nutrients; bracken poisoning; experimental liver necrosis; metabolism of fat; pig research; lactation; economies in feeding non-ruminants; man; reviews and general articles. There are two welcome innovations in the current volume: the titles in the list of papers are given cross-references to the relevant pages of the summary; and the volume carries two subject reviews covering several years of work on two important aspects of the Institute's research. One of the reviews, by Dr. A. T. Phillipson, is on absorption from the alimentary tract of sheep, and the other, which is by the staffs of the Applied and Farm Nutrition Departments, deals with the practical problem of winter keep. The publication will be welcomed not only by agriculturalists but also by many interested in the fundamental aspects of animal nutrition.

### Use of Fibrenyle

Mr. B. H. Newman, of the British Museum (Natural History), has recently described the use of fibrenyle in the preparation of palæontological specimens (*Mus. J.*, June 1955). In the alvar of 1930, a vinyl resin was used for repairing fossils. Later, asbestos fibres were mixed with the alvar and an exceedingly strong and resilient adhesive was obtained. Fibrenyle, a nylon–fibrous thermoplastic which is manufactured as a sheeting or in the form of a dough, has advantages over both the materials mentioned. The dough is dark brown, easily workable, and is soluble in acetone or industrial methylated spirit. The advantages of using this new material are that it can be obtained ready for use, the joint can be finished and made good with fibrenyle at the time of repair, its colour is in harmony with many fossils and it is light in weight.

### Social Medicine at Oxford

Referring to the review of "The Meaning of Social Medicine" (*Nature*, June 11, p. 1011), in which the reviewer wrote: "but when he [Prof. J. Ryle] died social medicine languished in the University [Oxford]", Dr. Roy M. Acheson writes: "Although it is true that the University's interest in it languished, the subject itself has continued to thrive. Since the Institute was finally closed in 1953 a small and extremely active department has continued without interruption. This department has consisted of a reader and a statistician as its sole University staff. They have been assisted by a physician on the permanent strength of the Medical Research Council, and a few other medically qualified research workers who have been employed on a temporary or part-time basis when funds from outside sources have permitted. With these meagre resources, an analysis of war-time civilian medical boards and of the Child Health Survey, two major studies which were begun before 1953, have been completed and the results published as a series of communications in the medical journals. New work has been undertaken on problems connected with old age, infant morbidity and mortality, tuberculosis in industry and acute leukæmia in childhood, and some of these new studies also have reached fruition. Finally, in the course of the past two months, papers have been read on two different aspects of the research of the department to the Royal Society of Medicine and to the Association of Physicians of Great Britain and Ireland".

### University of London

The following appointments in the University of London have been announced: Prof. D. P. Craig, professor of physical chemistry in the University of Sydney, to the University chair of chemistry with special reference to theoretical chemistry tenable at University College; Dr. B. G. Peters, senior principal scientific officer at Rothamsted Experimental Station, to the University chair of parasitology tenable at the Imperial College of Science and Technology; Dr. E. A. R. Braude, reader in organic chemistry in the Imperial College of Science and Technology, to the University chair of organic chemistry tenable at that College; Mr. G. Keith Allen, to the University readership in mining tenable at the Imperial College of Science and Technology; Dr. J. H. Burgoyne, senior lecturer in the Imperial College of Science and Technology, to the University readership in chemical engineering tenable at that College; Dr. G. L. Kingston, lecturer in physical chemistry in the University of Aberdeen, to the University readership in physical chemistry tenable at the Imperial College of Science and Technology; Dr. J. S. Webb, lecturer in mining geology at the Imperial College of Science and Technology, to the University readership in applied geochemistry tenable at that College.

### The Queen's University of Belfast

The Queen's University of Belfast has received the following grants: from the Rockefeller Foundation, 21,000 dollars over two years for the purchase of research equipment for use in the Department of Microbiology; from Imperial Chemical Industries, Ltd., £300 for three years to support work on heterogeneous catalysis; from Messrs. Gallaher, Ltd., £300 per annum under covenant to support work in the Department of Chemistry; from the Aliphatic Research Co., Ltd., £285 per annum for a research studentship in organic chemistry, together with expenses of special chemicals and equipment; from the Royal Society, £580 to support research in mathematics.

Robert E. H. Reid has been appointed to a lectureship in geology.

### The Australian National University, Canberra

Dr. I. F. Wright, of the Department of Natural Philosophy, University of Glasgow, has been appointed a research fellow in the Australian National University, Canberra, and will work in the Department of Nuclear Physics with Prof. E. W. Titterton. A visitor to the Department during

August 1955–August 1956 will be Prof. J. B. Warren, of the University of British Columbia, Vancouver.

In addition to 600-keV. and 1,250-keV. Cockcroft–Walton accelerators which have been in operation for some time, the 33 MeV.-electron synchrotron, originally installed at the Atomic Energy Research Establishment, Harwell, and which was moved to Canberra last year, has recently been brought into operation.

## Royal Commission for the Exhibition of 1851: Awards for 1955

THE Royal Commission for the Exhibition of 1851 has awarded senior studentships for 1955 (value £600–650 a year for two years) to the following for research at the universities indicated: A. D. Buckingham (Sydney), theoretical chemistry at Cambridge; H. E. Hall (Cambridge), physics at Cambridge; J. G. Hughes (Wales), botany at Cambridge; B. G. Forbes (Adelaide), geology at Durham. The Commission has also awarded the following overseas scholarships for 1955 (value £450–500 a year for two years). Canada: G. R. Freeman (Saskatchewan), physical chemistry at Oxford. Australia: J. W. G. Wignall (Melbourne), physics at Cambridge; Miss P. J. Hextall and R. F. C. Brown (Sydney), organic chemistry at Cambridge. New Zealand: R. G. Kulka (New Zealand), biochemistry at Oxford; J. B. Waterhouse (New Zealand), geology at Cambridge. South Africa: Miss E. M. Stephen (Witwatersrand), organic chemistry at the Imperial College of Science and Technology, London. Republic of Ireland: W. Hayes (Ireland), physics at Oxford. Republic of India: D. Premaswarup (Andhra), physics at Oxford. Pakistan: M. M. Khuda (Dacca), organic chemistry at the Imperial College of Science and Technology, London.

## Fourteenth International Congress of Pure and Applied Chemistry, Zurich

THE Fourteenth International Congress of Pure and Applied Chemistry will be held during July 21–27 in the Swiss Federal Institute of Technology, Zurich, under the presidency of Prof. P. Karrer, of the University of Zurich. In addition, the International Union of Pure and Applied Chemistry will hold its eighteenth conference during July 20–28. The Congress will deal with organic chemistry only, and the scientific programme consists essentially of five Congress lectures, nine section lectures divided between the three sections, and six hundred papers divided between the ten groups. The five Congress lectures will be as follows: Prof. V. du Vigneaud (Cornell University, New York), "Isolation, Structure and Synthesis of Oxytocin, the Principal Oxytocic Hormone of the Posterior Pituitary Gland"; Prof. C. Dufraisse (Collège de France, Paris), "La Photooxydation"; Prof. N. A. Nesmeyanow (Moscow Academy of Sciences), "Zweifache Reaktionsfähigkeit und Tautomerie"; Prof. C. K. Ingold (University College of London), "Developments in the Theory of Steric Hindrance"; Prof. K. Alder (University of Cologne), "Neuere Entwicklung der Dien-Synthese". The three sections will deal with, respectively: theoretical and physical organic chemistry; natural products; and synthetic, industrial and analytical organic chemistry. The ten groups are lettered *A–K* and cover the following topics: *A*, *B*, *C*, molecular structure, stereochemistry and reaction mechanisms; *D*, amino-acids, peptides, proteins, alkaloids and carbohydrates; *E*, *F*, *G*, aliphatic, alicyclic, aromatic and heterocyclic compounds (terpenes and steroids included) *H*, *J*, dyestuffs, high polymers and other syntheti organic compounds; and *K*, biological and medica chemistry, and analytical chemistry. Abstracts o the papers are being published in a special handbook which will be available at the Congress. The Congres and section lectures will be published in a specia autumn supplement (No. 2) of *Experientia* (subscription price, 26 francs; subsequent price, 32 francs) obtainable from Verlag Birkhäuser, Basle. Alternatively, the supplement can be ordered through the Secretary-General of the Fourteenth Internationa Congress of Pure and Applied Chemistry, Zurich 1 from whom further information on all other matter relating to the Congress can be obtained.

## Announcements

PROF. ARTHUR HOLMES, regius professor of geology in the University of Edinburgh, has been elected a foreign associate of the Paris Academy of Sciences.

SIR ARNOLD PLANT, Sir Ernest Cassel professor of commerce at the London School of Economics, has been appointed chairman of the Colonial Social Science Research Council in succession to Sir David Hughes Parry. Sir Arnold Plant is already a member of the Colonial Research Council, and has been chairman of the Colonial Economic Research Committee since 1945.

THE Seventh British Mathematical Colloquium will be held in Exeter during September 6–8. Those wishing to attend, who have not already registered as members, should write as soon as possible to the Organizing Secretary of the Colloquium at the University College of the South-West, Exeter, from whom further information can be obtained.

THE 1955 Biennial Exhibition of the School Nature Study Union will be held at Morley College, Westminster Bridge Road, S.E.1, on July 9, from 10 a.m. until 6 p.m. A variety of exhibits will cover the work of schools, training colleges, dealers, publishers, individuals and organizations interested in various aspects of biology. Further information can be obtained from the hon. exhibition secretary, Raymond Rivers, 12 Hillcote Avenue, Norbury, London, S.W.16.

THE Oliver Memorial Fund is offering an award of £50 to a British subject for original work or services in connexion with the research, organization or donor aspects of blood transfusion. Applications or information directing attention to suitable candidates must be submitted before August 31 to the honorary treasurer of the Fund, F. W. Mills, c/o National Provincial Bank, Ltd., Holborn Circus, London, E.C.1.

DURING June 1954 a conference of those interested in the conservation and protection of Nature in the Near East was arranged in Beirut and was attended by about fifty people from a number of countries in the Near East (see *Nature*, **174**, 289; 1954). The Proceedings, which have now been published by Unesco, include not only copies of the papers which were read but also full accounts of the subsequent discussions, as well as reports from the different study groups. It is printed in French and English.

ERRATUM. In *Nature* of July 2, p. 16, in announcing the award of the Manley–Bendall Prize, Dr. J. N. Carruthers is referred to as director of the National Institute of Oceanography; this is incorrect, Dr. Carruthers being assistant director of the Institute.

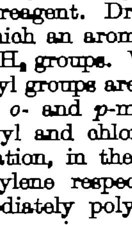
# ORGANO-METALLIC COMPOUNDS

THE symposium entitled "Organo-Metallic Compounds", which was held in the University of Manchester on April 21, was one of the annual symposia organized jointly by the Chemical Society, the Institute of Petroleum, the Royal Institute of Chemistry and the Society of Chemical Industry. These symposia have become very popular of recent years, and the interest in this year's subject was evident from the attendance of about four hundred members and the liveliness of the discussion. Dr. R. E. Fairbairn and Dr. H. Gudgeon, of the Manchester and District Section of the Royal Institute of Chemistry, are to be congratulated on their arrangement of so successful a meeting. The highlight was the evening lecture by Prof. K. Ziegler, of the Max-Planck-Institut für Kohlenforschung, Mülheim, who described some of the recent advances in the chemistry of organo-aluminium compounds and their important industrial applications, which were discovered in his laboratory.

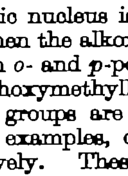
It was auspicious that this symposium should take place in Manchester, where the first professor of chemistry, E. Frankland, prepared the first organo-metallic compound, diethylzinc, just over a hundred years ago. The meeting was opened by Prof. E. R. H. Jones, who was chairman of the morning session; Mr. G. Osgood took the chair in the afternoon, and Sir Robert Robinson in the evening. The subject of the symposium was introduced by Prof. G. E. Coates (University of Durham) with a review of some recent developments in the chemistry of organo-metallic compounds. Although there has been little progress in the elucidation of the structures of the chromium phenyls and lithium alkyls, the realization that the lighter elements tend to use all their low-energy orbitals in forming covalent compounds has helped considerably in the understanding of the chemistry of the organo-metallic compounds of the lighter metals of groups 2 and 3 in the Periodic Table. The utilization of all low-energy orbitals is accomplished by the polymerization of the simple molecules, for example, $(R_2Be)_n$ and $(R_3Al)_2$, or, if suitable donor substances are present, by the formation of co-ordination compounds, for example, $R_3\overset{-}{\mathrm{Al}}\text{—}\overset{+}{\mathrm{N}}R_3$ or $K[BPh_4]$. Sometimes both methods are used together as in a series of compounds $(PMe_3)_2(Me_2Be)_m$ formed by the reaction of $PMe_3$ with $(Me_2Be)_n$. In an enclosed system the value of $m$ increases in a stepwise manner as the temperature is raised. The stabilities of the co-ordination compounds of the alkyls of the group 3 elements indicate that their acceptor properties increase from boron to aluminium, and then decrease regularly to thallium. Only thallium shows any evidence of $d_\pi$—$d_\pi$ bonding such as is found in the complex compounds of the platinum metals. The donor properties of the trimethyls of the group 5 elements in co-ordination to trimethylgallium decrease monotonously from trimethylamine to trimethylbismuthine.

The other extreme in structural type, when $d_\pi$-bonding by the metal is all-important, was next considered by Dr. J. Chatt (Akers Research Laboratories, Imperial Chemical Industries, Ltd.), who discussed the structure of the olefin complexes with metallic salts. He described the structure of the $[C_2H_4PtCl_3]^-$ ion in terms of atomic and molecular orbitals. No simple donation of π-electrons from the olefin to the metal can explain the properties of the stable olefin complexes. A structure was proposed in which the olefin-to-metal bond is a type of double bond. The σ-component of the co-ordinate bond is formed by donation of the π-electrons of the olefin to the metal atom, and the π-type component of the co-ordinate bond by the back donations of an electron pair from a $d$-orbital (or $dp$-hybrid orbital) of the metal atom into the anti-bonding π-molecular orbital of the olefin. It is significant that the only metals known to form stable olefin complexes have all their $d$-orbitals filled and are in low valency states, namely, Cu(I), Pd(II), Ag(I), Pt(II), Hg(II) and, recently added, Rh(I). Some of the more important properties of olefin complexes were described and shown to be consistent with the proposed structure.

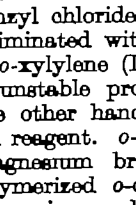
Dr. F. G. Mann (University of Cambridge) concluded the morning session with a paper on new reactions of Grignard reagents and their mechanisms. It is known that many β-substituted alkylhalides, for example, $ROCH_2CH_2X$, react with magnesium to give ethylene, $Mg(OR)_2$ and $MgX_2$, instead of a Grignard reagent. Dr. Mann has studied similar systems in which an aromatic nucleus is interposed between the $CH_2$ groups. When the alkoxymethyl and chloromethyl groups are in *o*- and *p*-positions to each other as in *o*- and *p*-methoxymethylbenzyl chlorides, the alkoxyl and chloro groups are eliminated with the formation, in these examples, of *o*-xylylene (I) and *p*-xylylene respectively. These unstable products immediately polymerize. On the other hand, the *m*-isomer gives a normal Grignard reagent. *o*-Methoxymethylaniline with phenylmagnesium bromide gives a small proportion of polymerized *o*-quinomonomethaneimine (II); but the major product is *o*-benzylaniline. The *p*-isomer behaves similarly; but there is no reaction with the *m*-isomer. The mechanism of these and many related reactions was explained in terms of electron shifts. The reactions are valuable in organic syntheses, especially for the preparation of some simple *o*-substituted benzene derivatives.



(I)



(II)

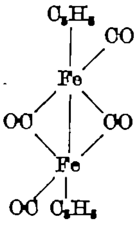


(III)

In the discussion which followed, Dr. G. Baddeley presented evidence that the alkoxyl group is eliminated only if the oxygen atom is free to turn out of the plane of the benzene ring; for example, the $o$-$CH_2$—O bond is not broken by action of magnesium on (III). Prof. Ziegler also mentioned experience of compounds where elimination does not occur; for example, the reaction of magnesium with $(RO)_2CHCH_2Br$ gives the coupled product $((RO)_2CHCH_2)_2$, provided $R$ is butyl or a higher alkyl group. Dr. E. A. Braude and Dr. N. R. Davies also took part in the discussion.

In describing organo-iron compounds, Dr. M. C. Whiting (University of Manchester) discussed some interesting acetylene complexes derived from iron carbonyl, and the analytical difficulties encountered in establishing their composition. Two distinct types of compounds were described. The first was exemplified by the products of the reaction of phenylacetylene with iron carbonyl in the presence of nickel carbonyl. It is a yellow, crystalline and very stable substance $(\text{PhC}{\equiv}\text{C})_2\text{Fe(CO)}_4$ isoelectronic with $\text{Cr(CO)}_6$. The second series was obtained by reaction of acetylenic substances with iron carbonyl hydride. They are acids, for example, $\text{H}_2[\text{Fe}_2(\text{CO})_7\text{CH}_3\text{C}{\equiv}\text{CH}]$; but the structure of the anion is unknown. Probably it is similar to that of the uncharged cobalt complex $[\text{Co}_2(\text{CO})_6R\text{C}{\equiv}\text{C}R]$.

Dr. P. L. Pauson (University of Sheffield) gave a historical review of the development of the chemistry of *biscyclo*pentadienyliron (ferrocene) and analogous compounds of the other transition metals. Of the more interesting reactions recently discovered is that of butyl-lithium to give dilithioferrocene, which has a lithium atom in each *cyclo*pentadienyl ring, and those leading to the synthesis of phenylferrocenes up to octa-phenylferrocene. The carbonyl compounds $\text{C}_5\text{H}_5\text{Fe(CO)}_2\text{Br}$ and $(\text{C}_5\text{H}_5)_2\text{Fe}_2(\text{CO})_4$ were described. An X-ray investigation indicates that the latter has the structure (IV) in which the $\text{C}_5\text{H}_5$ rings are perpendicular to the Fe—Fe bond, and the terminal CO groups perpendicular to the plane of the bridging CO groups.



(IV)

Dr. D. Bryce-Smith (King's College, London) described his investigation of whether free radical intermediates occur in the Wurtz reaction. Wurtz reactions were carried out in the presence of *iso*propylbenzene. Many free radicals react with this compound to form 2 : 3-dimethyl-2 : 3-diphenylbutane by the following reactions :

$$\cdot R\cdot + \text{PhCH(CH}_3)_2 \rightarrow R\text{H} + \text{Ph}\underset{\bullet}{\text{C}}(\text{CH}_3)_2\,;$$

$$2\,\text{Ph}\underset{\bullet}{\text{C}}(\text{CH}_3)_2 \rightarrow \text{PhC(CH}_3)_2\text{—C(CH}_3)_2\text{Ph}$$

The reaction of *n*-butyl iodide with sodium in *iso*propylbenzene gave, in addition to octane, about 1 per cent of 2 : 3-dimethyl-2 : 3-diphenylbutane, and the yield was similar when *n*-butylsodium was used in place of sodium metal. When lithium or *n*-butyllithium reacted with *n*-butyl halides in *iso*propylbenzene, the yields of 2 : 3-dimethyl-2 : 3-diphenylbutane were 15–20 per cent. Octane was also formed. The fact that 2 : 3-dimethyl-2 : 3-diphenylbutane was not formed by the thermal decomposition of alkyllithium, -sodium and -potassium in *iso*propylbenzene solution indicates that free radicals were not produced, contrary to recent suggestions by Morton and Cluff (*J. Amer. Chem. Soc.*, **74**, 4056 (1952); **75**, 134 (1953)). On the other hand, *n*-butyl radicals, generated in *iso*propylbenzene by the photolysis of di-*n*-butylmercury, gave 2 : 3-dimethyl-2 : 3-diphenyl butane in 50 per cent yield, but only traces of octane Although free radicals are formed in Wurtz reactions they probably contribute little to the coupling reaction and are produced in a secondary homolytic reaction between alkyl halide and alkali-metal alkyl

The organic compounds of lithium and their use in synthesis were admirably reviewed by Dr. E. A Braude (Imperial College of Science and Technology London). They offer definite advantages over Grignard reagents. They are more reactive, and their reactions are more free from side reactions, possibly because of the absence of such equilibria as $2R\text{Mg}X \rightleftharpoons R_2\text{Mg} + \text{Mg}X_2$. They are often easier to prepare, and many organic halides—for example, the vinyl compounds $R\text{CH}{=}\text{CHCl}$—which do not give Grignard reagents, yield lithium compounds. The lithium compounds of the vinyl derivatives retain their configuration about the double bond; thus *cis*-$R$CH : CHCl yields *cis*-$R$CH : CHLi. Dr. Braude also described numerous interesting syntheses in the aryl and heterocyclic series of organic compounds where the specific properties of lithium compounds are of especial importance.

It is not possible in the small space available to do justice to Prof. Ziegler's brilliant exposition of his recent researches into the properties of the alkyls of the lighter metals. He first described the pyrolysis of the methyl derivatives of lithium, magnesium and aluminium, then a new series of complex salts formed by aluminium alkyls and finally the use of aluminium alkyls as catalysts in the controlled polymerization of olefins.

The pyrolysis of the heavy-metal alkyls usually gives free alkyl radicals, and of the lighter-metal alkyls, olefins and metal hydrides. The above methyls decompose, however, in neither of these ways. Methane is always a product of the pyrolysis, and in the case of trimethylaluminium a residue of $\text{Al}_4\text{C}_3$ remains. Lithium and magnesium methyls yield acetylides; for example, $2\,\text{LiCH}_3 \rightarrow \text{CH}_4 + \text{Li}_2\text{CH}_2$, and then at higher temperature $3\,\text{Li}_2\text{CH}_2 \rightarrow \text{Li}_2\text{C}_2 + 2\,\text{LiH} + 2\,\text{Li} + \text{CH}_4$. Pyrolysis of such complexes as $\text{LiAlMe}_4$ give mixed carbides, for example, LiAlC.

Four types of complex salts derived from aluminium alkyls were described: $\text{Mg}[\text{Al}R_4]_2$; $R\text{Mg}[\text{Al}R_4]$; $\text{Na}[\text{Al}R_2\text{F}_2]$; and $\text{Na}[\text{Al}R_3\text{F}]$. Salts of the fourth type containing other halogens are stable only in the presence of the larger cations. The first are true salts; but the second do not conduct electricity and may be distilled in high vacuum. The third type, obtained from $R_2\text{AlCl}$ and NaF, decomposes on pyrolysis to give $R_3\text{Al} + \text{Na}_3\text{AlF}_6$, and so provides a method of converting $R_2\text{AlCl}$ into $R_3\text{Al}$.

In the polymerization of ethylene under pressure at 100–110° C. there are two stages: the growth reaction, $\text{al(CH}_2)_n\text{CH}_3 + \text{C}_2\text{H}_4 \rightarrow \text{al(CH}_2)_{n+2}\text{CH}_3$; and the displacement reaction, $\text{al(CH}_2)_n\text{CH}_3 + \text{C}_2\text{H}_4 \rightarrow \text{alCH}_2\text{CH}_3 + \text{CH}_2{=}\text{CH(CH}_2)_{n-2}\text{CH}_3$ (al = $\frac{1}{3}$ Al). The relative rates of these two reactions determine the length of the polymer chain. The displacement reaction is greatly accelerated by traces of colloidal nickel, poisoning of which is inhibited by phenylacetylene. In its presence smooth conversion of ethylene to butene is achieved. Prof. Ziegler also described schemes for the conversion of ethylene to higher *n*-alk-1-enes, and for obtaining *n*-alcohols from ethylene by oxidation and hydrolysis of the products of the growth reaction. His lecture was followed by an interesting discussion.

J. CHATT

# VISCO-ELASTIC BEHAVIOUR

A MEETING of the British Society of Rheology was held during April 29–30 in the Physics Department of King's College, Newcastle upon Tyne. About seventy members and visitors, including some from abroad, met to hear and discuss papers, under the chairmanship of Dr. L. R. G. Treloar, president of the Society.

The flow properties of a system consisting of a mixture of methylmethacrylate and pitch in tar oil were discussed by L. J. Wood and G. Phillips (Coal Tar Research Association). Measurements of viscosity and elastic modulus in the system, and also in one having no polymer added to it, have been made. Both the specific viscosity, defined as the viscosity divided by the retardation time, and the elastic recovery are practically independent of temperature, but markedly dependent on stress. The equilibrium rate of shear and the stress are related by a power law; the apparent viscosity increases as the stress is raised. The elastic recovery can be expressed as $1/e = 1/e_m + b/S$, where $e$ is the elastic recovery, $S$ the stress, $b$ the gradient, and $e_m$ the intercept of the reciprocal recovery/reciprocal stress plot. With increasing polymer concentration from 0 to 2 per cent the value of $e_m$ increases steadily and that of $b$ decreases slightly. Results to date suggest, however, that above this concentration $e_m$ and $b$ remain practically constant.

Dr. A. S. Lodge (Rayon Research Association) outlined a theory of the stresses and birefringence set up in flowing polymer solutions. The deformation of networks is considered to account for most of the viscous stresses observed, and flow birefringence is due to anisotropy of networks. The theory is developed from one which Treloar applied to the rubber-like state and compared with the results of experiments by Signer and by Schmidli.

Dr. K. Weissenberg (Colloid Science Department, Cambridge) demonstrated some interesting experiments, illustrating recent advances in the goniometry of flow, particularly those involving the three-dimensional case of pure shear. For quantitative experiments the material under investigation is contained between two rubber sheets, or within a rubber tube, and the displacements and forces across three mutually perpendicular planes are measured. The conventional technique of testing produced motions of 'simple' laminar shear, and in these the geometry is very complicated because there is a shear-dependent angular deviation between the main axes of the stresses, the strains and their various derivatives in time. The new method of testing resolves this complexity, as it produces motions of pure irrotational shear in which the main axes of all the stresses and strains and time derivatives remain always parallel to one another. The tube formation by rolling of a cylinder has now been established as a phenomenon of great generality which may be regarded as counterpart to the well-known normal pressure phenomenon occurring in elastic and visco-elastic solids and liquids (such as the climbing up of a material on a rotating stirring rod).

Drs. H. Kolsky and F. C. Roesler (Imperial Chemical Industries, Ltd., Welwyn) showed how relaxation spectra may be derived from mechanical measurements on solids. In attempting to correlate the mechanical behaviour of materials with the microscopic processes which cause them, it is desirable to obtain what is termed a 'relaxation–time spectrum' of the material. This treatment postulates that the mechanical behaviour of the solid corresponds to the summation of an infinite number of relaxing elements each with its own time of relaxation, and the spectrum describes the relative strength of these elements. Thus peaks in the relaxation–time spectrum would correspond to the presence of a large number of mechanisms which have characteristic times of values around the peak, and in many cases, especially with metals, it has been possible to correlate these peaks with specific processes taking place in the material.

A number of methods have been developed for the determination of relaxation–time spectra from experimental data and for the conversion of results of one type of measurement into another. The basis of this method is the Fourier analysis of the experimental curve on a logarithmic plot into its separate components. Each component is then multiplied by an appropriate eigen value, and a new curve is thus synthesized. These methods have been tried on a number of published experimental results, and have proved to be extremely effective in dealing with these problems. Recently a numerical iteration method, which avoids the necessity for an explicit Fourier analysis, has also been developed; and while this is not of such wide application as the other approach, in the cases where it may be used it is generally more convenient and may be shown to be equivalent to the more detailed method which employs Fourier analysis.

J. E. Caffyn and L. Goodfellow (Physics Department, Durham) described the mechanical and electrical properties of sodium chloride and made a survey of the effect of mechanical deformation on the electrical conductivity. Apparatus to enable transient electrical phenomena in sodium chloride to be investigated and its application to the study of the changes in electrical properties (particularly conductivity) of ionic crystals were described. Typical results were given for several of the alkali halides, and their variations among different crystals were discussed. A new electrical phenomenon associated with the plastic deformation of the alkali halides and its dependence on temperature was mentioned. Its significance for the earlier measurements was discussed.

Dr. R. Roscoe (Physics Department, Newcastle) spoke of the interpretation of mechanical relaxation in solids. It follows from Boltzmann's principle of superposition that the mechanical behaviour of any material which shows linear visco-elastic effects can be represented in terms of a spectrum of relaxation times or, alternatively, as a spectrum of retardation times. The question arises as to which of these two spectra can be more directly interpreted in terms of the molecular relaxation processes which are ultimately responsible for the visco-elastic effects. It is shown that, when these processes consist in the breaking of linkages in a solid structure, the spectrum of relaxation times for the molecular processes is identical with the retardation time spectrum, provided there is only weak interaction between the individual relaxation processes.

P. J. Kirby (James A. Jobling and Co., Ltd., Sunderland) described results of experiments on 'Pyrex' glass from which the relaxation spectrum over a range of temperature up to the annealing range can be derived. A migration of alkali ions in the vitreous network gives rise to another relaxation process—in electrical conductivity—and the half-maximum widths of the relaxation spectra are compared with those relating to the visco-elastic effects of the entire network. The distribution of relaxation periods suggests a distribution of the activation energies governing the process. A measure is thereby obtained of the associated distribution of potential barrier heights in the vitreous network. The migration of a network-modifying ion is subject to a wider range of irregularity of activation energy than the general visco-elastic deformation of the network-forming ions.

Drs. A. W. Pryor and E. G. Richardson (Physics Department, Newcastle) have carried out experiments using ferrite transducers of 50 and 100 kc./s. excited magnetostrictively to send torsional waves down long rods made of metal or glass. By varying the temperature in a container surrounding the rod, and measuring the attenuation and phase-shift of transmitted pulses, the elastic modulus and viscosity of the material of the rod or of a liquid under shear in the container were measured. The absorption is less in solutions of rubber in benzene than in pure solvent. The fact that the absorption in these highly viscous solutions is many times less than those calculated from the classical formula—by substituting the known shear viscosities—can be explained by assuming that the high viscosities are by-passed by associated elasticities (that is, these liquids behave at high frequencies more or less as solids).

## ADOPTION OF THE UNIFIED SCREW THREAD BY BRITISH INDUSTRY

REPRESENTATIVES of many branches of the engineering industries, the Service Departments and the nationalized industries met recently at the British Standards Institution, under the chairmanship of Mr. H. A. R. Binney, director of the Institution, to review how far the Unified Screw Thread has, in fact, been adopted in Great Britain. The conference was called in response to many inquiries as to how far and how fast the change-over from the Whitworth Thread has progressed during the seven years since the signing of the "Declaration of Accord" between the United States, Britain and Canada, under which the three countries agreed to accept the Unified Thread.

During the years immediately following the signing of the Accord, several British Standards were developed by the Institution for Unified bolts and nuts, screwing tackle and other details necessary for the implementation of the agreement. In the early stages manufacturers of bolts and nuts were unable to meet all the demands for Unified bolts and nuts; but recently the position has improved. The draft standard for black bolts and nuts in the 'normal' series will soon be issued, and manufacturers now foresee no serious difficulty in meeting any future demands likely to be made upon them. The motor, aircraft, oil and chemical industries and the Atomic Energy Authority have all adopted the Unified Screw Thread, and have found that the change-over has not been nearly as inconvenient as they had thought it would be. One of the major difficulties to be faced is not so much the change from Whitworth to Unified bolts and nuts; but the fact that tapped holes are employed in such a great variety of engineering equipment and that this equipment is produced in a wide range of separate industries which includes many comparatively small firms. The opinion at the conference was that the three key groups which can do most to further progress of the change-over are large organizations, such as the nationalized industries, with their ability to influence the market by the many large orders for equipment which they place; the stockist, who is responsible for supplying small orders to a great number of small firms; and the many small manufacturers, who produce miscellaneous industrial equipment with tapped holes.

Although the rate of the change-over to the new thread has been considerably faster than might have been expected some four or five years ago, the advantages to be achieved by working to a single screw-thread system, particularly one which there is every reason to believe will receive increasing support in the Commonwealth and other overseas markets, are so great as to make it very desirable that the tempo of the change-over should be increased. The British Standards Institution was asked to take such steps as may be appropriate to secure wider publicity for this objective, and it was decided that the conference should meet again in about six months time to review the progress then made.

## SUBJECT SPECIALIZATION AND CO-OPERATIVE BOOK PURCHASE IN BRITISH LIBRARIES

IN Library Association Pamphlet No. 12 (pp. 32; 1955), Mr. K. G. Hunt, chief librarian of Hammersmith Public Libraries, contributes a useful survey of schemes in subject specialization and co-operative book purchase by libraries in Great Britain, concluding with a quotation from the second interim report (January 1954) of the Working Party of the Library Association. Mr. Hunt gives first some examples of comprehensive schemes arranged by the universities and special libraries. In London, for example, while each of the specialist hospitals covers its own subject, the University Library is building up a large collection of medical periodicals. At Oxford the book selection committee of the Science Library, on which the departmental libraries are represented, avoids a duplication of expensive specialized scientific works. Most of the examples given by Mr. Hunt are outside the field of science, but for medicine the London School of Hygiene, the Medical Research Council, the Royal College of Physicians, the Royal College of Surgeons, the Royal College of Veterinary Surgeons, the Pharmaceutical Society and the Medical Science Library of University College formed a co-operative group, to which the British Medical Association also is attached; this group attempts to arrange that each library keeps to certain fields and informs the others of changes of holdings of periodicals.

A fairly full account of the Metropolitan Special Libraries scheme, inaugurated in 1948 by London Metropolitan public libraries, follows next in the pamphlet. This scheme enabled its constituent libraries to give a service far in excess of what was previously available and has also contributed towards a solution of the storage problem. Later, in January 1950, the South-Eastern Regional Library Bureau's scheme came into existence, under which an attempt was made to ensure that all newly published books were bought somewhere in the area. Afterwards, responsibilities under the scheme were assigned according to the resources of each library, and each library was also asked to become responsible for the biographies of persons connected with their special subjects. Later still, schemes were started among the public libraries of the Northern Region, the East Midlands (limited to books in foreign languages), Wales (for certain specialized books), and in April 1954, in the North-Western Region (in which seventy-five libraries participated, but periodicals and purchase of older books are excluded).

Mr. Hunt suggests that the most necessary future developments are likely to be concerned with increasing the provision of foreign books, and co-ordinating and improving the supply of periodicals. Such problems are mainly the concern of university and special libraries; but the various regional schemes of public library co-operation could easily be co-ordinated and improved by dividing the responsibilities for still higher degrees of specialization between the specializing libraries in each subject in each region on a systematic and orderly basis. This would give strong support to any co-ordination attempted by research institutions acting alone.

# AMERICAN PHILOSOPHICAL SOCIETY

## YEAR BOOK FOR 1954

THE Year Book for 1954 of the American Philosophical Society* includes E. G. Conklin's brief history of the Society, its charter and laws, reports of standing committees, and the usual lists of members and biographical memoirs, among which may be noted those of M. T. Bogert, Sir Henry Clay, K. T. Compton, H. E. Ives, T. Lyman, R. A. Millikan and H. A. Spoehr. The report of the Committee on Research lists 165 grants, totalling 144,770 dollars, and one conditional grant of 600 dollars, made during the year from the Penrose Fund. Six of these, totalling 8,300 dollars, were in astronomy, physics and chemistry; thirty-six, totalling 29,195 dollars, in zoology, botany, anthropology, biochemistry, physiology, psychology and related sciences; forty, totalling 37,755 dollars, in history, political science, economics and sociology; and eighty-three, totalling 72,520 dollars, in ancient, medieval and literary history, archæology, philology, art, literature, etc. Eight grants, totalling 21,336 dollars, were made from the Johnson Fund and six grants, totalling 13,335 dollars, from the Daland Fund for Research in Physical Medicine.

Reports from recipients of grants occupy some two hundred and fifty pages of the report of the Committee on Research. Among the more detailed of these summaries may be noted those of H. B. Levi on recent progress in the field of radiocarbon dating; M. K. Hecht on the comparison of recent and fossil amphibian, reptilian and mammalian faunas in the Bahamas; A. Carr's survey of the zoogeography and migrations of sea turtles, which indicates that under present conditions the green turtle is likely to be extirpated from the Caribbean within twenty years although it appears to be peculiarly amenable to conservation; K. T. Guthe's study of the myosin adenosine triphosphate of the echinoderm *Stichopus*; and C. J. Heusser's studies of glacier fluctuation, forest succession and climatic variation in the Canadian Rockies and pollen profiles from the Queen Charlotte Islands, northern Vancouver Island and northern coastal British Columbia. R. Singer reports on studies of the Basidiomycetes of South America in European herbaria, and J. L. Angel on the evidence as to human biology, health and history in Greece obtained by careful study of human bones excavated in Greece; M. J. Herskovits reports on field work in sub-Saharan Africa to assess how pre-existing cultural patterns react to different rates of industrialization and technological innovation, within the limits of differing Colonial policies, while W. B. Schwab discusses the analysis of material collected in a socio-economic survey of the Yeruba community in Nigeria with the object of examining the interrelations of urbanization and acculturation.

D. R. Brown summarizes an investigation of the effects on cortical currents of organic damage to the brain by the use of a behavioural measure involving the kinesthetic figural after-effect which appears to support the assumption that the lesion introduced in a lobotomy sets up a temporary physiological disturbance in the cortex which will change the conductivity of the higher brain centres and therefore the kinesthetic after-effect. W. S. Verplanck describes an interchange of experimental techniques and theoretical structures between European ethologists and American psychologists; and L. S. Ciereszko gives an account of the determination of vanadium in tunicates and of acidity in *Ascida nigra* as well as the collection, identification and preparation of various tunicates, sponges and gorgonians. N. C. Li reports on metal complexes of peptides containing sulphur, H. W. Neuberg on the metabolism of phosphophenolpyruvate, F. W. Crane on the spores of *Dryopteris*, and G. T. Johnson on the Mississippi species of the Trypetheliaceae.

In the social sciences, D. W. Meinig describes and analyses the nature of man's contact with the major agricultural frontier of the Pacific north-west and the Columbia Plateau grain region from 1805 to about 1910, and C. T. Mason an inquiry into the non-profit research institute and how it functions. In archæology, H. A. Carey reports on a study of the ancient Indian culture centring in the Casas Grandes Valley, north-west Chihuahua, Mexico; F. E. Day on early Islamic pottery related to that of Tarsus and 'Arija Hafir'; K. P. Kent on the textile industry of prehistoric south-western Pueblo peoples, particularly with regard to weaving in cotton; R. S. MacNeish on the development of agriculture and the concomitant development of civilization in Meso-America, Tamaulipas, Mexico; H. C. Palmatary on Brazilian, Swedish and American Tapago pottery; and A. N. Stilwell on pottery from the Potters' Quarter in Corinth. P. Drucker describes a study of intertribal organizations of the north-west coast of the United States, I. Greenwald a study of the history of goitre, and C. Eisele one of C. S. Peirce and the history of science. Investigations of the freshwater ostracods of South Carolina are described by E. Ferguson, taxonomic and ecologic researches on the ants of Nevada by A. G. Cole, and a detailed field study of spring Orthoptera in western and south-western States by J. A. G. Rehn.

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* American Philosophical Society. Year Book, 1954. Pp. 605. (Philadelphia: American Philosophical Society, 1955.)

# FINE STRUCTURE OF CELLULOSE AND OTHER MICROFIBRILLAR SUBSTANCES

By V. BALASHOV and

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THE sub-microscopic structure of matter has long been investigated by deducing it from the manner in which it scatters either electromagnetic or particle rays. A method of stating this relation in a most elegant form is offered by the Fourier transform which is sufficiently general to include scattering of electrons as well as of X-rays. X-ray crystal structure analysis, however, cannot be employed when we have wave-lengths much shorter than 0·5 A., since incoherent scattering, which is not governed by the Fourier transform, becomes dominant. For these shorter wave-lengths recourse has to be made to electron diffraction. Electron diffraction diagrams of *Valonia* cellulose have already been published from this laboratory[1], and it is the purpose of this article to examine some of the features of these diagrams which were not discussed at that time.

Hettich[2] pointed out that the transform of any group of atoms will describe the contribution of that group to the total scattering from any crystal in which it may occur. Transforms of molecules which consist mainly of parallel hexagons have one feature in common: they all tend to have hexagonal symmetry[3]. Since for a periodic structure, that is, a crystal, the transform reduces to its own weighted reciprocal lattice, the latter often exhibits symmetry of the transform which can be observed on the diffraction photograph. Electron diffraction diagrams of *Valonia* cellulose show a fairly well-developed hexagonal shape of the pattern (Fig. 1). The orientation of this hexagonal distribution of reflexions with respect to the direction of the microfibrils (Fig. 2) indicates that the glucose residues are arranged in such a way that two sides of the glucose residue rings are oriented approximately parallel to the fibre axis. This confirms, therefore, the orientation assumed in the commonly accepted structure of native cellulose[4,5].

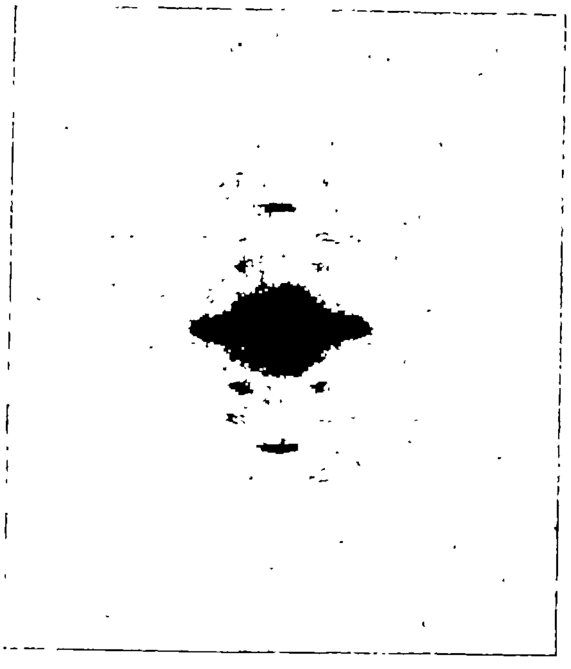

Fig. 1. Electron diffraction diagram of a single set of microfibrils of *Valonia* cellulose. Note the hexagonal shape of the pattern and the low intensity of the first and seventh layer lines

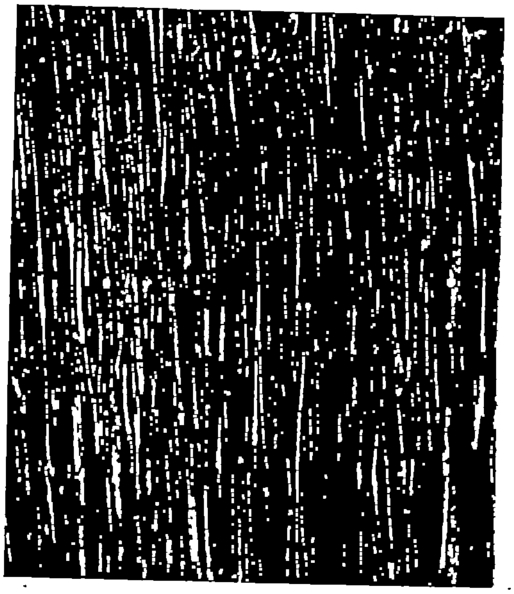

Fig. 2. Electronmicrograph of *Valonia* cellulose microfibrils in correct orientation with respect to Fig. 1 (× 30,000; shadowed Pd—Au)

The same electron diffraction photographs show also very prominently the effect of thermal motion of the cellulose chains. Since the wave-lengths used in these observations are about twenty times shorter than that of copper $K\alpha$ radiation, the intensities of diffracted rays are much more sensitive to molecular and atomic movement. The thermal vibration of the atoms is mainly shown in the direction perpendicular to the length of the chain, longitudinal waves in the direction of the chain-length being negligible. Thus the reflexion from the planes which are parallel to the chain-length fades away at much smaller Bragg angles than do the reflexions due to planes normal, or nearly normal, to chain-lengths.

At present, using the Philips electron microscope, it is possible to record nine layer lines above and below the equator. It is important to note that the distribution of intensities among the layer lines is such that, apart from very low intensity planes of the type $\{h1l\}$, there is another similar group of planes $\{h7l\}$. This phenomenon, being closely connected with the atomic architecture of the unit cell of cellulose, is a valuable guide in the refinement of the structure of native cellulose.

In contrast with the X-ray method, the amount of scattering material used in electron diffraction is enormously decreased, and thus the chance of having all scattering crystalline regions oriented in very nearly the same way is much higher. As a consequence the reflexions appear as fairly sharp spots. In fact, the electron diffraction pattern of native cellulose has more resemblance to a single crystal oscillation-rotation picture than to a fibre photograph.

The atomic scattering power in the diffraction of electrons is about $10^{8}$ times higher than for X-rays. Hence, although the collimating system has very

Table 1

| Microfibrils | Thickness in A. | Authority |
|---|---|---|
| *Valonia* cellulose | c 200 | Preston[7] |
| Ramie cellulose | 100 | Mühlethaler[11] |
| Hemp cellulose | 100 | ,, |
| Cotton cellulose | 100 | ,, |
| Bacterial cellulose | 100 | Franz and Schiebold[12] |
| Tunicin cellulose | 250 | Frey-Wyssling and Frey[13] |
| Baker's yeast | 250 | Houwink and Kreger[14] |
| Silk fibroin | above 100 | Hegetschweiler[15] |
| Fibrous insulin | 100 | Farrant and Mercer[16] |
| Deoxyribonucleoprotein | 90–120 | Himes and White[17] |
| Flagella of *Proteus vulgaris* | 120 | Astbury[18] |
| Tropomyosin | 250–300 | Astbury, Reed and Spark[19] |
| Actomyosin | 120 | Astbury[20]; Perry *et al.*[21] |
| Rod-like bodies of tobacco mosaic virus | 150 | Bernal and Fankuchen[22] |
| Vanadium pentoxide strands | 200 | Mühlethaler[23] |
| Crysotile (Italy) | 230 | Fankuchen and Schneider[24] |
| 'Harsh' crysotile (U.S.A.) | 250 | ,, ,, ,, |
| Canadian crysotile | 200 | ,, ,, ,, |

Table 2

| Miscellaneous | Thickness in A. | Authority |
|---|---|---|
| Carbon soot | 200–300 | Ardenne and Hofmann[25] |
| γ-FeOOH particles | 100 | Fricke, Schoon and Schröder[26] |
| α-$Fe_2O_3$ particles | 100–200 | ,, ,, |
| Iron airsol particles | 100–200 | Beischer[27], Ardenne[28] |
| Flakes of $Mg(OH)_2$ | 100 | Marx and Wehner[29] |
| Liquid helium II film | 190–230 | Burge and Jackson[30] |
| Liquid helium II film | 170–220 | Atkins[31] |

narrow openings and the distances between specimen and film in the electron microscope are of the order of tens of centimetres, the exposure time is usually a fraction of a second. On the other hand, the electron beam, being so strongly scattered, can pass through very thin layers only. From the formation of the spot pattern on the electron diffraction photograph of cellulose it follows that the thickness of the crystallites in the single layer of the cell wall of the alga *Valonia* is about 100–500 A.[6].

These numerical values lead to rather important conclusions. In the course of an investigation of the structure of the cell wall of *Valonia* it was shown[7] that microfibrils forming the cell wall are of width 200 A. More accurate data[8] obtained in 1951 revealed that the microfibrils vary in width from about 100 A. to about 350 A. and are flattish ribbons with the thickness to width ratio lying somewhere between 1/3 and 1/7. Comparison of the thickness of the crystallites derived from the electron diffraction pattern (from the single layer of *Valonia* cell wall) with the width of the microfibrils indicates strongly that the latter are in fact almost pure crystalline rods. It seems probable that the same considerations could be applied to all those algae in which the wall architecture resembles that of *Valonia*[9]. As has already been pointed out[9], it may not be concluded that the microfibrils of all celluloses are single crystals; on the contrary, it is clear that in bacterial cellulose and the celluloses of higher plants the internal structure may be of the general type figured by Frey-Wyssling[10], that is, with a lower degree of crystallinity.

Investigation along these lines concerning the fine structure of the crystalline state of native cellulose is continuing. The observation, however, that the microfibrils of cellulose are of the same order of diameter irrespective of their internal structure leads irresistibly to the speculation that there might be something special about dimensions centring roughly around 200 A. It is interesting, therefore, to note the order of size of various fibriform bodies (visible in the electron microscope), and we present in Tables 1 and 2 some of the data we have found in the literature. This is to direct attention to the remarkable similarity in size between the finest units visible in a number of substances of very different chemical constitution. We do not at the moment wish to comment further, nor indeed are we perhaps capable of usefully doing so; but it would seem reasonable to suggest that there may be some principle of structure conferring special stability in fibres or sheets about 200 A. thick. The microfibril of cellulose might then be not a biological unit, as we had thought, but a thermodynamic one. [May 4

*Note added in proof.* Since the above communication was presented, our attention has been directed to an article by R. Fürth (*Exp. Med. Surg.*, 13, 17; 1955) on the theoretical implications of fundamental dimensions in biological material.

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# SYMMETRY OF THE SECOND EXCITED SINGLET STATE OF BENZENE

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ALL π-electron theories have agreed in assigning the first singlet excited state of benzene, that responsible for the band-system at 2600 A., to the trigonally symmetrical species $B_{2u}$; and this assignment has since been fully established by experiment[1]. However, agreement between the different theories does not extend to the second excited singlet state—

that involved in the band system at 2000 A. Moreover, the nature of this state has not yet been made clear on experimental grounds, though the importance of the question, as the simplest crucial test of π-electron theories, is widely recognized.

This second state was originally assigned to the other trigonal species $B_{1u}$, in 1938, by Goeppert-Mayer and Sklar[2], on the basis of a calculation of benzene energy-levels by the method of molecular orbitals. In 1950 Craig extended this method outside its basic framework of the direct description of each molecular state in terms of a specified configuration of electrons in molecular orbitals, by computing the effect of configuration interaction, that is, resonance between the various possible distributions of electrons among orbitals[3]. On this broadened basis, Craig found the second excited level of benzene to belong to the degenerate class $E_{2g}$, the trigonal $B_{1u}$ level lying considerably higher. Also in 1950 he showed that the valency bond method, when extended within its own framework by the inclusion of polar structures[4], as is particularly necessary for the discussion of excited states, which are for the most part strongly polar, also gave the second excited state as an $E_{2g}$ state, the $B_{1u}$ state again lying considerably higher. The valency-bond method, though it employs bond orbitals rather than molecular orbitals, is essentially a resonance, or many-configuration, method; and so it appears to be the typical result of resonance among many electronic distributions that the degenerate $E_{2g}$ level of benzene lies lower than the trigonal $B_{1u}$ level. Since 1950, a number of authors[5] have continued to support the first assignment on the ground that, although Goeppert-Mayer and Sklar's form of the molecular orbital theory was not wholly satisfactory, other forms of it, particularly semi-empirical modifications, would have less need for account to be taken of configuration interaction, and so would continue to give the typical single-configuration result that the $B_{1u}$ state lies lower than the $E_{2g}$ state.

Here, then, is a clear issue; but in treating it, one must keep in mind such other alternatives as cannot already be shown to be impossible, even if they might appear improbable. One such possibility has been suggested[6]; and it is that the second singlet band-system of benzene constitutes the first member, with $n = 3$, of the allowed Rydberg series of states $2p\pi \rightarrow ns$. This implies an upper $A_{2u}$ state; and the diagnostic feature of the proposal is that such a transition must be polarized perpendicularly to the aromatic plane. However, Craig and Lyons made it very probable, by reference to the corresponding band-system of hexamethylbenzene, which they studied with polarized light in the layer-plane crystal of that substance[7], that the main intensity of the system is polarized in the aromatic plane. All pure π-type non-ionizing transitions must be polarized in the aromatic plane. This evidence is strong, but not perfectly conclusive, because the magnitude of the spectral disturbance, due to crystal forces, can only be roughly estimated; but we do not believe that it could be large enough qualitatively to invert the conclusion drawn. A subsidiary argument is that such Rydberg bands would be expected to be sharp. The bands of the system at 2000 A. are far from sharp. However, certain π-type transitions contain in their own nature a cause of band diffuseness, apart from any diffuseness that might be imposed on them by external perturbation.

We shall keep in mind also some just conceivabl interpretations of the second band-system whic have not been suggested before. One is that it ma be a π-type transition to a forbidden, partly pola $E_{1u}$ state, calculated by the valency-bond metho to lie next above $E_{2g}$ (and not to be confused wit the allowed, fully polar $E_{1u}$ state, which lies highe still). Another assumes that some current assignments of higher Rydberg terms, which are not full proved, are incorrect, thus allowing our state to b a forbidden *s*-type Rydberg state of symmetry $E_{1g}$. But the convenient procedure is to keep all suc ideas in reserve, for a subsequent consideration of an modifying effect they may have on the conclusion t be drawn from an attempt first to treat the questio of assignment as a straight issue between the contrar indications of single-configuration and resonanc theories. So we first set down the expected spectra characteristics of transitions to the states $B_{1u}$ an $E_{2g}$.

Transitions from the ground-state to a $B_{1u}$ stat are forbidden, but can occur, along with a one quantum change in that $e_{2g}$ vibration which involve radial motion of the CH groups (frequency 605 cm.$^{-}$ in the ground-state)[8]. There should be a main progression towards short waves in successive quanta o the upper-state ring-breathing vibration $a_{1g}$ (frequency 990 cm.$^{-1}$ in the ground-state). There shoul also be a similar, but temperature-sensitive, Boltzmann progression, shifted by about 1,100 cm.$^{-1}$ to lon waves, and about fifteen times weaker than the mai progression at room temperature. The bands shoul be sharp, apart from any effect of external perturbations. In short, a $B_{1u}$ band-system at 2000 A. should closely resemble the familiar $B_{2u}$ band system at 2600 A., for which, indeed, a $B_{1u}$ assignment wa at one time suggested[9]. An addition to this descriptio is made later.

Transitions from the ground-state to an $E_{2g}$ stat are forbidden, but can occur in association with a one-quantum change in a $\beta_{1u}$, $\beta_{2u}$ or $\epsilon_{1u}$ vibration most strongly with such a change in the $\beta_{1u}$ vibration of CH groups (frequency 1,010 cm.$^{-1}$ in the ground-state)[8]. The total consequences are somewhat complicated, and so we describe them in successive approximations. The first approximation is that there should be a main progression towards short waves in the ring-breathing vibration of the uppe state, but that the corresponding Boltzmann progression would be difficult to observe, as it would be more than a hundred times weaker, and displaced to long wave-lengths by about 1,900 cm.$^{-1}$, thus originating in the observable tail of the $B_{2u}$ band-system.

Our second approximation starts from Jahn and Teller's proof[10] that every non-linear molecule which is sufficiently symmetrical to permit degenerate internal motion will have a normal co-ordinate with the property that, in a degenerate electronic state, the energy will be minimized at a non-zero value of the co-ordinate, with the result that the original equilibrium symmetry will be lost, and the degeneracy of the electronic motion will be split. It is easily shown that, in benzene, the active normal co-ordinate is one of those belonging to the already mentioned $e_{2g}$ vibration; in particular, that one which flattens the hexagon vertically or horizontally by pulling apart or pushing together two opposite sides, thus reducing the symmetry from $D_{6h}$ to $V_h$. It is to be concluded[11] that the nominal $E_{2g}$ state will actually consist of the two, energetically separate, but close-

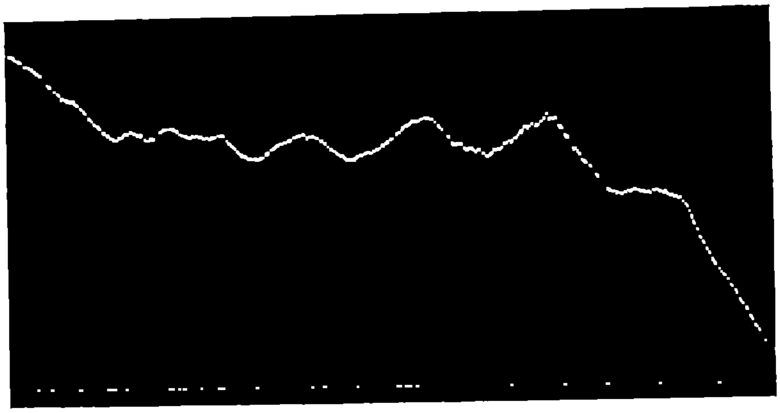

Fig. 1. The 2000 A. band-system of benzene vapour

ving states, $A_g$ and $B_{1g}$, approriate to the lower symmetry; and that each of these will have, s its equilibrium nuclear conguration, a different flattened hexagon of symmetry $V_h$, the two flattened hexagons being interconvertible by the $e_{2g}$ vibration. This has two immediate spectral consequences. First, because of the larger number of vibrations that are now totally symmetrical with espect to the reduced nuclear symmetry, our simple progression will become a compound one, involving combinations of different vibrations, especially the ring-breathing vibration (corresponding to $a_{1g}$ of frequency 990 cm.$^{-1}$ in the ground-state), which allows ring-size to change on excitation, and the ring-flattening vibration (corresponding to $e_{2g}$ of frequency 605 cm.$^{-1}$ in the ground-state), which, by converting the original regular hexagon into either flattened hexagon, allows ring-shape to change on excitation. Secondly, the whole of this compound progression should be doubled, with a separation of the order of magnitude of a vibration frequency[11], because of the doubled electronic origin.

A third approximation is necessary in this description, for the reason that the relatively small magnitude of the Jahn–Teller electronic splitting will cause a breakdown of the Born–Oppenheimer approximation, which normally allows each electronic state to have its own vibrations. This has two further spectral consequences. The first is derived from the circumstance that any vibration that could interconvert the flattened hexagons will belong in principle to both states, and will act as a vibration controlled by a potential with two unequal minima separated by a low barrier. We therefore expect our compound progression of doubled bands to break up at various points, depending on the interconverting vibrations concerned, into a series of single bands about twice as closely spaced. A very few quanta of the ring-flattening vibration, which is best suited to effect the change of shape, could bring about such a break-up; but more quanta of the ring-breathing vibration would be needed, inasmuch as change of shape on its account depends on the differences of amplitude of the radially moving carbon atoms. The second spectral consequence follows from the consideration that vibration will become coupled, not only with electronic motion, but also with rotation, because conserved angular momentum, quantized totally, and about the axis of a symmetrical top, but not about the axes of asymmetrical tops, and carried by degenerate vibrations in a symmetrical top, and by electronic motion and rotation in this, and in our interacting asymmetrical tops, will be shifted about between these carriers during excitation to the double state described. We can see here plenty of cause for expecting all bands to have a smooth appearance.

A final point can now be added to our theoretical description of a $B_{1u}$ band-system. The intensity of the system at 2000 A. is obviously stolen from the shorter-wave allowed system, involving the upper state $E_{1u}$. This is degenerate, and must suffer Jahn–Teller splitting. It follows that a $B_{1u}$ system at 2000 A. should, in its main progression, but *not* in its Boltzmann progression, exhibit a pale reflexion of the consequences of this degeneracy, by showing a narrow splitting, and a little smoothing of the bands. These effects should be small compared to those arising from an upper state, such as $E_{2g}$, to which degeneracy is indigenous.

Experimental study of the band-system at 2000 A. is, indeed, made difficult by the smoothness of the bands, and the consequent impossibility of securing frequency differences of the accuracy desirable for vibrational analysis. However, our study of the system includes an attempted analysis. We conclude that no analysis is possible on the basis of a $B_{1u}$ upper state, but that a plausible analysis can be given on the assumption of an $E_{2g}$ upper state.

The band-system has been described several times before[12]; but we reproduce a general microphotometer record of it as a reminder of its overall form (Fig. 1). We see a widely spaced progression of strong bands, breaking up at the fourth quantum into a series of closer, moderately strong bands, and carrying, from the first onset of strong absorption, a superposed ripple of closely spaced weaker bonds, which at higher energies die away. All bands are smooth, and, so far as can be seen, are shaded in both directions. None of the bands mentioned appears to be weakened by cooling. Little can be seen of any Boltzmann progression in the long-wave region. This remains true on heating.

So different is this appearance from that of the familiar $B_{2u}$ system, at 2600 A., that we think it unnecessary to elaborate the thesis that any attempted analysis of the present system on the basis of a $B_{1u}$ assignment is bound to fail. In particular, there are no Boltzmann bands remotely approaching the strength of those required for a $B_{1u}$ assignment in, or anywhere near, the expected region.

Although we have not the confirmation which might follow could we measure accurate frequency differences, the general lines of an analysis based on an $E_{2g}$ assignment can be given. The two vibronic origins demanded by Jahn–Teller splitting are identified with the first two bands at the onset of strong absorption, the first at 49,065 cm.$^{-1}$ and the second at 49,215 cm.$^{-1}$; the splitting thus amounts to 150 cm.$^{-1}$. The frequency of the first quantum of the ring-flattening vibration is taken as about 320 cm.$^{-1}$ in either state; and we account for the smallness of this value, compared to the corresponding ground-state frequency, 605 cm.$^{-1}$, by supposing that, although the zero-point levels in the split states are separate, even one quantum of this vibration will mix the electronic states. This vibration is totally symmetrical with respect to the deformed hexagons, and therefore is allowed to appear with successive quantum numbers. Consistently, we find it appearing with one, and then with a second quantum in each split state, or, putting it more correctly, with four successive quanta in the interacting pair of states. Then a quantum of the breathing frequency, taken to be about 900 cm.$^{-1}$ in either state, supervenes, leading to a strong maximum, doubled because of the two vibronic origins. After that, the pattern of weak bands repeats itself, gradually fading out over the next two strong bands, which represent the addition of a second and a third quantum of the breathing vibration. About here, the breathing frequency begins to show very strong anharmonicity; and immediately thereafter the breathing progression breaks up into more closely spaced, but apparently simpler, bands, which can be followed into the bank of intensity leading to the next band-system. We explain the sudden incursion of strong anharmonicity, and the immediately following break-up of the progression, by assuming that four quanta of the breathing vibration suffice to cause full mixing of the split electronic states.

In the long-wave region, only one Boltzmann band of more than very small strength has been observed; but it is very difficult to measure, being so overlapped in the first onset of strong absorption. Our measurements place it 275 cm.$^{-1}$ below the first maximum at 49,065 cm.$^{-1}$; but, because of the overlap, this estimate could be wrong by 50 cm.$^{-1}$. The only Boltzmann band which might be predicted from the $E_{2g}$ electronic assignment, to have sufficient strength and separation from main bands for fairly easy observation, would occur in this region. It is the 1 → 1 transition of the ring-flattening vibration; for, although 1 → 1 transitions in all vibrations are allowed by symmetry, no vibration other than this could have, at once, so large a Boltzmann factor, so large a frequency difference between upper and lower states, and a transition probability so favoured on Franck–Condon grounds. Because of the two vibronic origins, this 1 → 1 transition should produce two bands, situated, according to the figures already given, 140 and 285 cm.$^{-1}$ below the maximum at 49,065 cm.$^{-1}$. The first of these would be completely buried in the strong band; but the second could be the much overlapped band we have measured, 275 cm.$^{-1}$ below the first maximum.

The only other Boltzmann bands the presence and approximate location of which seem certain are two (at least) extremely weak bands near 850 and 1,000 cm.$^{-1}$ below 49,065 cm.$^{-1}$. They are not overlapped; but their extreme weakness makes measurement difficult. Two interpretations are possible, one depending on, and the other independent of, the electronic assignment. The strongest (though still very weak) Boltzmann progression that should be characteristic of an $E_{2g}$ electronic state is that which involves one quantum of the ground-state frequency 1,010 cm.$^{-1}$ throughout, and, in the upper state, a succession of quantum-levels of the breathing vibration. Each member of this progression should consist of a pair of bands 150 cm.$^{-1}$ apart; but the first member of the progression would be mixed with the tail of the long-wave $B_{2u}$ band-system; and the third and higher members would be under the strong bands of the band-system now under discussion. The one member that we might hope to find is the second, for the two reasons that it alone would not be overlapped and that it would be the strongest member of its progression, just as the second member is th strongest in the main ring-breathing progressio This second Boltzmann member would be represente by a pair of bands in about the positions in whic ours are observed. However, any electronic assign ment would permit a very weak Boltzmann pro gression involving one quantum of the ground-stat frequency 990 cm.$^{-1}$, and a succession of quanta c the upper-state breathing vibration. The second an higher members of this progression would be burie under strong bands; but the first member would no be overlapped, and would consist of a pair of band approximately where ours are observed. These tw bands are too weak and diffuse to belong to th main Boltzmann progression of a $B_{1u}$ system, which should consist of single, sharp and fairly stron bands.

Turning to the electronic assignments held i reserve, an interpretation of the system as one of th forbidden π-state $E_{1u}$, or of the forbidden Rydber s-state $E_{1g}$, must fail, for one of the reasons for whicl the $B_{1u}$ assignment fails, namely, all these assign ments require easily observable Boltzmann bands, where none can be found. Interpretation as a system of the allowed Rydberg s-state $A_{2u}$ fails among the main bands: it cannot account for the doubling, the ripple and the break-up; and it disagrees with Craig and Lyons's probable identification of the direction of polarization. Thus we are unable to suggest any type of upper state, other than $E_{2g}$, on the single basis of which all the chief features of the spectrum can be understood. Of course, this does not mean that some other electronic state, perhaps one of the others considered, may not be responsible for a minor part of the intensity or even for some of the spectral appearance near the high-energy limit, where our system merges with the next strong system.

It is our provisional conclusion, therefore, that the second excited singlet π-state of benzene has the symmetry $E_{2g}$, in agreement with configuration interaction and valency bond theory, but contrary to single-configuration molecular orbital theory, in all its proposed forms. Further details of this work, and an account of some supporting investigations on hexadeuterobenzene, and on some halogen substituted benzenes, will be given elsewhere.

This investigation has benefited much from theoretical suggestions by Prof. D. P. Craig, and from exploratory work by Dr. L. E. Lyons. One of us (T. M. D.) wishes to acknowledge the receipt of a Science Scholarship from the Royal Commission for the Exhibition of 1851.

[Feb. 18

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# LETTERS TO THE EDITORS

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## Isolation and Properties of a Collagen soluble in Salt Solution at Neutral pH

The presence of a soluble type of collagen in skin, extractable with slightly alkaline phosphate buffers, has been reported by Highberger *et al.*[1]. On the basis of their studies of the metabolism of collagen in rabbit skin, Harkness *et al.*[2] have concluded that this protein is almost certainly a direct precursor of mature collagen and have called it 'alkali-soluble collagen'. The isolation procedure of Highberger *et al.* involved purification by solution in citrate buffer of pH 3·8 and dialysis against distilled water; *but the final product was no longer soluble in either neutral or alkaline buffers used for the original extraction.* It thus seemed likely that the physical properties of alkali-soluble collagen had been altered during isolation. We report here a new method of isolation and preliminary studies of some of the physical properties of the isolated protein.

The material was extracted from the skins of young rabbits with *M*/15 phosphate of *p*H 7 and precipitated by addition of sodium chloride to a final concentration of 16 per cent. Purification was carried out by repeated solution in phosphate and precipitation with sodium chloride or ammonium sulphate. The isolated material had a hydroxyproline content of 8·2 per cent (expressed as amino-acid nitrogen per cent total nitrogen) and very low tyrosine content. It had a low solubility, approximately 0·2 per cent, in *M*/15 phosphate of *p*H 7.

Ultracentrifuge studies were made at 26° and 7° C., viscosity and birefringence measurements at 4° C., on solutions containing 0·02–0·09 gm. per cent in *M*/15 phosphate of *p*H 7·4. The schlieren diagram given in the ultracentrifuge showed a single sharp peak, without any evidence of gross heterogeneity. The sedimentation coefficient $S_{20}$, corrected to water at 20° C., varied considerably with the concentration $c$ (gm. protein per 100 ml. solution); $d(1/S_{20})/dc$ was constant at 1·68, and $S_{20}$ extrapolated to infinite dilution was 3·23 Svedberg units. The relative viscosity ($\eta_{rel.}$) measured in a Couette viscometer increased markedly as the velocity gradient was decreased below 5 sec.$^{-1}$. At zero velocity gradient, $(\eta_{rel.}-1)/c$ was 47 and did not change appreciably with concentration. Using Ogston's[3] method for a spheroidal particle, the following dimensions were derived: particle weight $\sim 10^6$, axial ratio 40, length 5,800 A. and an apparent hydration of 40 ml./gm. Birefringence measurements indicated a particle-length of about 4000 A., but showed that the material was not homogeneous. The ultracentrifuge schlieren diagram did not exclude inhomogeneity. The values are only approximate, but definitely indicate elongated particles. Electron micrographs made by Mr. R. Valentine of a solution of the material fixed on the grid by osmium tetroxide vapour and shadowed with platinum–palladium showed fine fibres of varying lengths. Material fixed in formalin, disintegrated by ultrasonic vibration and stained with phosphotungstate showed similar fibrils about 100 A. in diameter, and these were banded, with principal repeat units of about 2200 A. and 5000 A. (Fig. 1). This suggests that the material existed in solution as various linear aggregates of a unit of several thousand angstroms.

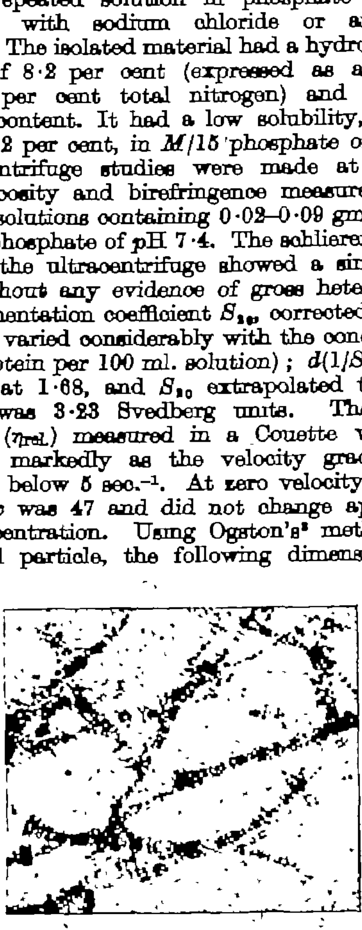

Fig. 1. Neutral salt-soluble collagen. Preparation as in text. × 50,000

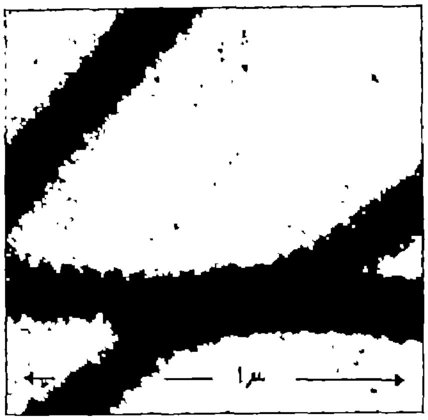

Fig. 2. Fibres formed at 5° C. from a solution containing 0·03 gm. per cent of neutral salt-soluble collagen, pH 7·2. Phosphotungstate stained. × 50,000.

On keeping solutions in various buffers at temperatures between 4° and 37° C., up to 80 per cent of the material was precipitated. This precipitate has been provisionally called 'heat-precipitated collagen'. The time taken for a precipitate to appear varied from seconds to weeks according to conditions. Between *p*H 6·5 and 7·4, the reciprocal of this time varied directly as the hydrogen ion concentration and also varied with the concentration of starting material. The logarithm of the reciprocal precipitation-time was approximately proportional to the reciprocal of the absolute temperature.

When the precipitate formed slowly, it consisted of fine fibres directly observable in the optical microscope and readily stainable with van Gieson connective tissue stain. Electron micrographs of the heat-precipitate stained with phosphotungstate show banded fibres of up to 2000 A. diameter with a major repeat distance varying from 580 A. to 800 A. in different fibres (Fig. 2). Various patterns of sub-striations, one 'polarized' in the direction of the fibre, are seen.

The appearance was quite different from that of neutral salt-soluble collagen, in which lateral aggregation did not exceed 100 A.

Preliminary studies indicate that heat-precipitated collagen is similar to acid-soluble collagen in that it is soluble in dilute acetic acid and citrate buffers, and has a similar appearance under the electron microscope. The transformation of neutral salt-soluble collagen to heat-precipitated collagen may then be similar to the *in vivo* transformation of alkali-soluble collagen to acid-soluble collagen suggested by Harkness *et al.*[3]. This possibility and the nature of heat-precipitated collagen are being further investigated.

After observing the phenomenon of heat precipitation, we received through Dr. A. Neuberger a personal communication from Drs. Gross, Highberger and Schmitt of similar findings; this work has now been published[4]. We are grateful to Dr. A. Neuberger and Dr. A. G. Ogston for valuable advice and to Mr. R. Valentine for the electron micrographs.

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## Sorption Chromatography of Polar Substances on Polyamides

Linear polyamides, in the form of fibres or fine powders, are able to absorb polar substances from solution[1], with the formation of hydrogen bonds. The sorption is restricted to the amorphous regions, where a solution process of the polar substance into the polymer takes place. The Flory–Huggins relation[2]:

$$\ln a_1 = \ln v_1 + (1 - 1/x)\, v_2 + \chi_1 v_2^2 \qquad (1)$$

has been found[1] to hold, when the volume fractions $v_1$ and $v_2$ of the polymer and the polar substance are corrected for the degree of crystallinity of the polymer.

The amount of a polar substance which can be absorbed at equilibrium by a unit weight of polymer (which is related to $v_1$ and $v_2$) therefore depends upon a number of factors. These are: (i) the chemical potential of the substance at a given concentration of solution (which is related to its activity $a_1$ in the polymer); (ii) its thermodynamic interactions with the polymer (which are expressed by the semi-empirical parameter $\chi_1$); and (iii) the degree of crystallinity of the polymer.

The sorption isotherms of very similar compounds have been found to show marked differences, and substances containing groups which are able to form strong hydrogen bonds with the amide groups of the polyamides are absorbed to a very large extent. These observations have turned our attention to the possibility of using polyamides as absorbents for chromatographic separation of polar substances. Experiments undertaken in this direction have so far given promising results.

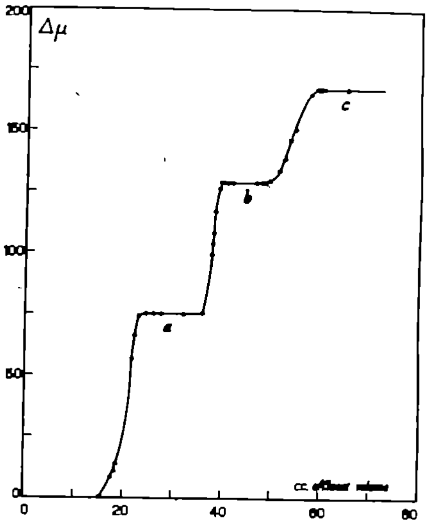
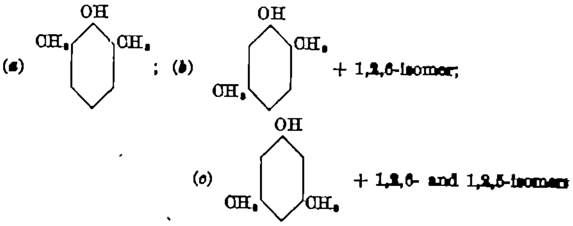


Fig. 1. Frontal chromatography of a mixture of three isomeric xylenols:



Two examples will be given here of absorption chromatography of compounds belonging to an isomeric group and to a homologous series. The first example deals with the frontal chromatography of a mixture of three xylenols, namely, the 1,3,5 (m.p. 68° C.; b.p. 219° C.), the 1,2,5 (m.p. 74° C.; b.p. 211° C.) and the 1,2,6 (m.p. 49° C.; b.p. 212° C.) isomers, all of which have very close physical constants. The second example deals with the frontal chromatography of a mixture of propionic acid, butyric acid and caproic acid.

The experiments were carried out in a Tiselius–Claesson apparatus of the *L.K.B.* type. A solution in *cyclo*hexane of the compounds to be separated was forced through a short column filled with a tightly packed powder of polyhexamethylene adip-

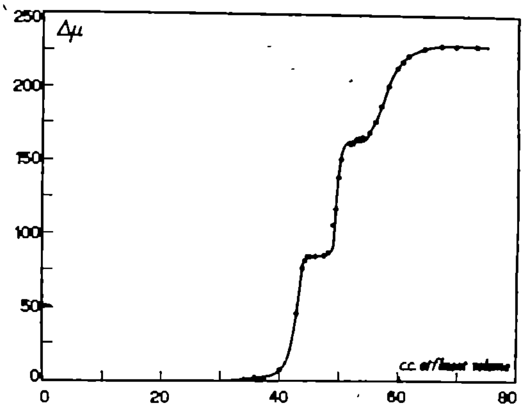


Fig. 2. Frontal chromatography of a mixture of propionic, butyric and caproic acids

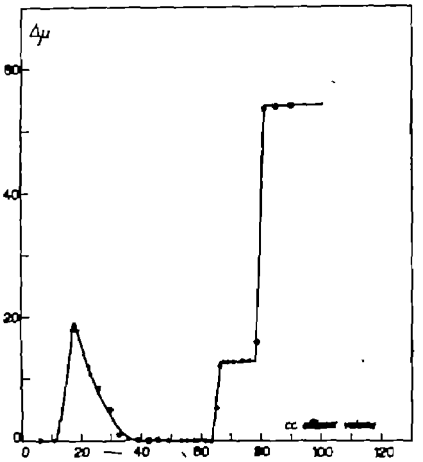


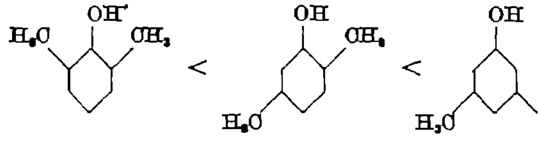
Fig. 3. Displacement chromatography of a mixture of 1,2,5- and 1,2,6-xylenols, using the 1,3,5-isomer as a displacer

amide obtained by precipitating the polymer from a concentrated solution in formic acid by the addition of a water–alcohol mixture. The change in refractive index in the effluent liquid was determined interferometrically according to Claesson[3].

The chromatograms of Figs. 1 and 2 show that sharp fronts have been obtained.

When a solution of the 1,2,5- and 1,2,6-isomers was absorbed at the top of the column and a solution of the 1,3,5-isomer was then forced through the column, the first two isomers were displaced[4] by the third and a complete separation was achieved, as can be seen from Fig. 3.

In the first example, the extent of absorption follows the sequence :

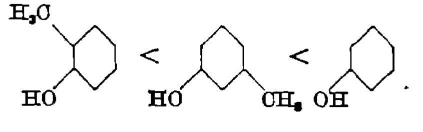


and in the second example :

caproic acid < butyric acid < propionic acid.

It must be emphasized that in the case of xylenols the extent of absorption increases with the separation between the methyl groups and the phenolic group.

The same rule has been found to hold for the absorption of *o*-cresol, *m*-cresol and phenol, where the sequence is :



Therefore, what might be called a 'screening effect' of the methyl groups on the OH group is likely to control the ability to form hydrogen bonds. It is interesting that the same effect seems to control the sequence in the partition coefficients of isomeric phenols between water and *cyclo*hexane[5].

This type of chromatography which has been described is an uncommon example of partition chromatography which might be termed 'sorption chromatography'. The method is very similar to liquid–liquid partition chromatography, the main difference being that one of the two solvents is the amorphous part of a polymer. The large capacity of the absorbent, which may take up to 50 per cent of its own weight of a polar substance, and the fact that it is able to support itself might make sorption chromatography very efficient for preparative purposes and for large-scale separations. Interesting results may be achieved in this way by applying less traditional chromatographic methods, taking advantage of the possibility of using the polymer both as fixed and mobile phase. The polymer could, for example, be used as a mobile phase in the form of long fibres, which, as pointed out by Martin[6], would be the most suitable form for an adsorbent to be used in a continuous separation.

Finally, an attractive feature of sorption chromatography lies in the possibility of choosing a suitable polymer for any given group of compounds to be separated. The sorption capacity of a given polymer could also be enhanced by suitable chemical modifications, or by block or graft copolymerization.

We are indebted to Dr. A. J. P. Martin for a valuable discussion and for reading the manuscript of this communication.

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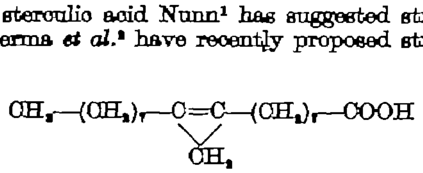
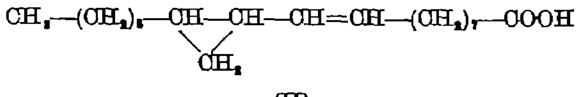
## Structure of Sterculic Acid and other Analogous Fatty Acids

For sterculic acid Nunn[1] has suggested structure (I) ; Verma *et al.*[2] have recently proposed structure (II).



$$\mathrm{CH_3{-}(CH_2)_7{-}\underset{CH_2}{C{=}C}{-}(CH_2)_7{-}COOH}$$

(I)



$$\mathrm{CH_3{-}(CH_2)_5{-}\underset{CH_2}{CH{-}CH}{-}CH{=}CH{-}(CH_2)_7{-}COOH}$$

(II)

In the course of an investigation into the composition of kapok seed oil, which is supposed to contain a fatty acid with a similar grouping, evidence has been found in support of structure (I) suggested by Nunn.

(1) Characteristic of the particular grouping in question is an infra-red absorption at 1,009 cm.$^{-1}$ (1,004 cm.$^{-1}$ by Verma); on careful hydrogenation a dihydro-derivative was obtained having an absorption of 1,021 cm.$^{-1}$ (1,015 cm.$^{-1}$ by Nunn). This characteristic frequency near 1,020 cm.$^{-1}$ of the *cyclo*propane ring is an 'in-plane wagging vibration' of the CH$_2$-group[3]. On conjugation with a C=O bond a slight displacement is to be expected, which actually occurs towards higher frequencies; Slabey[4] has found the following values: 2-*cyclo*propylpropane 1,018 cm.$^{-1}$; 2-*cyclo*propylpropene 1,023 cm.$^{-1}$.

However, the difference between 1,021 cm.$^{-1}$ and the 1,009 cm.$^{-1}$ occurring on the transition of dihydrosterculic acid to sterculic acid is considerably greater, and means a displacement in another direction. This may be due to the increased ring strain which is to be expected in a *cyclo*propene ring, and which has been established by means of electron diffraction measurements[5].

That this frequency is actually lowered by ring strain is also borne out by its displacement in the following series: *Cyclo*hexane 1,028 cm.$^{-1}$, *cyclo*pentane 1,028 cm.$^{-1}$, *cyclo*propane 1,023 cm.$^{-1}$, *cyclo*propene (?) 1,009 cm.$^{-1}$.

(2) *Sterculia fœtida* oil[6], kapok seed oil[7], and cotton seed oil[7] give the Halphen reaction (reddening with a solution of sulphur in carbon disulphide). With the first two oils the reaction is attended with the occurrence of a band at 1,009 cm.$^{-1}$; with cotton seed oil this band could not be detected, but this is probably caused by the sensitivity of the reaction and the extremely small amount of a similar fatty acid in cotton seed oil.

Whenever treatment of the oils caused the band to disappear, the Halphen reaction became negative, so that this reaction is apparently characteristic for the grouping in question.

As *cyclo*propane derivatives or conjugated systems do not give the Halphen reaction, it seems characteristic of the *cyclo*propene grouping rather than of structure II.

(3) The *cyclo*propane group is less reactive than the ethylene bond. A smaller activity is also to be expected from this system in conjugation with a C=C bond (II) than from a system of two conjugated double bonds. Sterculic acid, however, polymerizes very rapidly[1], whereas 9,11-octadecadienoic acid is fairly stable at room temperature.

In a more detailed publication we intend to adduce further arguments. Our work has mainly been concerned with the isolation of an as yet unknown 'kapok fatty acid'. The dihydro-bombacic acid (we suggest the name 'bombacic acid' for the unknown 'kapok fatty acid', derived from the family name Bombacaceae) prepared by us appeared to be a C$_{18}$-acid, in contrast to dihydro-sterculic acid, the chain-length (C$_{19}$) of which was verified.

Thanks are due to the management of Unilev N.V., Rotterdam, for permission to publish th communication.

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## Paper Electrophoresis of Amino-Acids an Oligopeptides at Very High Potential Gradients

THE importance of the amino-acids and oligo peptides and the complexity of their mixtures ofte encountered stimulate a demand for more powerfu analytical tools to complement those already available. Paper electrophoresis does not show satisfactor resolving power, particularly in the separation o the neutral amino-acids, at the low potential gradient (5–10 V./cm.) usually applied. Its value is greatl

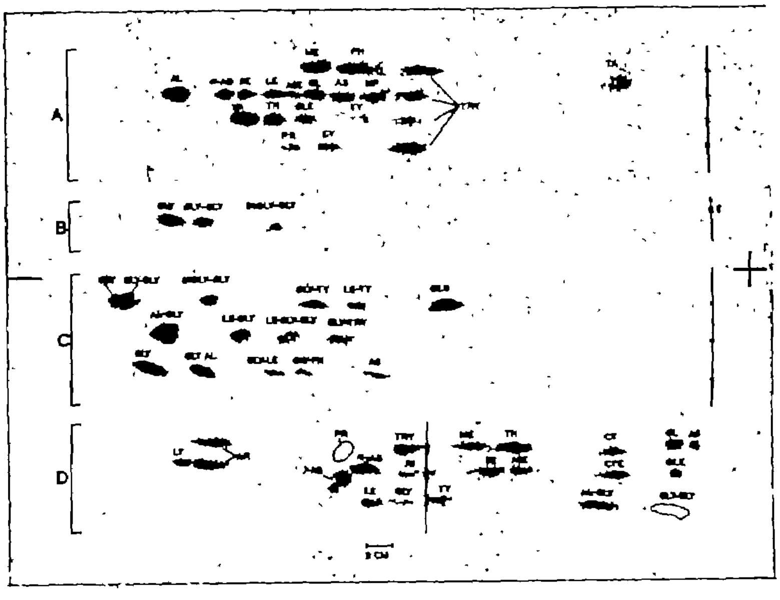

Fig. 1. Electrophoresis of amino-acids and peptides

*Amino-Acids*: *α-AB* = α-amino-butyric acid, *β-AB* = β-amino-butyric acid, *γ-AB* = γ-amino-butyric acid, *AL* = α-alanine, *AR* = arginine, *AS* = aspartic acid, *ASN* = asparagine, *CY* = cystine, *CYN* = cysteine, *GL* = glutamic acid, *GLN* = glutamine, *GLY* = glycine, *HI* = histidine, *HP* = hydroxy-proline, *I-LN* = isoleucine, *LN* = leucine, *LY* = lysine, *MN* = methionine, *PH* = phenyl-alanine, *PR* = proline, *SN* = serine, *TA* = taurine, *TH* = threonine, *TRY* = tryptophan, *TY* = tyrosine, *VA* = valine.

*Peptides*: *AL-GLY* = alanyl-glycine, *DIGLY-GLY* = diglycyl-glycine, *GLU* = glutathione (red.), *GLY-AL* = glycyl-alanine, *GLY-GLY* = glycyl-glycine, *GLY-LN* = glycyl-leucine, *GLY-PH* = glycyl-phenylalanine, *GLY-TRY* = glycyl-tryptophan, *GLY-TY* = glycyl-tyrosine, *HI-HI* = histidyl-histidine, *LN-GLY* = leucyl-glycine, *LN-GLY-GLY* = leucyl-glycyl-glycine, *LN-TY* = leucyl-tyrosine.

Conditions: (*A*) 90 V./cm., 6 m.amp./cm., Whatman No. 3 *MM*. 4 in. × 22½ in. strip, 1·5 *M* formic acid + 2 *M* acetic acid (1 : 1) buffer sol., pH 2·0, 2–10 μgm. of each compound (according to sensitivity of ninhydrin reaction) applied 3 in. from anode end, 1½ hr. (*B*) 65 V./cm., 9 m.amp./cm., 1·5 *M* formic acid buffer sol., pH 1·8, 1½ hr. (*C*) 90 V./cm., 6·5 m.amp./cm., buffer sol., pH 2·0 (as above), 5–15 μgm. of each compound applied, 1½ hr. (*D*) 90 V./cm., 8 m.amp./cm., 0·05 *M* sodium borate buffer sol., pH 9·2 applied in centre of strip, 1 hr.

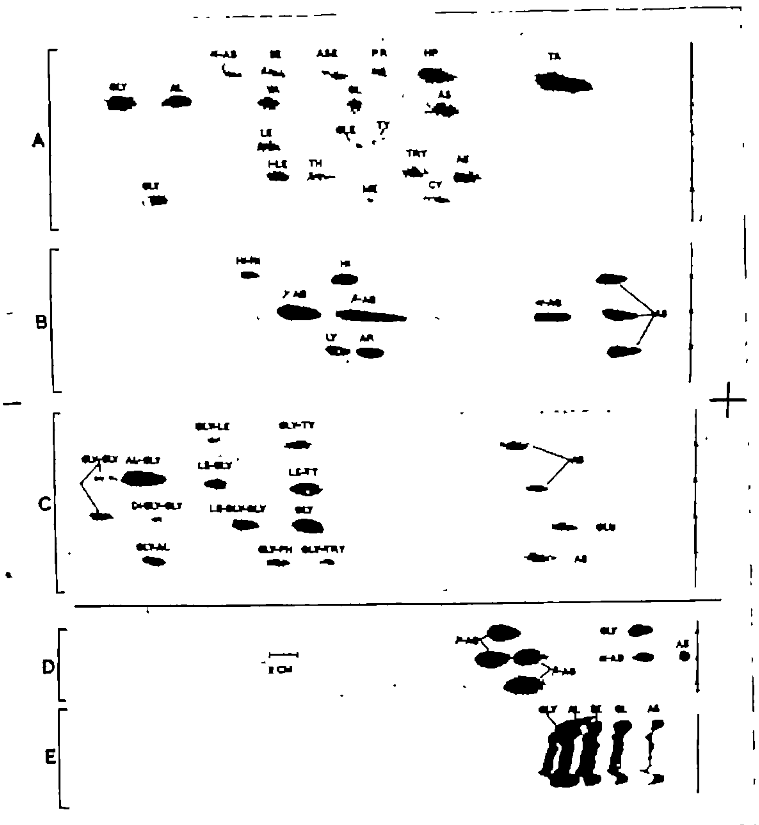

Fig. 2. Electrophoresis of amino-acids and peptides
As in Fig. 1. Conditions: (*A*) 110 V./cm., 2·4 m.amp./cm., Whatman No. 3 *MM* 5 in. × 22½ in. strip, buffer sol., pH 2·9 (454 ml. 2 *M* acetic acid, 6 ml. 2 *M* sodium acetate, 540 ml. water), amount of compounds and place applied as in Fig. 1, 1½ hr. (*B*) 90 V./cm., 2·2 m.amp./cm., ½ hr. (*C*) 110 V./cm., 2·3 m.amp./cm., 1 hr. (*D*) 200 V./cm., 7 m.amp./cm., 2 in. × 11 in. strip, 8 min. (*E*) 200 V./cm., 8 m.amp./cm., 15 min.

enhanced, however, by the application of high potential gradients, most likely because the great reduction in time required for the molecules to traverse a given distance minimizes the detrimental effects of diffusion and moisture changes in the paper strip. Technical difficulties arising from increased heat generation can be overcome by modification of the design of basic equipment and by efficient cooling.

Although Durrum[1] applied a field strength of about 25 V./cm. satisfactorily, it was Michl[2] who first used high potential gradients of more than 40 V./cm., but the shortness of the paper strip used limited his results. Kickhöfen and Westphal, and more recently Heilmeyer *et al.*[3], by adopting Michl's design of equipment and applying potential gradients of up to 120 V./cm., achieved very striking separations of mixtures of chemically and electrically closely related amino-acids and peptides.

My high-voltage technique[4] differs basically from that of the former workers[2,3] in that it is a horizontal closed-strip method with applied pressure and efficient water cooling, allowing the application of 0·7 W./cm.[2] and even more, depending on the temperature of the tap water. The effective length of the strip is 45 cm. A smoothed, full-wave rectified current at up to 6,000 V. is supplied by a power pack, making the application of potential gradients of up to 130 V./cm. possible. In one particular series of experiments 200 V./cm. was applied to a strip of 25 cm. length. A detailed description of the equipment will be published elsewhere[5].

Results obtained using three selected buffer solutions of pH values 2·0, 2·9 and 9·2 are illustrated by Figs. 1 and 2. It is thought that the presentation of results in this form is preferable to the tabulation of mobility values or migration-rates, since separations are often dependent not only upon the differences in migration-rates, but also upon the quality of the spot, that is, its shape, size, tendency to streak, etc. This applies to a lesser degree to bands. Fig. 1 shows the electrophoretic behaviour of twenty-three amino-acids and twelve oligopeptides at pH 2·0 (*A–C*) and pH 9·2 (*D*).

At pH 2·0 (*A*) the positions of some compounds, both absolute and relative to each other, were found to be in disagreement with those reported previously by Kickhöfen and Westphal[3]; for example, tryptophan, serine, proline and tyrosine. In the case of glycine, glycyl-glycine and diglycyl-glycine (*B* and *C*), the pH of the buffer solution appeared to be very critical, as between pH 2·9 and 1·8 the migration-rate of glycine increases rapidly with decreasing pH. On the whole, migration-rates of amino-acids were faster, so that they could be separated in about one-third of the time reported by Kickhöfen, whereas comparable peptides required about the same time. Separation at pH 9·2 offers additional differentiation between methionine and threonine, tyrosine and aspartic acid, cystine and glutamic acid, etc. Fig. 2 shows the electrophoretic behaviour of 24 amino-acids and 13 oligopeptides at pH 2·9.

Of particular interest are the separation of the basic amino-acids (*B*) within half an hour and the exploratory separations at 200 V./cm. of some basic, acid and neutral amino-acids within 8–15 min. (*D* and *E*).

Good reproducibility and speed of process have made electrophoretic separations very helpful in my laboratory for testing fractions of eluate from ion-exchange columns during the run. Used as a second dimension for paper chromatograms, electrophoresis has provided additional and often decisive information on the identity of components of mixtures derived from plant products.

Thanks are due to Mr. H. C. S. de Whalley, director of research, for encouragement, to Mr. S. D. Gardiner for valuable suggestions for the design of electrical equipment, and to the Directors of Tate and Lyle, Ltd., for permission to publish this communication.

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## Xylanase in the Soil and the Rumen

In connexion with experiments on enzymatic decomposition of wheat straw xylan[1], the xylanase activity in the soil has been investigated by a method very similar to that of Hofmann[2]. To 5 gm. of air-dry soil in 50-ml. Erlenmeyer flasks were added 2 ml. of toluene, and, after 10 min., 5 ml. phosphate buffer ($p$H 6·5) and 5 ml. xylan solution, or 5 ml. water in the blanks. The stoppered flasks were placed in an incubator at 37° C. and shaken now and then. Samples were taken out by means of a pipette and centrifuged, and reducing power was determined in 1 ml. of the supernatant by the Somogyi method[3]. Soil samples were taken from unfertilized, artificially fertilized and farmyard manured plots in fertilizer experiments at Danish Government field experiment stations.

The xylanase activity was found to vary with the manuring and the kind of crop. The activity was smallest in the unfertilized plots and greatest in the farmyard-manured ones. The variation caused by the crop was, however, much larger; the xylanase activity was three to five times greater after a crop containing xylan (wheat) than after a crop containing no or little xylan (beets); but the same order was observed within each set of samples (plots), activity being smallest in the unfertilized and greatest in the farmyard manured plots.

Recent investigations have shown that a correlation exists between the activity of soil enzymes (saccharase, urease) and fertilization or manuring especially with nitrogen[4,5], and biological activity of the soil as determined by production of carbon dioxide[6].

Portions of 25 gm. of a loam soil ($p$H 6·2, humus 2·2 per cent) from an unfertilized plot with low xylanase activity were incubated in beakers for fifteen days at 25° C., with addition of: (*a*) powdered wheat straw in amounts from 0–2·0 per cent, (*b*) 0·5 per cent xylan, mannan, starch, cellulose, xylose, arabinose or glucose. 10 per cent water and 0·05 per cent ammonium nitrate were added in each case, and evaporated water was restored during incubation. The xylanase activity increased six times due to t incubation with xylan, but only 1·3 times with t other carbon sources (except straw); the resul found in soil incubated with wheat straw are se in Fig. 1.

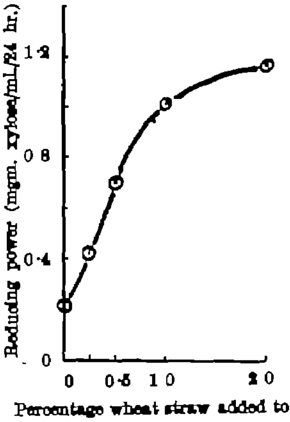

Fig. 1

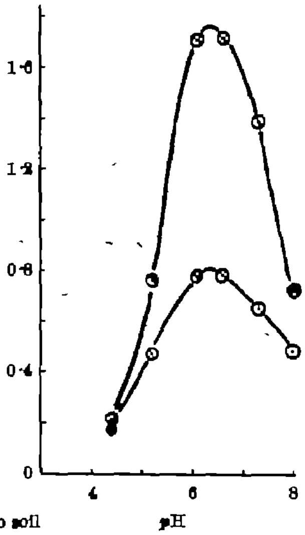

Fig. 2

Fig. 1. Xylanase activity in soil after incubation with increasing amounts of powdered wheat straw

Fig. 2. Xylanase activity in rumen liquid at different $p$H. Upper curve, centrifuged liquid; lower curve, sterile filtrate

The amount of xylanase in the soil appea primarily to be a function of the amount of xyl decomposed in the soil giving rise to an accelerat excretion of the adaptive enzyme xylanase, besid an increase of the microflora, provided that sufficie available nitrogen is present. The small rise in xyla ase activity observed on addition of non-xyla carbon sources may be caused by a general increa of the microflora.

*Xylanase activity in rumen content.* Material large consisting of straw was taken from the rumen of newly slaughtered cow. Juice was expressed fro this material by means of a fruit press and centrifuge to give a liquid almost free of bacteria; part of th liquid was filtered through a bacterial filter (Jena gla filter 11*G*5), and its xylanase activity was measure in the following experiment: stoppered test-tube with 1 ml. of centrifuged or filtered liquid, 1 ml. o phosphate buffer ($p$H 6·2), 2 ml. of 1 per cent xyla solution, 0·5 ml. toluene were incubated at 37° C. and reducing power was determined[3]. Fig. 2 show the xylanase activity at different $p$H values. Th bacteria in the sediment from the centrifugation wer separated from most of the impurities, washed an precipitated in acetone. 10 mgm. of this powde had almost the same xylanase activity as 1 ml. o the liquid.

The xylanase in the soil and the rumen conform in respect of $p$H and temperature optimum with th xylanase from pure cultures. The reaction product have been isolated and determined on paper chromatograms, and xylose, xylobiose, xylotriose, etc., hav been observed, as in studies with xylanase fron pure cultures[1].

A more detailed account will appear later.

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## Auxotrophic Mutants of *Pseudomonas aeruginosa*

Auxotrophic mutants of a strain of *Pseudomonas aeruginosa* were isolated by Loutit[1] following X-ray treatment and using a modification of the penicillin-isolation technique devised by Davis[2] and Lederberg and Zinder[3]. An attempt was made to repeat this work using a new strain of *Pseudomonas aeruginosa*; but from a series of ten experiments only one auxotrophic mutant was isolated. A further thirty experiments were carried out on this new strain, using ultra-violet irradiation instead of X-rays and employing the same isolation technique. From these thirty experiments only eleven mutants were isolated, presenting less than 0·2 per cent of the total lonies examined. Six of the eleven mutants were olated in one experiment; but five of these had the me nutritional requirements.

The possible reasons for the inability to isolate utants lay either with the mutagenic agent or the lective technique. Since the mutagenic agent was und to be satisfactory when working with *scherichia coli*, attention was concentrated on the lective technique. One aspect of the selective chnique which was considered was the possibility f genetic exchange, which could occur either as a sult of sexual fusion or some transforming process.

To examine the possibility of genetic exchange, xperiments were carried out by inoculating two utants together into nutrient broth. At the same ime, controls were set up for each mutant using the ame inoculum in half the quantity of broth used for he mixture of mutants. The tubes were incubated vernight, the cells centrifuged, washed twice with terile distilled water and the total cells were spread ver the surface of minimal agar plates prepared sing the medium devised by Davis and Mingioli[4], which would not support the growth of the mutants. The plates were incubated for 24 hr. and the number f prototrophic colonies counted on the plates noculated with the mixed growth and those inocu- ated with the control growth of each mutant. The results of these experiments are shown in Table 1.

Table 1

| Cross | Number of prototrophs | |
|---|---|---|
| | Mixture | Total controls |
| $B_1 me^-$ × $B$[illegible] $me^-$ | 0 (2 ml.) | 0 (1 + 1 ml.) |
| $B_1 me^-$ × $B$[illegible] $me^-$ | 92 (5 ml.) | 8 (2·5 + 2·5 ml.) |
| $B_1 me^-$ × $B$[illegible] $me^-$ | 3,628 (20 ml.) | 447 (10 + 10 ml.) |
| $B_1 me^-$ × $B_{11} h^-$ | 609 (2 ml.) | 183 (1 + 1 ml.) |
| $B_1 me^-$ × $B_{11} h^-$ | 4,593 (5 ml.) | 1,581 (2·5 + 2·5 ml.) |
| $B_{17} ad^-$ × $B_{21} l^-$* | 51 (2 ml.) | 2 (1 + 1 ml.) |

$me^-$ = methionineless; $h^-$ = histidineless; $ad^-$ = adenineless; $l^-$ = leucineless.

* This result was obtained using two mutants isolated in subsequent experiments.

Since the number of prototrophic colonies was greater on the plates inoculated with the mixed mutants than those inoculated separately with individual mutants, there was some justification in assuming that a process of genetic transfer could occur.

In the isolation method, genetic transfer could occur at the stage of incubation of the cells in broth immediately after irradiation and thus prevent the isolation of the mutants. To overcome this difficulty, the technique of Adelberg and Meyers[5] was adapted. In this technique the cells were incorporated in minimal agar after irradiation and incubated for 6 hr., thus isolating each cell from its neighbour and preventing either fusion or transformation. The only modifications necessary to the technique were increases in the amount of penicillin and penicillinase. The quality of the penicillinase was important; a purified product was necessary. Most commercial preparations were unsatisfactory as they were simply culture filtrates containing growth factors. The material used for the present work was prepared in this laboratory according to the method of Morgan and Campbell[6].

Using the Adelberg and Meyers technique, relatively high numbers of mutants were isolated in three separate experiments as shown in Table 2.

These results showed that the penicillin-isolation technique was satisfactory for isolation of mutants, provided the organisms were not grown in broth but in minimal agar for the period of incubation necessary for full expression of the mutants. It is suggested that a process of genetic exchange occurred during that period of incubation in broth, masking any mutants which were present. To confirm that genetic transfer could occur under the conditions used in the early isolation work, two mutants, $B_{17}ad^-$ and $B_{21}l^-$, were grown separately and irradiated. Half the cells of each mutant were then mixed in broth and the remainder inoculated separately in broth. The tubes were incubated for 6 hr., the cells were centrifuged, washed twice in distilled water and spread over the surface of minimal agar plates. The plates were incubated and scored for the appearance of prototrophs. From the mixture of irradiated cells in two experiments, eight and seven prototrophs respectively were found, while there was none in any of the controls. This amount of genetic exchange considered in conjunction with the fact that all mutants do not survive the penicillin treatment would probably be sufficient to prevent the isolation of mutants.

Table 2

| | Number of mutants | Total number of colonies examined after penicillin treatment |
|---|---|---|
| Experiment I | 10 | 70 |
| " II | 25 | 170 |
| " III | 60 | 170 |

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## Mode of Cleavage of the Eggs of *Hydroides norvegica* in the Mediterranean

In a recent paper[1], it was pointed out that the eggs of the marine polychaete *Hydroides norvegica* may have different cleavage patterns in the North Sea and in the Mediterranean. Whereas at the Kristineberg Zoological Station (near Fiskebäckskil), on the west coast of Sweden, Wolsky found the early cleavage to be spiral and equal, an earlier observer, Soulier[2], working at Cette (Séte), on the Mediterranean coast of France, found it orthoradial and unequal. It was suggested that this difference may be a sign of differentiation of two distinct physiological races within the species, and it was thought desirable to check the correctness of this suggestion. A short visit to Naples in April 1954 and the hospitality of the Stazione Zoologica, for which I am greatly indebted, made it possible to carry out such a check on Mediterranean material.

As regards the relative position of the cleavage planes, Soulier's finding that the cleavage is orthoradial up to the 16-cell stage could not be confirmed. Spirality can be detected in the 4-cell stage already, and an analysis of camera lucida drawings almost invariably reveals polar furrows (Fig. 1*a*). Consequently, the sudden change of the configuration of the blastomeres from the orthoradial to the spiral type in the 16-cell stage, as described by Soulier,

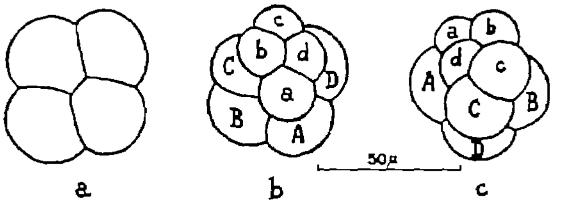

Fig. 1. Cleavage stages of *Hydroides norvegica* in the Mediterranean (Gulf of Naples). (*a*): 4-cell stage showing spirality and polar furrow; (*b*) and (*c*): 8-cell stages showing extreme inequality of blastomeres and irregularity of blastomere arrangement. (In both cases it is the blastomere labelled *C* which seems to have drifted 'out of place')

cannot take place. However there is evidence that blastomeres frequently change their original position relative to each other, and sometimes their configuration is quite irregular (cf. Figs. 1*b* and *c*).

Concerning the inequality of the cleavage, the difference between North Sea and Mediterranean eggs is also less striking than assumed on the basis of Soulier's categorical statement (ref. 2, p. 1662). The 1/8-blastomeres of *Hydroides* eggs are slightly unequal even in the North Sea (ref. 1, Table 1), and therefore the difference between the North Sea and Mediterranean material is rather one of degree than of category.

Circumferences of blastomeres were measured on a number of camera lucida drawings of eggs in the 8-cell stage, and the results are given in Table 1. (The results are in the same arbitrary units as used for the North Sea material, one unit being approximately 9μ.) A comparison of these data with those for North Sea eggs (ref. 1, Table 1) shows that the inequality of the cleavage is somewhat more pronounced in the Mediterranean than in the North Sea material. In the North Sea the size difference of sister blastomeres ranges from 0 to 20 per cent and is on the average 6·5 per cent. (In my earlier paper[1], this figure is given erroneously as 3·5 on pp. 343 and 347, but the correct value can be obtained from the data of Table 1 on p. 343.) In the Mediterranean, on the other hand, the size differences vary between 0 and 39 per cent, and the average is 16·8 per cent, that is, 2½ times the value for the North Sea eggs. This is a definite indication that the cleavage is somewhat more unequal in the Mediterranean than in the North Sea material. However, it is rather difficult to treat these data statistically and to express exactly the degree of the inequality of cleavage or the significance of its difference in two or more populations. For this reason the difference between the Mediterranean and North Sea material as regards inequality of the cleavage cannot be considered as statistically established. Although it very probably exists, further results must be awaited before statistical evidence can be furnished.

Table 1

| Blastomere / Egg | *A* | *a* | *B* | *b* | *C* | *c* | *D* | *d* |
|---|---|---|---|---|---|---|---|---|
| 22/120 | 6·5 | 5·8 | 6·8 | 5·2 | 7·2 | 5·2 | 5·8 | 5·8 |
| 22/330 | 7·8 | 7·2 | 7·8 | 5·8 | 6·5 | 6·5 | 7·2 | 7·2 |
| 22/358 | 7·8 | 7·2 | 7·2 | 5·8 | 7·2 | 6·5 | 7·8 | 6·5 |
| 22/415 | 7·8 | 7·2 | 9·0 | 6·5 | 8·5 | 6·5 | 8·5 | 7·2 |
| 22/425 | 8·5 | 6·5 | 8·5 | 5·8 | 7·8 | 5·8 | 8·5 | 5·2 |
| 24/300 | 8·5 | 6·5 | 7·2 | 5·8 | 7·2 | 7·2 | 5·8 | 6·5 |
| 24/505 | 7·2 | 5·8 | 7·2 | 5·8 | 7·8 | 6·5 | 6·5 | 5·8 |
| 24/518 | 7·2 | 5·2 | 7·8 | 6·5 | 7·2 | 6·5 | 7·2 | 5·2 |
| 24/525 | 7·8 | 5·8 | 7·8 | 5·8 | 7·2 | 5·8 | 7·2 | 7·2 |
| 26/200 | 7·8 | 6·5 | 7·8 | 6·5 | 7·8 | 6·5 | 8·5 | 6·5 |
| 26/210 | 7·2 | 5·8 | 7·2 | 5·2 | 7·8 | 6·5 | 7·2 | 6·5 |
| 26/220 | 7·8 | 6·5 | 7·8 | 6·5 | 7·8 | 6·5 | 7·8 | 5·8 |

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## Demonstration *in vivo* and *in vitro* of Peristaltic Contractions in the Portal Vein of Adult Mammals (Rodents)

In previous investigations evidence has bee produced of a spontaneous peristaltic activity i veins of the hepatic portal system of chick embryo and newly hatched chickens[1] and of adult goldfinche and in the portal vein of adult mice[2], cultivate *in vitro*. In the latter the contractions are ver powerful and of very high frequency (up to 70 pe min.), and activity continues for a long time (up t more than two weeks without washing or renewa of the nutritive medium).

In continuation of these investigations a simila peristaltic activity has been observed in the porta vein of albino rats and guinea pigs, explanted *in vitro*: in the former a frequency of contraction up to 35 per min., in the latter up to 20 per min., have been recorded.

With the aim of ascertaining whether this rhythmical contractile activity occurs also in the vessel *in situ* in the living animal, I have made some observations on albino mice and rats.

For this investigation the following technique has been employed. The animal is anæsthetized by ether and laparatomized; the liver is lifted up and the duodenum displaced to the left, so that the portal vein is exposed. The field is continuously irrigated with a physiological salt solution at 38°–39° C. and a coverslip is placed over it, care being taken not to bear any pressure upon the vessel. It is thus easy to observe rhythmical contractions of the portal vein, with a propagation of the contractile wave in the direction of the liver and a frequency up to 30 per min. in the mouse, up to 14 per min. in the rat. In the state of relaxation of the wall, it is possible to recognize on its surface one or more slight indentations, which correspond to the spiral fold projecting into the lumen, which has been described in the portal vein of these and other mammals[3,4].

If the animal is killed, for example, by administration of a large dose of ether, the peristaltic activity persists for some hours with remarkable intensity; indeed, the activity can be studied more easily, as the respiratory excursions of the diaphragm, which cause rhythmical movements of the liver and of the vessels attached to it, no longer interfere with observations. After the death of the animal a frequency of the contraction up to 52 per min. in the mouse and up to 22 per min. in the rat has been recorded.

Half an hour to one hour after death it becomes possible, owing to the sedimentation of the blood cells and the transparency of the plasma and of the venous wall, to perceive within the lumen, in the phase of relaxation of the vessel, the spiral fold already mentioned; during the contraction of the vein the spiral fold seems to be incorporated in the wall, so that it becomes for the most part invisible.

The function of this fold, as well as that of similar spiral structures projecting into the lumen described within the portal vein of other mammalian species[4-6], is probably, according to Barnett, to mix the various streams of blood that enter the portal vein, so that the different lobes of the liver can all receive the same kind of blood. This is especially important in animals possessing multilobed livers, and as a matter of fact in these animals spiral structures are particularly well marked.

As regards the rhythmical peristalsis of the portal vein, it seems safe to assume that it plays a part in the propulsion of blood towards the hepatic capillary bed.

Further researches in this direction are in progress.

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## Rust Resistance in Sunflowers (*Helianthus annuus* L.)

Rust (*Puccinia helianthi* Schw.) is a major hazard to sunflower production in a number of countries. The area devoted to sunflowers for edible oil in Canada, all in southern Manitoba, was reduced from 60,000 acres in 1949 to 3,500 in 1952, largely because of losses from rust. The Argentine crop was severely damaged by rust in 1952–53. In Peru, where sunflowers were grown for fodder, rust has practically eliminated the crop. The search for rust resistance is therefore a prime objective in sunflower breeding. The present communication is a preliminary report on resistance which has been discovered in the Canadian sunflower investigations.

Three sources of rust resistance have been recognized to date. The first resistant plant was found in 1949 in an $F_2$ population of the natural cross, Sunrise × Texas Wild Annual, in a field nursery. Seedlings from selfed seed of this plant proved resistant to rust when inoculated in the greenhouse. Field-grown plants of the progeny were used as male parents in crosses with rust-susceptible inbred lines of commercial agronomic type. The $F_1$ populations contained plants which were only lightly infected in the field in 1951, the year of the severest rust outbreak ever recorded in Canada. One hundred and thirty-three lines of later generations, selected on the basis of agronomic type from 1,500 lines, averaged only 9·6 per cent rust infection in the field compared to an average of 26·9 per cent in susceptible check material. From the 133 lines, 320 plants with 5 per cent or less rust were selfed. Seedlings derived from them were inoculated in the greenhouse with three different single-pustule isolates of rust. On the basis of reaction type, 70 per cent of the progenies showed resistance. Twenty-six progenies were grown in isolation and allowed to interpollinate to produce the recently licensed rust-resistant variety Beacon. Several inbred lines from the same source have uniformly low rust infections, in some cases less than 1 per cent when susceptible check plants have 10–90 per cent.

The second source of rust resistance was one large plant discovered in 1951 in the $F_3$ progeny of the natural cross California Oilseed × Texas Wild Annual. When eleven seedlings from open-pollinated seed of this plant were inoculated with the three isolates of rust mentioned above, six proved resistant and five susceptible. Seed of fifty-eight selfed plants of the same progeny yielded two outstanding lines in the field in 1952. Of thirty plants in the two lines, eleven were free of rust, fifteen had only one or very few pustules, and four had one or a few pustules on most leaves. Several other lines also contained plants which were free of rust. Nearby check plants had 20–80 per cent infection.

Selfed progenies of twenty-one plants from the two lines mentioned above were inoculated in two tests with three isolates of rust in the greenhouse in 1952–53. Ten of the twenty-one progenies were resistant in all inoculations; the others segregated. Derivatives of the ten progenies continue to show high field-resistance in later generations. Sunflowers with the same parentage have also proved resistant to rust in the field in Peru and Argentina.

The third source of resistance was one plant with low rust infection in a field plot in 1952 from seed of open-pollinated plants of the variety Hopi. The second selfed generation from this plant, tested in the greenhouse with a field collection of rust, contained twenty-five resistant and twenty-four susceptible seedlings. Eleven third-generation selfed progenies, each with eight to fifteen plants, were grown in the field. One progeny had 1 per cent or less rust on all plants; two progenies had 2 per cent or less; and seven progenies had 5 per cent or less. Adjacent susceptible plants had up to 90 per cent infection.

The first two of the three sources of resistance are assumed to have been derived from wild *Helianthus annuus* L., on the basis of plant type in the segregating populations, and because of the absence of other wild annual species of *Helianthus* in the region of Renner, Texas, where the seed originated. As the rust-resistant Hopi plant came from open-pollinated seed produced at Renner, it may also have derived its resistance from the wild *H. annuus*. Although wild forms of *H. annuus* occur over a large part of the North American plains, including the sunflower-growing region of Canada, no rust resistance has been recognized from any location other than Renner.

Studies are now in progress to determine if the same genes are involved in all three sources of rust resistance, and to determine the inheritance of resistance from each of the three sources when crossed with susceptible plants.

Fuller reports of these and related investigations will appear elsewhere. We acknowledge the contributions made to this work by Dr. W. A. Russell during 1949–52, while he was at the Experimental Station at Morden, and by Mr. A. M. Brown, Plant Pathology Laboratory, Winnipeg, during 1949–50.

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## Termination Reaction in Vinyl Polymerization: Preparation of Block Copolymers

THE nature of the termination reaction in vinyl polymerization, that is, the question of disproportionation or combination of polymeric free radicals, has been the subject of controversy. A number of methods have been used for distinguishing between the various possibilities[1–4]; these depend on relations between degrees of polymerization measured by osmotic pressure and end-group analysis, or on relations between rate and molecular weight data. In all these cases the extremes of 100 per cent disproportionation of radicals and 100 per cent combination give rise only to a difference of a factor of two in the appropriate quantity which is compared with experiment. These methods have been applied to comparatively few monomers, and results obtained by different groups of workers have not always been in agreement[3,4]. We therefore thought it worth while to attempt to devise an independent method of general application which would be more sensitive in its distinction between combination and disproportionation. We now wish to describe briefly the method which has been developed and its application to four vinyl monomers.

The method depends on the use of an initiator containing functional groups so arranged that every free radical produced contains one such group. If the conditions of polymerization are such that chain transfer to monomer, solvent and polymer is negligible, each growing radical will carry one functional group at its inactive end; hence the final polymer molecules will have a functional group either at one or both ends, depending on whether termination occurs by disproportionation or combination of radicals. (The argument so far is identical with that employed in methods involving the use of labelled initiators.) The two types of polymer may readily be distinguished by reaction with an equivalent of a bifunctional reagent capable of linking the polymer molecules by their terminal functional groups. If termination occurs exclusively by disproportionation, the polymer molecules can only be joined in pairs, so that the number average degree of polymerization can increase at most to twice its initial value (neglecting the molecular weight of the ligand). On the other hand, if termination occurs exclusively by combination, theoretically *all* the polymer molecules could be joined together, and under suitable conditions the degree of polymerization would be expected to increase to much more than twice the initial value. Both types of behaviour have been observed.

One initiator employed was γγ′-azo-(γ-cyano-*n*-valeric acid), which decomposes thermally to yield radicals of structure, $HOOC(CH_2)_2\dot{C}(CH_3)CN$. After polymerization and purification of the polymer by repeated precipitation, the carboxyl content was estimated by titration. A sample of the polymer was converted into the corresponding acyl chloride by treatment with thionyl chloride, the excess of which was then removed in vacuum. Coupling was carried out in methyl ethyl ketone solution at 90° C., using 1 : 6 hexane diol or 1 : 10 decane diol. After precipitating and drying the polymer, its intrinsic viscosity was measured and compared with the original value. Some results are shown in Table 1. In each case we have taken $1/\alpha = 1{\cdot}40$, $\alpha$ being the Houwink constant.

Table 1

| Monomer | Conditions of polymerization | Intrinsic viscosity (decilitres per gm.) Initial $[\eta]_i$ | Final $[\eta]_f$ | $\left(\frac{[\eta]_f}{[\eta]_i}\right)^{1/\alpha}$ |
|---|---|---|---|---|
| Styrene | 100°, in *o*-dichlorbenzene | 0·143 | 0·618 | 11·5 |
| | ,, | 0·143 | 0·797 | 11·1 |
| Methyl methacrylate | 90°, in benzene | 0·145 | 0·201 | 1·59 |
| | ,, | 1·145 | 0·210 | 1·69 |
| Vinyl acetate | ,, | 0·169 | 0·254 | 1·76 |
| | ,, | 0·169 | 0·268 | 1·92 |
| Methyl acrylate | ,, | 0·183 | 0·220 | 2·08 |
| | ,, | 0·183 | 0·227 | 2·11 |

The results show that chain-termination occurs substantially by combination in the case of styrene, and by disproportionation with the other monomers. Our conclusions agree with those of Mayo, Gregg and Matheson[1], Baysal and Tobolsky[2] and Bevington-Melville and Taylor[4] for styrene, and with Bevington *et al.*[4] for methyl methacrylate.

The use of initiators of the type described, together with suitable coupling reactions, obviously enable a large range of block copolymers to be prepared in a simple manner. For example, a block copolymer of styrene and methyl methacrylate in which the molecules contain one block of about a hundred units of styrene between two blocks of methyl methacrylate each of approximately 120 units has been prepared in the pure state, free from the parent polymers. These preparations may be scaled up without difficulty.

This work is being extended to other monomers and to different conditions of polymerization, including the use of other initiators. We hope to publish a more quantitative treatment elsewhere.

We wish to thank Dr. W. A. Waters, of the Dyson Perrins Laboratory, Oxford, for providing us with practical details of the synthesis of γγ′-azo-(γ-cyano-*n*-valeric acid).

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[3] Arnett, L. M., *J. Amer. Chem. Soc.*, **74**, 2027 (1952).

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## Density of Amorphous Polyethylene Terephthalate

POLYETHYLENE terephthalate can be melt-spun and afterwards hot-drawn to form continuous filament yarn[1] marketed under the trade name of 'Terylene'. In the quenched or spun form, it possesses a very low degree of molecular orientation, and the X-ray diagram shows a characteristic amorphous halo with no evidence of crystalline reflexions. The density of this amorphous form is 1·335 gm./c.c., whereas the calculated crystallite unit-cell density is 1·455 gm./c.c.[2]. With the onset of crystallinity, indicated by an increase in density, the growth of crystallite reflexions in the X-ray diagram, and an increase in the brittleness of the sample, the amorphous halo in the X-ray diagram disappears and hence no X-ray estimate of the degree of crystallinity is possible. It can, however, be estimated from the ratio of the infra-red absorptions in the 898 cm.$^{-1}$ and the 875 cm.$^{-1}$ bands[3], and from the density.

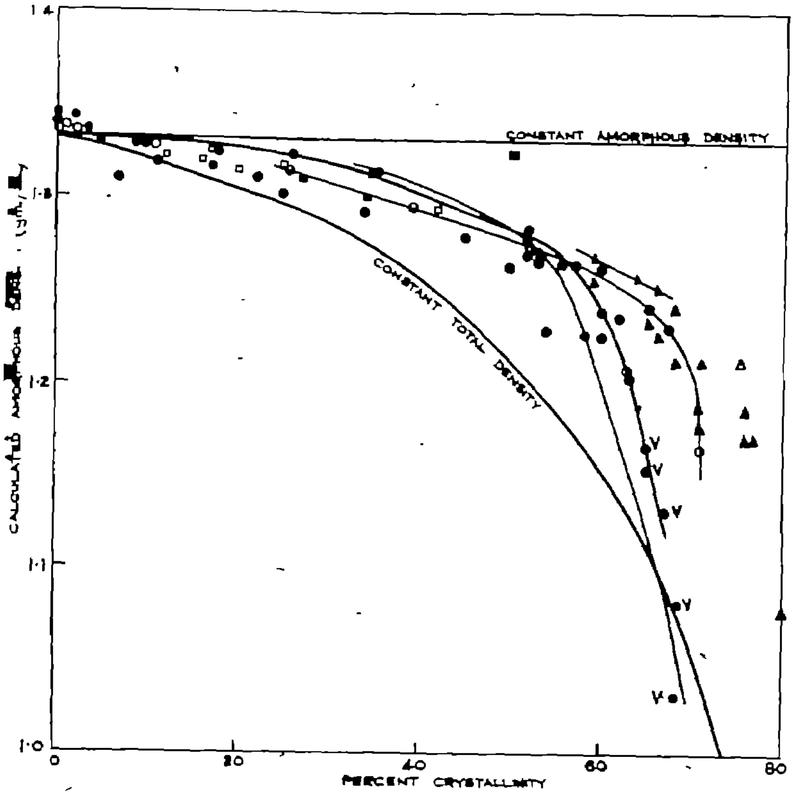

Fig. 1. Calculated amorphous density (gm./c.c.) *vs.* percentage crystallinity

▲, Production 'Terylene' polyester yarns; ▲, Production 'Terylene' polyester yarns (heat-set); ●, yarns spun at low speed; ○, yarns spun at high speed; ○, ⊕, ⊟, other experimental yarns; ⊞, unoriented crystalline polymer; *V* denotes presence of internal needle-shaped voids

It has been found that these two measures disagree, the density estimates being considerably lower than the infra-red estimates. Previous work on polyethylene[3] has shown a similar situation in which the crystallinity estimate obtained from the density of the sample is less than that obtained from X-ray data. With increasing hot-stretching of polyethylene terephthalate, the density rises to a flat maximum or even actually decreases, whereas the birefringence, the initial tensile modulus and the infra-red absorption ratio all continue to rise. Furthermore, at high stretch ratios, microscopic voids sometimes appear. These observations thus suggest that the density estimate of crystallinity is suspect, while the infra-red estimate agrees with the other data, increasing uniformly with increasing stretching and heat treatment. Whereas infra-red estimates of up to 80 per cent crystallinity have been obtained, the highest density estimate obtained from a large number of measurements of highly crystalline material is 55 per cent.

Table 1

| Polyethylene terephthalate filaments | Density of sample | Crystallinity | |
|---|---|---|---|
| | | Density estimate (per cent) | Infra-red estimate (per cent) |
| Non-crystalline, non-oriented | 1·335 | 0 | 2 |
| Partly crystalline, non-oriented | 1·385 | 42 | 48 |
| Highly crystalline, highly oriented | 1·390 | 46 | 65 |
| | 1·389 | 45 | 76 |
| | 1·381 | 38 | 80 |

Assuming the validity of the infra-red estimate, and knowing the density of the sample and the calculated crystallite density, the corresponding densities of the amorphous region have been calculated for drawn yarns produced under a wide range of conditions and are given in Fig. 1. This shows that the amorphous density decreases with even a small amount of crystallinity, and falls very rapidly at high crystallinities: an increase in the spinning speed, and also a heat treatment after drawing, delay the reduction in density. At the lowest amorphous densities, needle-shaped voids appear at the centre of the filament without any discontinuity in the curves, suggesting that similar voids of submicroscopic size may exist at higher amorphous densities.

It is thus concluded that the amorphous region gradually changes character as crystallization proceeds, and the data suggest the gradual appearance of a fibrillar structure in general qualitative agreement with electron microscope and low-angle X-ray results[4].

The effect of random crystal growth on the amorphous regions would be expected to be less than that due to crystallization which accompanies drawing, on account of the absence of external stress, and Table 1 shows that the density estimate for the former is in better agreement with the infra-red crystallinity estimate.

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## Acid Character of Some Phenolic Resins in Relation to their Structure

AQUEOUS suspensions of finely ground phenol formaldehyde, resorcinol formaldehyde and phloroglucinol formaldehyde resins gave potentiometric titration curves each of which showed an inflexion at a pH between 11·0 and 12·0. The amounts of phenolic hydrogen in the three resins indicated by these inflexions were in approximate agreement with the values, 898, 1,563 and 2,083 milliequivalents per 100 gm. calculated from the formulæ, $C_6H_3(OH)(CH_2)_{1\cdot5}$, $C_6H(OH)_2(CH_2)_{1\cdot5}$, and $C_6(OH)_3(CH_2)_{1\cdot5}$, of the repeat units contained in the three resins respectively.

Titration with a dilute base, for example, dilute potassium hydroxide, revealed additional inflexions at lower $pH$ values, as can be seen from Fig. 1. Phenol formaldehyde showed an inflexion at $pH$ 10·3. The acidity calculated at this inflexion was only about 57·0 m.equiv. per 100 gm. Resorcinol formaldehyde gave two inflexions corresponding to acidities of about 58·0 and 115·0 m.equiv. per 100 gm. Three inflexions were found in the case of phloroglucinol formaldehyde, indicating acidities equal to 55·0, 110·0 and 162·0 m.equiv. per 100 gm. These values were found to be independent of the particle-sizes of the resins and they were obtained, subject to variations of less than ± 2·0 per cent, as often as the resins were prepared with an acid or an alkali as the catalyst, and with any molecular ratio between 1·5 and 3·0 of formaldehyde to the phenolic compound.

The cataphoretic velocity (in cm./sec./volt/cm.) of the resin particles, when plotted against added potassium hydroxide, showed a maximum corresponding to each inflexion (see Fig. 1), the second and the third inflexion of phloroglucinol formaldehyde being covered by a flat maximum. The potassium ion activity of the suspensions measured with the help of clay-membrane electrodes[1] also showed sharp changes corresponding with the inflexions in the $pH$ curve.

These inflexions are therefore real. They indicate the neutralization of hydroxyl groups which, apparently, have a stronger acid character than the majority of the hydroxyl groups present in the resin. It is possible that some benzene nuclei are not attacked at all three points by the formaldehyde, and if one assumes that the 'strong' hydroxyl groups are attached to such nuclei, one readily sees why, as noted above, the number of additional inflexions is the same as that of hydroxyl groups present per benzene nucleus. The amount of acid neutralized at the last additional inflexion bears to the total quantity of phenolic hydrogen a ratio which varies from 1:13 to 1:15 in the three resins, and this indicates, in the light of the above assumption, that one in about fifteen benzene nuclei is not attacked at a three points by the formaldehyde. This slig deficiency in cross-linking does not make an appr-ciable difference between the total quantity phenolic hydrogen actually found on titration an that calculated on the assumption that complet cross-linking had taken place.

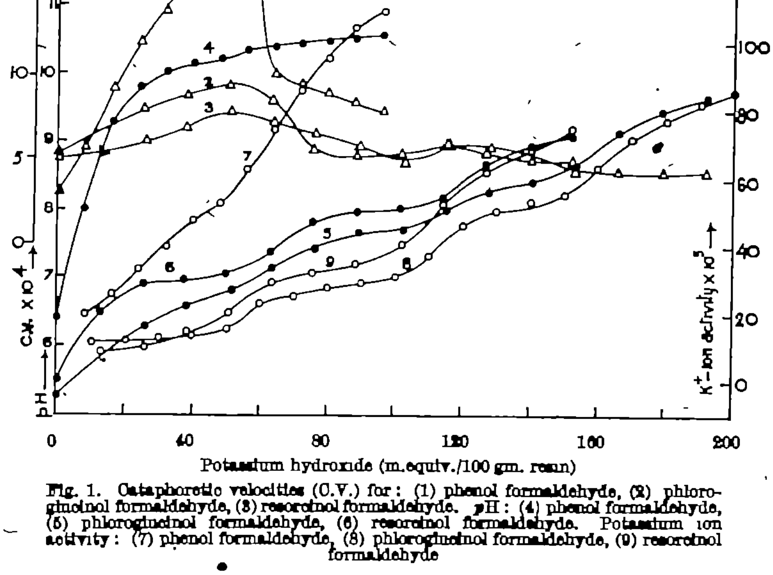

Fig. 1. Cataphoretic velocities (C.V.) for: (1) phenol formaldehyde, (2) phloroglucinol formaldehyde, (3) resorcinol formaldehyde. $p$H: (4) phenol formaldehyde, (5) phloroglucinol formaldehyde, (6) resorcinol formaldehyde. Potassium ion activity: (7) phenol formaldehyde, (8) phloroglucinol formaldehyde, (9) resorcinol formaldehyde

Additional inflexions similar to those reporte above have also been found with several other typ of solid condensation polymers. Details and fulle discussion will be published elsewhere.

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## A New Class of Compounds containing the Pentacyanoferrate Group and an Unpaired Electron

RECENT work in this Laboratory has establishec the existence of a class of compounds containin anions of the general formula $[\mathrm{Fe^{II}(CN)_5}R_1\dot{\mathrm{N}}R]^{3-}$. Here $R$ is an aromatic nucleus which may carry certain substituents and $R_1$ may be a hydrogen atom or an alkyl group such as a methyl or an ethyl radical. The dot over the nitrogen atom in the formula represents an odd, unpaired electron which, for convenience, is shown associated with a nitrogen atom.

The sodium salts of many of these anions are very soluble in water and give rise to intensely coloured solutions. The maximum extinction coefficients are often comparable with those of dyestuffs. Thus the logarithm to the base 10 of the maximum extinction coefficient in the visible region of the salt $\mathrm{Na_3[Fe(CN)_5H\dot{N}C_6H_4OH]}$ prepared from $p$-aminophenol is 4·29, which may be compared with values of 4·5 and 5·0 for malachite green and crystal violet respectively. Several of these compounds (for example, that derived from $p$-aminophenol) are relatively stable and have half-lives of many days in aqueous solution in the presence of air.

The solubilities of the salts of these anions are generally similar to those of the corresponding ferrocyanides; but the groups $R$ and $R_1$ have some effect on the solubilities. As several of the heavy-metal salts are insoluble in dilute aqueous acetic acid, and as many of these salts are intensely coloured solids, it is probable that solutions of the sodium salts of these complexes will find application as colour reagents for paper chromatography.

These complexes can be made conveniently by allowing the appropriate aromatic amine to react with a faintly alkaline solution of disodium pentacyanoammino-ferrate, that is, with the salt

$_3[Fe(CN)_5NH_3]$. For example, *p*-aminophenol acts with this salt to give the anion e$^{II}$(CN)$_5$H$\dot{N}$C$_6$H$_4$OH]$^{3-}$; but many amines give a ore complicated reaction. Thus aniline yields the ion [Fe$^{II}$(CN)$_5$H$\dot{N}$C$_6$H$_4$NHC$_6$H$_5$]$^{3-}$, identical with at obtained by the reaction of *p*-aminodiphenyl-aine with disodium pentacyanoamminoferrate.

Although the iron in these compounds is in the valent state, yet strong reducing agents (for ample, sodium hydrosulphite) destroy the com-exes and release the corresponding amine, $RR_1$NH. is reaction provides a method for the identification the organic radical in a complex. For example, duction of the complex prepared from aniline yields aminodiphenylamine and not aniline.

Unique syntheses may be carried out with the aid these compounds. For example, *p*-aminodiphenyl-nine can be prepared directly from aniline, and : 7-dimethylphenazine (Chemical Society Number-g System) can be made in 40 per cent yield from toluidine in a single step.

Full details of the preparation and behaviour of ese substances, together with evidence of their ructure, will be published elsewhere. The work scribed has been carried out as part of the research ogramme of the Chemistry Research Board, and is communication is published by permission of the irector, Chemical Research Laboratory

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## A New Model Material for Photoelasticity

Gelatin, and a number of imported plastics like atalm 800', '*BT*.61-893', '*CR*-39', 'Marco Resin', c., are commonly used as model materials. Gelatin optically more sensitive than all other materials, ut has some disadvantages. The stress-optical ensitivity of gelatin[1] varies considerably with the elatin concentration, glycerine content and tem-erature; the recommended working range of tem-erature is 14°–19° C.[2]. In the tropics, the gelatin mix very weak elastically at room temperature, whereas gar has proved to be more stable.

I have used agar as the model material for photo-lastic experiments. This material is cheap, easily vailable, and very widely used in preparing solid edia for bacteriological work; and the models can asily be prepared from it. The stress-optic sensitivity f this material has been calculated from the fringe ystem obtained with a model of a circular disk in iametral compression, and is found to be better than ther plastic substances and as good as gelatin itself.

The fringe constant of the material is found to be s low as 0·08 lb./sq. in./fringe/in. thickness (approx-mately) for 2–3 per cent agar concentration at 29° C. using an analyser as the compensator). For 15 per ent gelatin models this value is as high as 0·14[3]. hough low, the Young's modulus of about 14 lb./sq. n. for 5 per cent agar (obtained by loading a free ample without any side support) compares favourably vith the figure 6 lb./sq. in. for 13 per cent gelatin.

An attempt to increase the Young's modulus and he stress-optic sensitivity of the material in com-ination with other ingredients is being made and he results will be published elsewhere.

I am much obliged to Messrs. T. Ramasarma and . J. Mohanrao, research students of the Bio-chemistry Department of this Institute, for discussions and suggestions in the preparation of the model material.

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## Spot Chromatography of Hydraulic Mineral Oils using Fuller's Earth

The recent communication by L. H. Bryant[1] on an adsorbent-coated glass technique for circular chromatography of terpenes, etc., was read with interest. A rather similar method was developed in this laboratory in 1948, and various adsorbents were tried; pulverized silica gel appeared to cause some alteration (darkening) in certain of the mineral hydraulic oils tested, so its use was discontinued and ordinary fuller's earth (B.P. grade) used instead. This material (prepared as a trichlorethylene slurry poured on the glass to form a pool and then rapidly poured off to leave a thin film, which is allowed to dry in air) has proved consistently satisfactory. Spot tests made with it provide a convenient means of checking the consistency of different batches of mineral oils by examining the fluorescence of the rings containing the various oil constituents, using ultra-violet light from a mercury in quartz lamp fitted with a Wood's glass filter.

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[1] Bryant, L. H., *Nature*, 175, 556 (1955).

## A Simple Version of Bragg's X-ray Microscope

The method described by Bragg[1] for the artificial production of the image of a crystal structure from its X-ray diffraction pattern is of fundamental importance in the subject of X-ray optics. The experiment, however, requires the use of two accurate lenses which may not be available in most laboratories, and it is the purpose of the present brief communication to show how simpler apparatus can be made to serve the same purpose.

The simplification consists merely in making a small diffracting mask. This may be accomplished in a number of ways[2], but we have found that simple photographic reduction of a drawing is sufficient; over a distance of about 2 mm., a photographic plate is often sufficiently uniform for the optical thickness to be reasonably constant. Moreover, with a small diffracting mask the angles of diffraction are large enough for a lens of long focal length to be unnecessary for viewing the diffraction pattern.

The experiment has been carried out as follows. A drawing (Fig. 1) was made of the *h0l* weighted reciprocal-lattice section of nickel-phthalocyanine.

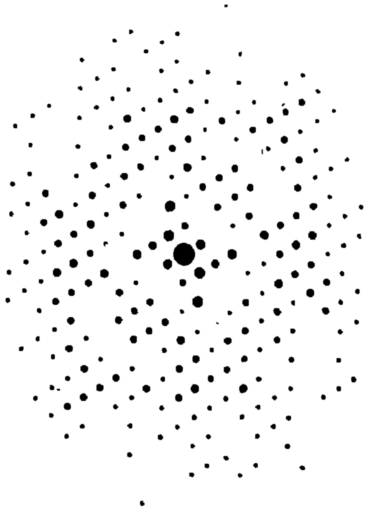

Fig. 1. Weighted reciprocal-lattice section of 'rhodium' phthalocyanine

This crystal nearly satisfies the condition that all the structure factors should be positive, but a few of appreciable magnitude are negative[2]; these were removed by the general addition of a positive scattering factor, so that the results corresponded to a central atom of atomic number 45 (rhodium) instead of 28. The spots in Fig. 1 were given areas roughly proportional to the structure factors. At first sight it may seem that the areas should be proportional to the intensities of the corresponding X-ray reflexions, but this would be so only if the dimensions of the diffraction pattern of a hole were independent of the size of the hole; it can easily be shown that the amplitude at the centre of the diffraction pattern of a circular hole is proportional to the area of the hole.

The drawing was photographed down directly to about 2 mm. diameter on a maximum-resolution plate. An ordinary telescope was then focused on a hole of 5 mm. diameter, about 10 metres distant, illuminated by filtered light from a compact-source mercury-vapour lamp. When the photograph of the reciprocal-lattice section was placed in front of th objective of the telescope, an image of the phthalocyanine molecule could be clearly seen around th central maximum. An improved image (Fig. 2a) wa obtained by covering the diffracting object with thin film of cedar-wood oil held in place by a microscope coverslip. Comparison with the calculate Fourier synthesis[3] (Fig. 2b) shows that the image a reasonable representation of the molecule.

Although the demonstration is valuable chiefly as teaching device for those departments that stress th relationship between physical optics and X-ra diffraction, it is hoped also to explore its usefulnes in connexion with the Fourier and Patterson method for general crystal-structure work.

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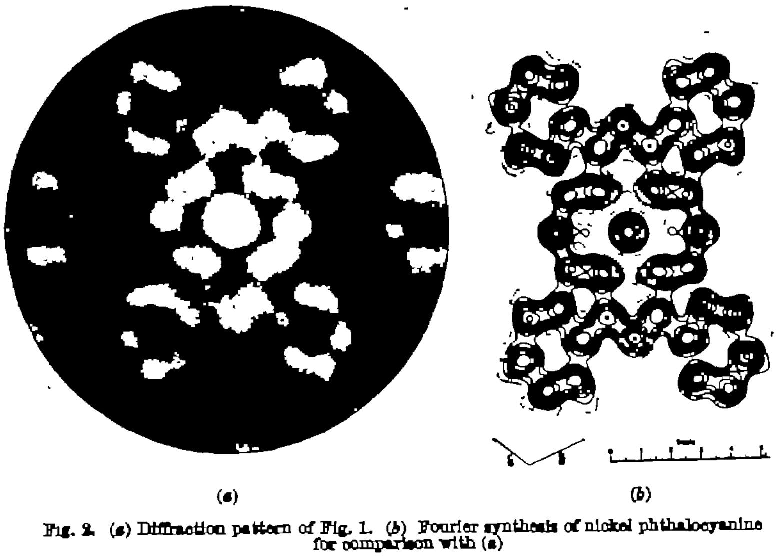

(a) (b)

Fig. 2. (a) Diffraction pattern of Fig. 1. (b) Fourier synthesis of nickel phthalocyanine for comparison with (a)

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## Evaporation of Water from Soil under Field Conditions

Canavan[1] has shown that, under field condition at Wellesbourne, very small deficits of soil moistur may adversely affect the germination of many kind of vegetable seeds and the subsequent establishmen of the crop. Further investigations have shown tha the top inch of a seedbed on light sandy loam contains approximately 0·30 in. of water, not all o which is available for germination.

On the basis of laboratory experiments, Penman concludes that, under summer conditions, evaporation of water from a bare soil takes place at th same rate as evaporation from a free water-surfac until a certain critical deficit is reached, approximately 0·35 in. Work during the summer of 195 at Wellesbourne has shown that several factors ma change the relationship between rate of evaporatio from bare soil and from a water-surface.

A number of undisturbed core of soil were taken from a seedbed which was at field capacit and were enclosed in water tight containers. They wer then replaced in the seedbe Similar containers were fille with water and were placed i the seedbed adjacent to th soil cores. All the surfaces wer protected from rainfall by a movable glass shelter. The rate of evaporation from the soil an from the water surfaces wer compared by daily weighing o the respective containers.

When the total evaporatio from the soil surfaces was plotte against total evaporation fron free water-surfaces, the curv showed two distinct stages. I the first stage, the loss was equa to the water-loss; but in th second stage the soil-loss becam

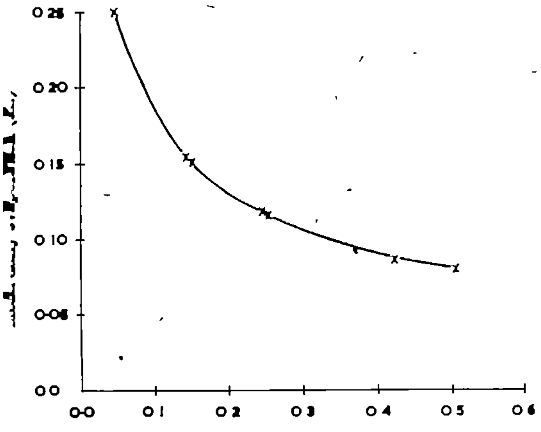

Fig. 1. Relationship between intensity of evaporating conditions and water loss from soil during the period when loss from soil surface equals loss from water surface

ogressively less. Fig. 1 shows the mean daily loss uring the first stage plotted against the total loss the end of this stage. The duration of the first age depended on the intensity of the evaporating nditions during this period.

Such a relationship between intensity of evaporing conditions was to be expected, for in 1907 uckingham[3] showed in laboratory experiments that e greater the intensity of evaporating conditions e sooner did evaporation-loss exceed the supply moisture to the surface by capillarity, thus reucing subsequent loss by the formation of a surface ulch of dry soil.

As the evaporation-rate is governed by capillary pply as well as by evaporating conditions, any il factor which reduces capillary movement may e expected to reduce the evaporation-rate. Field periments have indicated that differences between e apparent specific gravity of a number of soil ores altered the relationship between the rate of ater evaporation from the soil-surface as compared ith that from a water-surface.

In other experiments it was found that the modication of the soil structure brought about by sieving fluenced the rate of evaporation of water from the il surface independently of the apparent specific ravity of the soil. This may explain differences etween results obtained in these field experiments, n which the natural structure of the soil cores was ndisturbed, and laboratory experiments in which eved soil was used[1]. Further experiments at Wellesourne have shown that even small differences in the moisture content of the surface layers affected the rate of evaporation.

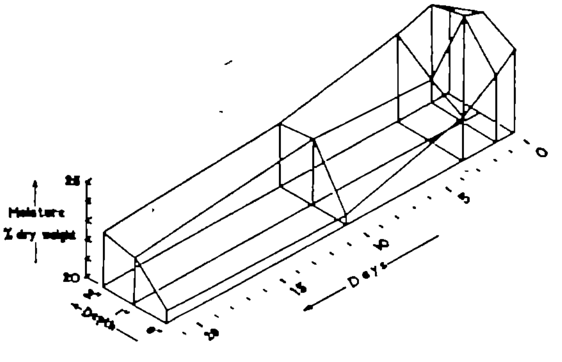

Fig. 2. Progress of drying in the top 3 in. of a seedbed

Staple and Lehane[4] have shown recently that the capillary movement of water in an unsaturated soil was affected by apparent specific gravity and moisture content, and they have described a method of estimating the rate of capillary movement from these two factors.

Detailed knowledge of the factors influencing the rate of capillary movement and a consideration of the intensity factors of evaporating conditions would enable the overall soil moisture deficit to be estimated more accurately than Penman's purely meteorological methods at present permit[5].

In addition to the overall deficit, it is desirable to know the progress of drying at various depths in order to determine the moisture environment of seeds sown in the soil. Fig. 2 shows the progress of drying in the top 3 in. of a seedbed exposed to slow evaporating conditions. After three days, the drying zone extended to 2 in. in depth, and half the deficit was in the top inch of the seedbed. After twenty-one days the deficit was demonstrable to a depth of 3 in., 55 per cent in the surface inch, 29 per cent in the second inch and 16 per cent in the third inch.

These studies of evaporation in the field are being continued, the aim being to establish the relationship between apparent specific gravity, moisture content and evaporation under the yearly cycle of evaporating conditions, and to investigate their effect on the drying of soils at various depths.

This work was done at the National Vegetable Research Station during the tenure of a Ministry of Agriculture Scholarship.

G. STANHILL

National Vegetable Research Station,
Wellesbourne,
Warwick.
March 25.

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[1] Canavan, H. M., Ann. Rep. Nat. Veg. Res. Stat. 1954.

[2] Penman, H. L., *J. Agric. Sci.*, 31, 454 (1941).

[3] Buckingham, E., "Studies on the Movement of Soil Moisture" (U.S. Dept. Agric., Bureau Soils, 38 (1907).

[4] Staple, W. J., and Lehane, J. J., *Canad. J. Agric. Sci.*, 34, 329 (1954).

[5] Penman, H. L. *Proc. Roy. Soc.*, A, 193, 120 (1948).

# Effect of Temperature and Initial Moisture Content on the Heat of Wetting of Wood

THE results of tests by Shipley, Campbell and Maass[1] and Clarke (unpublished results), and also of tests at the Forest Products Research Laboratory (Department of Scientific and Industrial Research)[2], clearly show that the variation in the specific heat of cellulosic materials with moisture content does not follow the relation for simple mixtures. Assuming the specific heat of the cellulose to be unchanged, the apparent specific heat of the sorbed water has been calculated to be as high as 1·8 times the value for liquid water.

It can be shown thermodynamically[3] that if the heat of sorption is dependent on the temperature, $T$, the following relation holds:

$$c_m = \frac{1}{1+m}\left\{mc_w + c_s + \left(\frac{\partial \Delta H}{\partial T}\right)_{p,m}\right\} \qquad (1)$$

where $\Delta H$ is the integral heat of sorption, defined as the heat absorbed when $m$ gm. of sorbate are sorbed

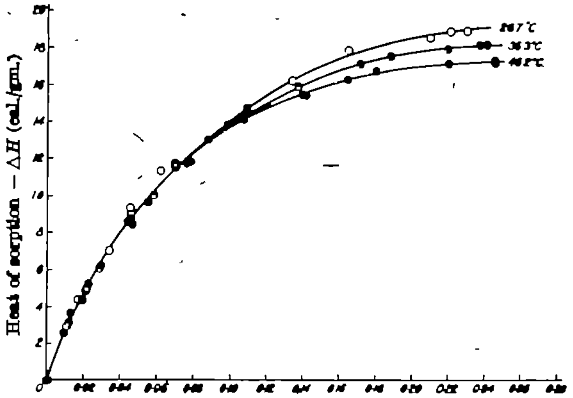

Fig. 1

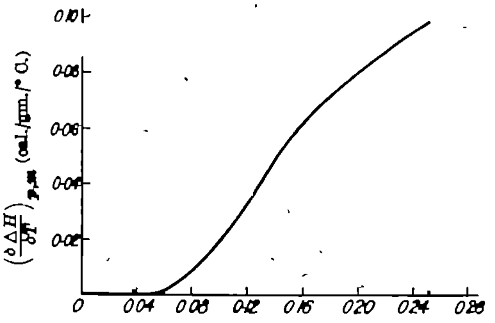

Fig. 2

by 1 gm. of pure sorbent, and $c_m$, $c_s$ and $c_w$ are the specific heats at constant pressure of the sorbent at moisture content $m$, of the pure sorbent, and of the water, respectively. Wahba and Nashed[4] found that the heat evolved on wetting dry cellulose decreased with an increase in temperature, that is, at saturation $\partial \Delta H/\partial T$ was positive, and they concluded that the specific heat of the sorbed water at saturation is greater than that of liquid water.

We have determined the heats of immersional wetting of wood samples having initial moisture contents, $m$, ranging from 0 to 0·24 gm./gm. The tests were made at three different temperatures using an adiabatic calorimeter of the type described by Hirst and Kerridge[5]. Matched samples of ground klinki pine (*Araucaria klinkii* Lauterb.) were used, the experimental conditions being chosen so that wetting occurred as rapidly as possible. The heat of sorption, $\Delta H = \int_0^m \left(\frac{\partial \Delta H}{\partial m}\right)_{T,p} dm$, was obtained by subtracting the calorimetrically measured heat, $\int_m^{\text{sat.}} \left(\frac{\partial \Delta H}{\partial m}\right)_{T,p} dm$, from the heat of wetting of dry wood.

The variations of $\Delta H$ with both temperature and moisture content and of $(\partial \Delta H/\partial T)_{p,m}$ with moisture content are shown in Figs. 1 and 2 respectively. The results confirm the observations of Wahba and Nashed, the quantitative agreement between the two sets of data being quite good since, in both cases, the value of $(\partial \Delta H/\partial T)_{p,m}$ at saturation is 0·4–0·5 per cent of $\Delta H$ for a rise in temperature of 1° C.

Our results show that the value of $(\partial \Delta H/\partial T)_{p,m}$ decreases with decreasing moisture content. At very low moisture content its value is zero (within experimental error), and this is confirmed by the res of Taylor's isosteric measurements[6] at low relat vapour pressures, which showed that the differen heat of sorption $(\partial \Delta H/\partial m)_{T,p}$ for viscose rayon independent of temperature at all moisture conte less than 0·02 gm./gm. Shipley, Campbell and Ma found that for bleached sulphite pulp at a moist content of 0·02 gm./gm. the apparent specific h of the sorbed water, measured between 5° and 25° was 1·13, this being the maximum value obser at any moisture content. From equation (1), corresponding value of $\partial \Delta H/\partial T$ at this moist content is 0·0026 cal./gm./° C.; but this deviat from zero is within the experimental error of tests.

The present results clearly show that the eff of temperature on the heat of sorption is adequ to account for the departure of the specific he moisture content relation for cellulosic materi from that for simple mixtures. Since the effect m be regarded as being significant compared with perimental error only at moisture contents grea than 0·12 gm./gm., it is suggested that the ene of binding of the most strongly held water is relativ unaffected by temperature.

KATHLEEN E. KELSEY
L. N. CLARKE

Division of Forest Products,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.

March 25.

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[1] Shipley, J. H., Campbell, W. B., and Maass, O., *Can. J. Res.*, 1 40 (1939).

[2] "Forest Products Research 1953" (H.M.S.O., London, 1954).

[3] Guggenheim, E. A., "Thermodynamics" (North Holland Pub. ( Amsterdam, 1950).

[4] Wahba, M., and Nashed, S., *Nature*, 166, 998 (1950).

[5] Hirst, W., and Kerridge, M., *J. Sci. Instr.*, 27, 161 (1950)

[6] Taylor, J. B., *J. Text. Inst.*, 43, T157 (1952).

## Fitness of Microcythæmics : a Correctio

I MUST apologize for an error I made in a co munication[1] about the fitness of microcythæm heterozygotes, published in *Nature* by Silvestro Bianco, Montalenti and myself. I am grateful Dr. T. E. Reed (University of Michigan) for pointi out that, in Table 2 of that communication, the seemed to be an excess of *MM* among sibs as co pared with the theoretical number if calculated fro the proportion of *Mm* among the parents, given the communication as 0·101. This query gave the opportunity of rechecking the data and findi the error.

Actually, in Table 2 the proportion of *Mm* paren should have been given as 0·1496, and therefore t direct estimates and theoretical values for the fi nesses would have to be accordingly recalculate However, I do not propose to do this here, becau a careful examination of the data in the light of t criticism made by Dr. Reed has convinced me tha in fact, the data from which Table 2 was prepar were biased by incompleteness of ascertainme among parents and even more so among sibs (f example, only those families with tested childr were taken into account, and even in these famili not all the children could be tested).

Penrose's method for estimating fitness seems be correct only when the gene frequencies have be obtained from data collected with complete ascerta

Table 1. 1951 AND 1952 DATA: COMPLETED FAMILIES ONLY

| Type of mating | No. of families | No. of children | Mean No. of children per family, and standard error | Theoretical fertility |
|---|---|---|---|---|
| $mm \times mm$ | 1,886 | 9,217 | 4·89 ± 0·188 | $2f'$ |
| $Mm \times mm$ | 793 | 3,978 | 5·02 ± 0·217 | $f' + g'$ |
| $Mm \times Mm$ | 79 | 394 | 4·99 ± 0·749 | $2g'$ |

nt. Such conditions are very difficult to satisfy the case of human data. But perhaps the data ven in Table 1 of the previous communication[1] may used to give some further information. (This ble covers data collected in 1952 as well as 1951; e heading to the table should be corrected accordgly.) The table is reproduced here in an expanded rm.

The distribution of genotypes among the children not given here, because it was determined for the 51 sample only. Also, as stated in the previous mmunication, this table refers to completed families ly, that is, those in which the mother was more an forty years old, and therefore presumably would t have any more children. This limitation was cessary in order to avoid having different average mbers of children per family according to the fferent ages of the parents. Furthermore, this table cludes practically all the completed families in the stricts studied. (The standard errors were calculated om the observed distributions of family size.)

In this population, *M* genes are constantly being st through the death of *MM* individuals from ooley's disease; so, if equilibrium is to be mainined, the *Mm* individuals must have some kind of lective advantage over the *mm* (assuming that the utation-rate is inappreciable). Taking the frequency f the *M* gene to be about 0·09, corresponding to the opulation under consideration, Penrose's theory[2] ows that the fitness of *Mm* must be about 1·11 mes that of *mm*. This assumes additive fitness ncluding additive fertility, as shown in the last olumn of Table 1); if the fitness is assumed to be ultiplicative, almost identical values are obtained. This advantage may result either from a greater rtility of *Mm* individuals, or from a greater survivalate between conception and reproduction, or to a ombination of these factors.

An estimate of the fertilities $f'$, $g'$ of *mm*, *Mm* dividuals, respectively, may be obtained by applying ast squares to Table 1, that is, by minimizing

$$= \frac{(2f' - 4{\cdot}89)^2}{0{\cdot}188^2} + \frac{(f' + g' - 5{\cdot}02)^2}{0{\cdot}217^2} + \frac{(2g' - 4{\cdot}99)^2}{0{\cdot}749^2}$$

which gives the estimates $f' = 2{\cdot}45 \pm 0{\cdot}068$, $g' = {\cdot}55 \pm 0{\cdot}193$, covariance of $f'$ and $g' = -0{\cdot}00342$. Other methods of estimation lead to substantially he same conclusions[2].

The difference between $f'$ and $g'$ is accordingly $-0{\cdot}10 \pm 0{\cdot}22$. Although the deviation is in the direction required for producing stability, it is insufficient in quantity and not statistically significant. Thus the data are compatible either with the assumpion that there is no difference of fertility (true value of $f' - g' = 0$), or with a ratio $g'/f' = 1{\cdot}11$ (true value of $g' = 1{\cdot}11$, $f' = 2{\cdot}72$, $f' - g' = -0{\cdot}27$). On the first hypothesis, it would be necessary to suppose that the gene frequency of *M* is increased by a greater survival-rate between birth and reproduction, or at least that there was such a greater survival value until recently (for example, possibly acting as a protection against malaria). For data on survival, see Montalenti[3]: a difference of this kind has been established for the sickle-cell condition by Allison[4]. On the second hypothesis, the difference in fertility alone would be sufficient to maintain equilibrium. With an explanation of this kind it would have to be supposed that the fertility ratio would differ from district to district to agree with fluctuations in gene frequency. But it is clear that the evidence so far gathered is indecisive.

M. SINISCALCO

Istituto di Genetica,
Università, Naples.
April 1.

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[1] Silvestroni, E., Bianco, I., Montalenti, G., and Siniscalco, M., *Nature*, 173, 357 (1954).

[2] Penrose, L. S., *Ann. Eugen., Lond.*, 14, 301 (1949); *Lancet*, ii, 425 (1950); *J. Génét. hum.*, 3, 159 (1954).

[3] Montalenti, G., Proc. IXth Int. Cong. Genet., Supp. *Caryologia*, 6, 554 (1954).

[4] Allison, A. C., *Ann. hum. Genet., Lond.*, 19, 39 (1954).

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## "Air Pollution"

I SHOULD like to direct attention to a statement made in the leading article entitled "Air Pollution" in *Nature* of March 5 dealing with cement kilns which might be misleading.

Reference to Clauses 43–47 of the Beaver Report will show that the matter of dust emission from cement works is already subject to the Alkali, etc., Works Regulation Act, 1906, and the Alkali, etc., Works Order, 1935, which deal with scheduled processes. In 1935, cement works were specifically scheduled under this Act, which obliges the owner of any scheduled process to use the best practicable means to remove or reduce nuisance. The Act requires the processes to be operated to the satisfaction of the Chief Alkali Inspector, and various penalties are imposed for non-compliance.

It may be noted that power stations and similar coal-burning installations do not come under this Act, and the recommendation of the Committee is to bring such installations under control to a greater extent than indicated in Clause 40.

EDWARD BURKE
(Director of Research)

Associated Portland Cement Manufacturers, Ltd.,
Research Laboratories,
Stone, Greenhithe, Kent.
March 15.

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IT is correct that the Beaver Report referred to the statements as set out in Mr. Burke's letter, and the Report urged an acceleration of effort in the directions desired. It is our view that the comment in the Report was not strong enough.

A parallel case arose in which reference was made in the Report to the pollution emerging from motor-car exhausts. In that case it was pointed out that legislative provision had been made; but that no effective action was taken towards abating the resulting nuisance.

We have in mind a very beautiful part of the country in which the amenities of the countryside continue to be reduced by emission from cement works. A law may exist whereby provision is made for action; but unless the law is observed it becomes ineffective. Only by sufficiently strong protest can the nuisance in question be abated.

EDITORS

# FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

### Monday, July 11—Tuesday, July 12

Society for Analytical Chemistry (joint meeting of the Biological and Physical Methods Groups and the Scottish Section, with the Edinburgh and East of Scotland Sections of the Royal Institute of Chemistry, the Society of Chemical Industry and the Chemical Society, in the Department of Biochemistry, University New Buildings, Teviot Place, Edinburgh 8)—Meeting on "The Use of Radioactive Materials in Biological Assay".

### Monday, July 11—Saturday, July 16

Society of Chemical Industry (at Birmingham)—Seventy-fourth Annual Meeting.

### Wednesday, July 13—Friday, July 15

Chemical Society (at the University College of the South West of England, Prince of Wales Road, Exeter)—Symposium on "Recent Work on Naturally Occurring Nitrogen Heterocyclic Compounds".

### Thursday, July 14

National Institute of Agricultural Botany (at Huntingdon Road, Cambridge), at 2.15 p.m.—Annual General Meeting.

### Friday, July 15

Biochemical Society (in the Department of Agricultural Chemistry, University College of North Wales, Bangor), at 11 a.m.—Scientific Papers.

Bone and Tooth Society (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 3 p.m.—Discussion on some of the Proceedings of the Ciba Foundation's Symposium on "Bone Structure and Metabolism".*

### Friday, July 15—Saturday, July 16

British Association for the Advancement of Science, Division for Social and International Relations of Science (in the Washington Singer Hall, University College of the South-West, Exeter)—Conference on "Land Use".

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Inorganic and Physical Chemistry—The Registrar, Trinity College, Dublin (July 20).

Lecturer or Assistant Lecturer in Agriculture with special reference to Grassland Husbandry—The Registrar, Wye College, Wye, Ashford, Kent (July 20).

Senior Assistant in Research in the Department of Geodesy and Geophysics—The Secretary, Appointments Committee of the Faculty of Geography and Geology, Department of Geography, Cambridge (July 21).

Chemist, Senior Scientific Officer grade (with a first- or second-class honours degree or equivalent in chemistry, postgraduate research experience in physical chemistry, preferably on the properties of surfaces or of high polymers, and some knowledge of biological subjects), at the Ministry of Supply Experimental Establishment, near Salisbury, Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.458/5A (July 23).

Lecturer in Mathematics—The Secretary of University Court, The University, Glasgow (July 30).

Lecturer in Social Anthropology—The Registrar, The University, Manchester 13 (July 30).

Organic Chemist (honours graduate and preferably with experience in handling natural products, or of chromatography and enzyme work), at the Colonial Products Laboratory, London, S.W.7, for fundamental investigations into the chemistry of pyrethrum—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.465/5A (July 30).

Senior Lecturer in Agriculture—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (July 30).

Lecturer/Senior Lecturer in Biochemistry at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Sydney, July 31).

Professor of Experimental Physics, and a Lecturer in Mathematics at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 10).

Senior Lecturer (with a university degree in mechanical engineering, and preferably with experience in industrial or production engineering) in Mechanical Engineering, at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 15).

Lecturer (with special qualifications in physical chemistry) in Chemistry—The Secretary, The University, Aberdeen (August 20).

Chair of Applied Mathematics at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (August 30).

Assistant Lecturer in Anatomy, to undertake teaching research—The Secretary, University College, Gower Street, Lond W.C.1 (August 31).

Lecturer or Senior Lecturer in General and Experiment Psychology at the University of Melbourne, Australia—The Sec tary, Association of Universities of the British Commonwealth, Gordon Square, London, W.C.1 (Australia, August 31).

Lecturer (with a degree in agriculture and preferably some perience of teaching) in Agriculture, at the Imperial College Tropical Agriculture, Trinidad—The Secretary, Imperial College Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (August 31)

Chair of Botany at the University College of the West Indie The Secretary, Inter-University Council for Higher Education Ov seas, 1 Gordon Square, London, W.C.1 (September 30).

Lecturer, a Reader, and a Professor in Physics at t Chulalongkorn University, Bangkok, Thailand—Royal Thai Embas 21 Ashburn Place, London, S.W.7.

Lecturer (with a good honours degree, teaching and indust experience) in Chemistry, at Rutherford College of Technolo Newcastle-upon-Tyne—The Director of Education, Northumberla Road, Newcastle-upon-Tyne 1.

Senior Physical Chemist (with a first- or second-class hono degree in physical chemistry or biochemistry, together with consid able research experience), to lead the newly formed Technolog Irradiation Group, and carry out research and development work the field of beta and gamma irradiation—The Establishment Offic U.K. Atomic Energy Authority, Atomic Energy Research Establi ment, Harwell, Didcot, Berkshire, quoting 2/103/236.

Senior Scientific Officer (with at least a second-class hono degree, and preferably with experience in electronic circuit desig for work on the design of electronic instruments and development techniques in using such instruments in the discovery and ass of radioactive ores—The Establishment Officer, United Kingd Atomic Energy Authority, Atomic Energy Research Establishme Harwell, Didcot, Berkshire, quoting 2/103/273.

# REPORTS and other PUBLICATION

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Institution of Gas Engineers. 92nd Annual Report and Accoun of the Council of Gas Engineers. Pp. 41. (Publication 460.) (London Institution of Gas Engineers, 1955.) [1

Institution of Professional Civil Servants. Annual Report for t year 1954. Pp. 44. (London: Institution of Professional Ci Servants, 1955.) [19

The British Non-Ferrous Metals Research Association, 1930–195 Pp. 48. (London: British Non-Ferrous Metals Research Associatio 1955.) [19

National Institute of Agricultural Botany. Farmers' Leaflet No. Lucerne. (Revised edition, March 1955.) Pp. 8. (Cambridge National Institute of Agricultural Botany, 1955.) [20

Department of Scientific and Industrial Research and Fire Office Committee. Report of the Fire Research Board, with the Report of t Director of Fire Research for the year 1954. Pp. vi+48+8 plate (London: H.M. Stationery Office, 1955.) 3s. net. [20

Department of Scientific and Industrial Research. National Physic Laboratory. Report for the year 1954. Pp. viii+98+7 plate (London: H.M. Stationery Office, 1955.) 4s. net. [20

International Committee for Bird Preservation—British Sectio Annual Report for 1954. Pp. 66+4 plates. (London: Internation Committee for Bird Preservation, c/o British Museum (Natur History), 1955.) 2s. 6d. [24

Building Research Station Digest. No. 76 (April, 1955): Machine for Handling Materials in Traditional House Building. Pp. 7. (London H.M. Stationery Office, 1955.) 3d. net. [24

### Other Countries

Publikationer fra det Danske Meteorologiske Institut, Charlottenlund. The State of the Ice in the Arctic Seas, 1952. (Appendix to th Nautical Meteorological Annual 1952.) Prepared by Helge Thomsen and Cmdr. M. V. L. Lorck, R.D.N.R. Pp. 23+5 maps. (Charlottenlund: Danske Meteorologiske Institut, 1955.) [19

Research Council of Alberta. Thirty-fifth Annual Report, 1954 Pp. 47. (Report No. 69.) (Edmonton: Research Council of Alberta 1955.) [20

Notulae Naturae of the Academy of Natural Sciences of Philadelphia. No. 256 (February 17, 1954): The pH Tolerance of the Common Bluegill (*Lepomis macrochirus* Rafinesque). By Francesc B. Trama. Pp. 13. No. 257 (February 17, 1954): The Acute Toxicity of Copper to the Common Bluegill (*Lepomis macrochirus* Rafinesque) By Francesco B. Trama. Pp. 13. No. 258 (June 3, 1954): A New Gastropod and other Fossils from the Cretaceous of New Jersey. By Horace G. Richards. Pp. 5 (1 plate). No. 259 (July 21, 1954): A New Method for Determining the Pattern of the Diatom Flora. By Ruth Patrick, Matthew H. Hohn and John H. Wallace. Pp. 12. No. 260 (September 17, 1954): Birds of Turneffe and Northern Two Cays, British Honduras. By James Bond. Pp. 10. No. 261 (November 19, 1954): Pariostegus, a Triassic Coelacanth. By Bobb Schaeffer. Pp. 6 No. 262 (November 19, 1954): The Idaho-Montana Slug Magnipelta (Arionidae). By Henry A. Pilsbury and Royal Bruce Brunson. Pp. 6. No. 263 (November 19, 1954): Mollusks from the Mississippi Delta. By Horace G. Richards. Pp. 8. No. 264 (November 29, 1954): A New Race of Gallinula Chloropus from Barbados. By James Bond. Pp. 2. No. 265 (November 29, 1954): Description of a New Blennioid Fish from Southwest Florida. By Henry W. Fowler. Pp. 3. No. 266 (November 29, 1954): Miocene Land Shell Fossils from the Dominican Republic. By Henry A. Pilsbury and Axel A. Olsson. Pp. 4. (Philadelphia: Academy of Natural Sciences of Philadelphia, 1954.) [245

# DEVELOPMENT IN EAST AFRICA

THE report of the Royal Commission on East Africa*, appointed in January 1953, with Sir ugh Dow as chairman, to examine the measures ecessary to achieve an improved standard of living, cluding the introduction of capital to enable peasant rming to develop and expand production, is a assive document of nearly five hundred pages and nges over a distinctly wider field than its strict rms of reference cover. The Commission was indeed arged to examine, and where necessary comment pon, policy in such related fields as education and ublic health which appeared to it to bear on the roblems with which it was primarily concerned, and particular the extent to which existing technical aining facilities are adequate to meet the require- ents of extensive industrial development. It was so to consider probable trends of population in East frica and to make appropriate recommendations in lation to the other problems involved. Specifically, was instructed to frame recommendations with articular reference to six topics: the economic evelopment of the land already in occupation by e introduction of better farming methods; the daptations or modifications in traditional tribal stems of tenure necessary for the full development f the land; the opening for cultivation and settle- ent of land at present not fully used; the develop- ent and siting of industrial activities; conditions f employment in industry, commerce, mining and lantation agriculture with special reference to social onditions and the growth of large urban populations; nd the social problems which arise from the growth f permanent urban and industrial populations.

Even without the broad interpretation of its terms f reference—including some study of the historical ackground, of the results of past legislative and dministrative measures, and an attempt to under- and how East Africa's modern environment has risen—which the Commission has wisely chosen to dopt, the report deals largely with details which lie utside the field of science and even of technology, hough they are of indirect interest to both scientist nd technologist and may determine the success or ilure of his work in Africa. Nevertheless, in its nsidered unprejudiced approach, even more than its comprehensive grasp and constructive un- hibited suggestions, the report is characterized sentially by the scientific spirit. Its whole approach nd treatment of the problems are in keeping with e late General Smuts's plea for the cool, serious, entle spirit of science in world affairs in his Sidgwick emorial Lecture at Cambridge more than a quarter f a century ago, though in that interval neither the ientific expert nor the scientific spirit has won the lace and influence which Smuts considered necessary a truly democratic order.

For that reason alone although, apart from some oints in the chapters on manufacturing industries nd on African labour, particularly relating to technical education, the chapters on health and education, water development, statistics, agricultural potential and alternatives to customary land use contain most of the material of immediate concern to the scientific worker; the main conclusions and the recommendations and suggestions collected at the end, numbering nearly five hundred, will be read with interest by all men of science concerned with African problems. Not only do they confirm important findings of the recent Binns report on education and of Dr. E. B. Worthington's survey of research and scientific services in East Africa, but they also provide background for the consideration of work being carried out by the Colonial Research Council, or with the assistance of Colonial Development and Welfare Funds or Technical Aid. They indicate how large a contribution science can make to African development and welfare, and indeed that, without such assistance and a scientific approach to many of the problems involved, these problems are unlikely to be solved.

The Commission does not over-simplify the issues or disguise its belief that many of the problems it was called upon to examine are highly complex. It agrees with Sir Philip Mitchell's description of them as "complex and recalcitrant". Nevertheless, its main message can be stated quite briefly. Throughout most of East Africa agricultural development is impeded on the physical side by inadequate or unreliable rainfall, by soil deficiencies and by the scourge of the tsetse fly; and on present knowledge there are few of the exploitable mineral resources which have contributed so largely to the greater national incomes of some other African territories. The economic development and prosperity of the local populations thus depend in the main on the capital and knowledge which are brought to bear upon the limited natural resources rather than upon the persistent bounty of Nature.

Moreover, while the capital, knowledge and enterprise mainly responsible for economic expansion in East Africa have come almost entirely from outside the territories, the majority of Africans are still ill-equipped to face the complex problems confronting a people so recently brought into intimate contact with Western civilization; and in particular they are handicapped by their traditional form of society, which has sought its security and stability in a mode of life that has had little specialization on the side of production, few opportunities for the exchange of goods and few human contacts with the outside world. Those responsible for policy in East Africa have always been alive to the importance of introducing the capital, organizing ability and technical skill which progress requires. They have also been alive to the economic weakness of the African when confronted by enterprising forces emanating from more developed regions, and as part of a policy designed to safeguard and protect the indigenous populations a land policy has been introduced which preserves the customary rights in land that the

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* East Africa Royal Commission 1953–55 Report. (Cmd. 9475.) p. xiv+482+4 maps. (London: H.M.S.O., 1955.) 17s. 6d. net.

African has enjoyed; in other directions, too, endeavours have been made to insulate the African from rigorous external competition.

This policy, however, conflicts with the desire to create the new income which alone can make possible a rise in African living standards; and the combined effect of a strong resistance to change on the part of the African, modified by an increasing desire to participate in the advantages derived from the ideas and practices of the modern world, and of a strong protective urge in official policy, has been to create a network of restrictions and controls which impede the progress it is sought to attain. All communities in East Africa face an apparent choice between progress and security; but there is no real security in the institutions which now seem to offer it. What is required, the Commission finds, is to create conditions favourable to the exercise of those activities which make for progress, and to substitute for policies hindering change other policies which will facilitate those modifications of traditional African society that will enable the requirements of the modern economy to be met.

In examining the population problem, the Commission accordingly focused attention on the conditions under which the African may participate in the advantages that a modern society has to offer, concentrating on the possibility of raising income per head of population in an environment which perhaps offers more discouragements than assistance. There are no short cuts, and there is no escape from the necessity to transform the traditional methods of production and exchange if the desired result is to be achieved. The Commission never flinches from facing difficulties; if at times it may appear to be looking too far ahead, the imagination and vision of the report are unmistakable, and the real issues are laid bare. Whatever reservations may be made as to timing, the essential soundness and value of the Commission's ideas and practical suggestions are unmistakable, and they are presented with a courage and clarity that should commend them to the many scientific workers and technologists who will be called upon to play their part in implementing them.

Fundamentally, the creation of larger incomes per head of population means greater emphasis on specialized production and greater facilities for the exchange of goods and services, as well as a greater mobility of economic resources, so that new forms of production become possible. It means greater access to supplies of new capital and the acquisition of new skills and new knowledge; but the Commission points out that the essential pre-requisite for creating an effective African labour force is the stabilization of African labour and the severance of its ties with the reserves. The key to a permanent rise in the supply price of African labour is to foster an increase in the incomes of the peasants, whether they produce for their own subsistence or for the market. Moreover, while the Commission believes that African labour can be trained to a considerable level of proficiency, the low productivity of ordinary African labour is not due merely to the lack of technical skill but also to such factors as under-nourishment, poor physique, endemic disease, inadequate supe vision and a lack of interest in ordinary econom incentives.

If these conditions can be fulfilled, the fear over-population which dominates so much of t contemporary debate may well prove to be illusory, but their fulfilment will demand not only coura but also a degree of open-mindedness and the reac ness to put the general interest in front of section interests that, from the Commission's comments such diverse matters as economic developmen transport, statistics and research, has often be conspicuously absent. In particular, a re-examinati of the whole system of restriction and controls whi dominates the distributive system is called for, wi the view of discarding those administrative devic which serve only to perpetuate an obsolete co ception of self-sufficiency or to promote a section interest. Moreover, whether in the field of educatio in the supply of credit facilities or in the acquisitic of technical skill, the expenditure of resources providing such aids should be concentrated whe they are likely to be most effective; and there shoul not be undue disappointment if positive results a slow to appear.

While the Commission thinks that a stage has no been reached when a more direct contribution fro the African to the development of East Africa is bot possible and desirable, it does not believe that an appreciable amount of capital for new industri development can conveniently be raised from th African population through compulsory saving with out imposing unreasonable burdens or doing damag to African enterprise and production. No larg reservoir of investable resources for rapid industria ization or for investment in new social capital exis in East Africa, and any substantial amount of ne industrial development will depend on the productio of increased income from the land. The econom cannot afford to provide large and effective induc ments to encourage any large-scale promotion new enterprise from abroad, and public expenditu on development projects should be concentrated objects likely to yield immediate and reasonab certain results in the form of increased income, that there will be a larger surplus to devote projects which take longer to mature. It is importa that the public expenditures of the territories shoul be closely geared to their respective national income

Such considerations imply that land policy mu be directed towards the removal of those condition which prevent the available land from being effectivel utilized and equally towards the creation of co ditions which will facilitate the application of tech nical knowledge, labour and capital in proportion suitable over the long period to the generation maximum income; what may be called individu rights of land tenure must replace the existing trib controls. It is from this point of view that th Colonial development and welfare schemes for Ea Africa, including research schemes, educationa policy, and the specific scientific problems of agr culture, forestry, hydrology and the like, should b considered.

"One of the most useful roles for statistical analysis," wrote Prof. Ely Devons, in *Lloyds Bank Review* last year, "is to reveal the implications, and sequently the consistencies in policy decisions and to attempt to ensure that the main lines of policy are in harmony and not in conflict." Much in the recent report of the Royal Commission admirably illustrates that thesis, and the main argument of the chapter on statistics, with its strong plea for adequate support for the East African Statistical Department, is that some of the political and administrative problems have now become so urgent that policies formulated on the basis of inaccurate data, or on the general impressions of observers with different standards of reliability, may, at the best, be ineffective and, at the worst, dangerous, and that the regular collection and publication of statistical data are one means of reducing or avoiding these dangers. While, however, it is of the utmost importance that the exceedingly limited resources of East Africa should be employed in the most effective manner, the resources at the disposal of the East African Statistical Department, alike in finance and qualified personnel, are inadequate for the proper discharge of the duties and responsibilities assigned to it, notwithstanding that its work is efficiently conducted.

Nor is this all. These limitations are intensified by the unsatisfactory and uncertain relationship existing between the Department and the Territorial Governments. While the East African Statistical Department is the most technically qualified official agency in the field of statistics in East Africa, and additional expenditure on the Department would yield far greater benefits if devoted to the Department than if spread over three territorial departments, the Department is so restricted that initiative for any improvement in the statistical services has to come from the Territorial Governments. Of this position the Commission is severely critical, and suggests re-examination of the position by the three governments and by the High Commission. The suggestion that the three Territorial Governments should be encouraged to build up independent statistical services is firmly rejected, and the Commission insists that it is primarily the relationship between the Department and the Territorial Governments which requires clarification. It is suggested also that the East African Statistical Department should receive a grant from Colonial Development and Welfare Funds for the development of its statistical and research work, in addition to the financial support provided by the Territorial Governments, and that the funds from both sources should be provided in accordance with a scheme covering several years at a time.

This is not the only point on which the Royal Commission is critical of the Territorial Governments or of the East Africa High Commission. Elsewhere, asserting that economic policy must be based on the assessment of economic potentialities in the territories and of East Africa as a whole, it says that development must not be impeded by policies of economic self-sufficiency within the three territories. In place of the present East African Railways and Harbours Administration, tied to the political exigencies of the separate Territorial Governments, it recommends reconstitution of the Administration as an independent autonomous Railway and Harbours Corporation, the share capital of which should be owned by the three governments, but which would be empowered to determine its rates and charges and operate and develop as a financially independent concern. It suggests, further, the establishment of a Colonial Transport Development Fund to finance the construction of railways, roads and the inauguration of air services.

These recommendations are intended to divorce railway finance, management and operation from political considerations and from uneconomic territorial rivalries which undermine the viability of the system as a whole. Similarly, the Commission recommends the establishment of an East African Road Corporation, financed jointly by the East African Governments and by loans from the Colonial Transport Development Fund and managed as an autonomous body under the High Commission. Again, while in regard to the discovery and development of water supplies, lack of which throughout East Africa is the major factor in preventing the use of otherwise productive resources, the Commission is concerned chiefly to secure adequate co-ordination within each territory, it insists that the hydrological research required should be carried out under the ægis of the East African Agriculture and Forestry Research Organization.

This would involve the water department in each territory—concerning the organization and staffing of which specific recommendations are made—working in close touch with the High Commission, the body to which the East African Agriculture and Forestry Research Organization is responsible; elsewhere in the report, the Royal Commission is rather critical of some aspects of the present research organization. The major technical obstacles to agricultural development and the economic use of land are the lack of basic data and information, the absence of co-ordination in research, and finance. While the Commission found that much effort was expended on research directed towards the solution of the many problems posed by the harsh environment and towards the evolution of methods for the more economic use of available natural resources, it noted a tendency for research to be conducted in water-tight compartments, and a general lack of liaison and exchange of valuable experience. Our knowledge of East African soils is still rudimentary, correct systems of usage have still to be evolved for various types of vegetation regimes and adequate hydrographical data are an essential pre-requisite to the irrigation projects which East Africa urgently needs. Moreover, the areas of high potentiality are very unequally distributed, and in the absence of a regional approach the tempo of development will be retarded in all the territories at a time when it is imperative to accelerate the process.

While the Commission thus expects important help towards the discovery of better systems of land usage from research, it found great need for a regular sequence of experiment from research plot to pilot field-unit, to representative test-area, and then to rehabilitation and development plan, so as to determine the patterns of usage most suitable for each locality. Impressive examples are cited of opportunities for an attack with the resources of the East African Agriculture and Forestry Research Organization on problems quite beyond the limited resources of a district team. The Commission points out, however, that there is some risk that the centrifugal political force which pulls the three territories apart at present will leave the Research Organization too weak financially and too remote administratively to make its full contribution. There is no alternative basic research station, and the budgeting vote for the Organization is subject to considerable risk in the legislatures, where few appreciate the importance of basic research or the necessity of re-examining under tropical conditions knowledge obtained in temperate climes.

While recognizing this danger, the Royal Commission sees no solution in the separate financing of the Research Organization from Colonial Development and Welfare Funds, but looks to a better relation between the central research institute and the territorial departments when the legislatures and technical staffs are united in a clear view of the objectives. To assist this process, it suggests that the staff of the East African Agriculture and Forestry Research Organization should be strengthened so that it can make available for travel in the territories scientific workers free from basic research responsibilities, who can specialize in bringing the Organization's findings to particular local problems. Within each territory there should be a special liaison research officer responsible for seeing that there is a continuous progress from research to development. It is also suggested that one of the first requirements of the East African territories is a district-by-district survey which will describe in factual terms the available land, the topography, the soil, rainfall, population and means of communication of the districts; the Commission recommends the initiation, as soon as circumstances permit, of a detailed ecological survey indicating the kind of agricultural specialization, the appropriate kind of farming system and the suitability of different types of farm organization.

There are other points of scientific interest in the report which cannot be mentioned here. The foregoing will, however, illustrate sufficiently the scientific and objective approach of the Royal Commission to the problem of development and welfare in East Africa, its receptivity to new ideas and the firmness and courage with which it challenges customs, vested interests, practices and privileges which lead to wasted resources or are anti-social in their effects. It will be apparent how closely its findings bear on the effectiveness of research already being conducted in the region and on proposals for technical assistance or Colonial development and welfare. It is a challenge to promote co-operation and understanding between races as well as between Governments, between scientific workers and legislators as well as between industrialists and settlers; it is also a challenge to the goodwill required to implement the rigorous reforms advocated by the Commission.

# FOOD PRODUCTION IN SOUT AFRICA

## A Survey of the Food and Feed Resources of t Union of South Africa

By G. Van de Wall and E. D. Alvord, Jnr. (Pretori J. L. van Schaik, Ltd.) 31s. 6d.

AMONG the many difficult problems in the Uni of South Africa, one of the most important that of food production. The population is expandin in 1951 it was ten millions as against five millions 1918; with the further development of mining ar other industries, further expansion seems inevitabl By Western European standards the country sparsely populated, the density being only twent one per square mile compared with more than thr hundred in India; it has a large farming populatio nevertheless it is barely self-supporting in food. Th year-books of South Africa give considerable inform tion about crop production in the Union and th reserves, and the Food and Agriculture Organizatio of the United Nations has in its food balance shee tabulated the available quantities of human foo both home-produced and imported. The presen survey is the most complete yet published, givin not only more detail but also providing for the firs time a reasoned estimate of the output of anim food, and therefore ultimately of human food, from the veld. The period covered was from 1917–18 t 1946–47. It was apparently impracticable to brin the survey up to date; but it serves the invaluabl purpose of constituting a reliable standard wit which later surveys may be compared.

The first part of the survey, by E. D. Alvord, deal with livestock and their products. As the veld contributes some 90 per cent of the nutrients availabl to the animals, their numbers are limited by it productiveness, which in turn depends to a considerable extent on the management. During the perio investigated, the average rate of stocking on th European farms was about fifteen acres per matur beast, the range being from more than twenty o the Karroo to between six and ten in the semi-ari regions, and less where the rainfall was higher. Bu the management is faulty; considerable quantitie of digestible protein and other nutrients are not use but are destroyed in the periodic burnings. A mer increase in the density of stocking would not solv the problems because of difficulties associated wit the long dry season; better management and close linkage with arable husbandry are recommended a the way out of the difficulty.

The arable land is much more productive; it constitutes only about 10 per cent of the land area o the Union yet it contributes more to the nationa food supply than the 90 per cent of veld. But mor could be achieved: the yields are lower than i other countries and the author courageously attribute much of this to inefficiency on the part of the farmers Sugar-cane is the one exception: it is "the onl agricultural crop which is produced efficiently in South Africa at present". But it is practically confined to Natal.

The second part of the Survey is by Dr. Van d Wall and deals with the utilization of food-stuff and especially the consumption by human beings. Estimates of total production and of total quantities available for consumption show that while th total requirements of protein and of carbohydrate were covered there were overall deficiencies of som

7 per cent in supplies of calories, 40 per cent in hose of fats, and 13 per cent in those of animal rotein. The dietary of the European population, ho form about 20 per cent of the whole, is considerably better than that of the 80 per cent non-uropean, and the author feels justified in assuming hat these carry all the deficiencies, making their ietary worse than the above figures indicate.

As in the first section, the facts are fearlessly aced, and the author discusses possible improvements. The deficiency of fats and of animal protein an be met only by increasing the output of livestock roducts. It seems remarkable that a pastoral ountry like South Africa should produce insufficient neat for its rather sparse population.

The authors are to be congratulated on a very useful piece of work which will not only be invaluable o later investigators of agricultural economics but also gives clear indications to the agricultural staff as to he directions in which improvements should be made. Earlier workers, I. B. Pole Evans, P. J. du Toit, T. D. Hall, D. Meredith and others, have long emphasized the need for better management of the eld and the livestock; this survey raises the question again in such clear perspective that it can scarcely fail to receive attention.

E. JOHN RUSSELL

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# JUVENILE DELINQUENTS IN THEIR URBAN SETTING

## Growing Up in the City

A Study of Juvenile Delinquency in an Urban Neighbourhood. By John Barron Mays. (Social Research Series.) Pp. ix+216. (Liverpool: University Press of Liverpool, 1954.) 17*s*. 6*d*.

IT has long been known that in many cities certain unfavourable characteristics combine to produce what have been rather inelegantly termed 'delinquency-producing areas'. The author of this book, J. B. Mays, gives a warm and interesting description of one such as these, by the Liverpool docks, which he has come to know and understand through many years of work with the young people of the neighbourhood.

It is good to see a book which, as Prof. R. M. Titmuss writes in an eloquent preface, ". . . leads us to think more about boys and boyhood in a particular situation and less about delinquent boys in a social vacuum. . . . Such behaviour is for the majority of these boys not so much a manifestation of individual maladjustment but is part of the total process of adjustment to a subculture in conflict with the culture of society as a whole". In principle, such a book would be welcomed in order to redress the balance which, of late, has tended to favour clinical studies of small groups of individual, apprehended delinquents. Like myself, Mays believes the issue of detection to be irrelevant to the problem of delinquency; most of his sample of eighty boys have passed through a delinquent phase, though they were rarely caught, and they do not seem to be neurotic, psychopathic or mentally defective, in his judgment.

Yet the author has not used fully this opportunity to improve on the work of the early Chicago ecologists. The emphasis throughout is on the social setting, rather than on the 'under the roof' culture, on environmental treatment and anti-delinquency services rather than on family problems. This is not merely a question of emphasis. Given the fact that a delinquency-producing area exists, what are the influences which determine whether or not an adolescent will take part in delinquent activities? And how can we account for those youngsters who do not 'grow out of it', and who become the 'hardened criminals' of later years? Whatever the virtues of the ecological approach, it fails to give us answers, or more than hints of answers, to these questions.

As a research document, the book leaves the critical reader dissatisfied when it comes to finding a genuine contribution to the better understanding of juvenile delinquency. Altogether, the book is too wordy, presents its evidence too unsystematically and is rather too well garnished for a scientific study. On the other hand, it is obvious that the writer is a sincere and interested youth worker, who has made a point of collecting information, albeit with some naïvety. It is perhaps not unfair to say that his aims in many ways are didactic and descriptive, rather than analytic. He wants his youngsters to "come alive to the imagination", and he feels the need for a study "with more sympathy and greater psychological depth, to place upon the bare bones of statistics the flesh and blood and spirit of recognizable humanity". This is an aim which will commend the author to many who have responsibility for the care of young people; it makes the study readable and interesting, but, where it might have 'proved' something, it can do no more than illustrate from a number of abstracted case-histories or offer a certain amount of discussion.

Perhaps, in the final analysis, the book should be read not so much as a research into juvenile delinquency, but rather as one of the relatively small number of British community studies, and as a piece of living social history. As such, it makes a valuable contribution.

A. N. OPPENHEIM

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# THE STAR CARR 'TREASURE'

## Excavations at Star Carr, an Early Mesolithic Site at Seamer, near Scarborough, Yorkshire

By Prof. J. G. D. Clark. With chapters by D. Walker, Dr. H. Godwin, F. C. Fraser and J. E. King. Appendix by John W. Moore. Pp. xxiii+200+24 plates. (Cambridge: At the University Press, 1954.) 63*s*. net.

THE word 'treasure' is usually confined to articles of intrinsic value; but the Mesolithic artefacts of antler and bone excavated by Prof. Grahame Clark at Star Carr, near Scarborough in Yorkshire, fully deserve this title. Their intrinsic value is nil, but the additions they make to knowledge and the speculations they arouse as to origin and relationship make them an archæological treasure to be ranked with the wonders of Sutton Hoo. During the past twenty years the Fenland Research Committee has been fostering a close co-operation between archæologists and natural historians in East Anglia. This collaboration was transferred with great success to the site discovered by Mr. John Moore at Star Carr. For three seasons the Cambridge Department of Archæology and Anthropology carried out the excavation, the Cambridge Sub-Department of Quaternary Research studied the geological, botanical and chronological implications of the site, and the Department of Zoology in the British Museum (Natural

History) preserved and studied the animal material found.

Hitherto, scholars have spoken of Baltic Forest Cultures of Mesolithic age, and have admired the wealth of barbed bone points and flint core-axes and microliths found on Danish Maglemosean sites dated to the Boreal period. The very limited quantity of similar material found in Britain, and the barbed point dredged up from the Dogger Bank, led to the assumption that there had been a diffusion of Baltic influence westward across the former dry bed of the North Sea. In this book Prof. Clark and his colleagues show us the Yorkshire countryside of Late Glacial and early Post Glacial times, and set in this environment we see a small Maglemosean lakeside settlement dated to 7500 B.C., which yielded more than twelve hundred flint implements, almost two hundred barbed points, and many other interesting artefacts. The settlement is clearly earlier than its Danish counterparts and cannot be derived from them.

The most exciting discoveries were the antler head-dresses. Skulls of male red deer, sufficiently mature to carry well-formed antlers, but still young enough not to be burdened by excessive antler weight, were selected. The skull was cut away, leaving the antlers attached to a base-plate which was thinned down and pierced by two holes. The antlers were lightened by thinning and hollowing, but the natural profile was retained. Antlers so elaborately prepared must have been worn as a head-dress, either in hunting or in ceremonial.

Summing up, Prof. Clark skilfully silhouettes the Maglemosean (*s.l.*) cultures of north-west Europe against the rapidly changing environment of the Late Glacial and early Post Glacial periods. We first see a group of Palæolithic people with Aurignacian and Magdalenian traits who utilized the burin to cut splinters out of antlers; the splinters were worked up into implements. On the Late Glacial park-tundras the reindeer was abundant, and the Hamburgian folk utilized reindeer antler only. In the birch woods of the Pre-Boreal period, red deer and elk were common, and at Star Carr the antlers of these animals were the principal raw material, though the bones of the elk and the urus were sparingly used. In the high forest of the Boreal period red deer was still common, and on the Danish sites the bones, rather than the antlers, of this animal were chiefly used.

Such important material demanded adequate publication, and Prof. Clark and the Cambridge University Press have produced a more than adequate book. There is a schedule which describes all the antler points; twenty-five are illustrated in half-tone, and line-drawings (showing three aspects) are given of one hundred and twenty. The scheduling of the one hundred and four antlers from which splinters had been cut seems scarcely justified. When so much illustration was available, it is to be regretted that the "curious spoon-like object" made from elk antler, which is only poorly shown in a preliminary publication, was not illustrated more clearly. The reduction of the illustrations is as consistent as the exigencies of size allowed, and has obviously been carefully thought out. The same cannot be said of the scales of linear measurement used. Inches, fractions of an inch, decimals of an inch, centimetres and millimetres follow one another almost on successive pages. Treatment of percentages is also uneven. When seventeen thousand flints are divided into three groups, the percentage value of the groups can certainly be carried to the first place of decimals but when thirteen barbed points are similarly divided little is gained by expressing the relationship of the groups by percentage values. When space has not been at a premium in the main body of the book it seems ungracious to use a smaller face of type in the short appendix contributed by Mr. Moore. It is unfortunate that the only error also occurs here, Fig. 80 does not correspond with its caption.

The comments of the preceding paragraph do not take away from the high value to be placed on this book, which will for years to come be studied by all interested in the events of the early Post Glacial period in Europe.

G. F. MITCHELL

# COMMONWEALTH UNIVERSITIES YEARBOOK

### Yearbook of the Universities of the Commonwealth

Thirty-second issue. Pp. lviii+2026. (London: Association of Universities of the British Commonwealth, 1955.) 63*s*.

THIS, the thirty-second edition of the "Commonwealth Universities Yearbook", follows very closely the pattern of that published last year, but there are a number of changes, some of which are the result of recent academic developments. Thus, entries are included for the first time for two new university institutions—University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia, and the University of Rajshahi, East Pakistan; and for two Canadian institutions which have recently been admitted to the National Conference of Canadian Universities—St. Mary's University, Halifax, Nova Scotia, and Assumption College, Windsor, Ontario. Also, for the first time, an introduction has been added to the New Zealand section, and this gives a general account of university institutions in that country, written by the Registrar of the University of New Zealand. The first appendix, on qualifications for admission to first-degree courses in universities in the United Kingdom, Canada, Australia and South Africa, has been increased to include details of faculty and departmental requirements in United Kingdom universities. The third appendix, on postgraduate awards tenable overseas by United Kingdom graduates, has been rearranged under subject headings for convenience of reference.

These are the major alterations; but, of course, there are a multitude of small changes throughout the work. Generally, it can be said that these latter are additions, for nearly all the universities of the Commonwealth are expanding, some rapidly, and year by year there is a demand for information on fresh topics. Thus the present edition is about a hundred pages longer than the previous one (an increase of about 5 per cent); but the Association is to be commended for keeping the price the same.

There are 111 university institutions in the British Commonwealth which have been granted degree-giving rights in their respective countries, 22 of which are in the United Kingdom. Together they contribute a very considerable fraction of the world's higher learning, and it is obviously a great convenience to have the principal details about them published in a single reference volume. This work amply fulfils such a need.

# UROPEAN ORGANIZATION FOR NUCLEAR RESEARCH AT GENEVA

## FOUNDATION-STONE CEREMONY

ANOTHER milestone was reached in the history of the European Organization for Nuclear Research, when on June 10 the foundation-stone as laid of the laboratories at the Meyrin headquarters of the Organization near Geneva, followed y the signature of an important Agreement between he Organization and the Swiss Government. The tone-laying ceremony was conducted jointly by M. Max Petitpierre, president of the Swiss Confederation, M. François Perréard, president of the State Council of the Republic and Canton of Geneva, and Sir Ben Lockspeiser, president of the Council of the Organization. The ceremonies were attended by a arge number of eminent scientific workers and iplomatic and other representatives of the twelve member States, and by other guests.

The Agreement with the Swiss Government, which was generously given the site on which the labortories are being built, will give the Organization numerous important privileges and amenities which will greatly facilitate its work. Those who have been closely associated with the years of planning came away feeling that this unique Organization has good eason to be proud of what has been achieved so far. The high level of scientific and technical competence of the research and design teams and the spirit of enthusiasm which animates all concerned provide solid grounds for confidence in the healthy growth of the new Organization.

Since last September, when the 1953 Convention setting up the Organization came into force, full advantage has been taken of the preparations of the previous years, and work has been proceeding at an ever-increasing speed, of which there is now impressive evidence at the Meyrin site. Good progress has been made with the massive foundations and the housing for the smaller of the two accelerators, the synchro-cyclotron. Its magnet and coils are being made, and it is hoped to have the machine working early in 1957. The larger accelerator, the proton-synchrotron, still presents formidable scientific and technical problems, and work is naturally less advanced. Even here, however, impressive progress has been made, and on the site itself excavation has begun on the vast circular space required to accommodate the magnet.

In his speech at the stone-laying, M. Petitpierre said that, since the time when the project was first mooted, a considerable distance had been covered and most of the eminent scientists of the day had co-operated to achieve this. It was an important occasion, for he thought it was the first time in history that a community of nations had undertaken the construction of an international scientific laboratory. There will be no secrecy whatever about the work done there, the single purpose of which is to extend the field of knowledge. The machines will place at the disposal of scientific workers very powerful instruments to open up hitherto unknown horizons. This is particularly important at the present time when the vast possibilities for the use of nuclear energy for peaceful purposes are beginning to be realized. Thanks to the initiative taken within the framework of the United Nations Organization and thanks also to the work of the European Organization for Nuclear Research, atomic energy has begun to assume a peaceful significance instead of being thought of in terms of weapons of destruction. It is the belief of the Swiss Confederation, continued M. Petitpierre, that, particularly in the field of nuclear energy where the discoveries made hitherto represent but a beginning, it is only by mutual co-operation and with the added feeling of dependence upon one another and their common destiny that nations can employ this source of energy as an instrument of progress. It is the sincere hope of the Swiss Federal Council, he concluded, that the foundation-stone ceremony will mark not only the beginning of collective scientific investigation but also that it will stand as a memorial to pacific collaboration among nations.

In expressing the pleasure of the Geneva authorities, whom he represented, M. Perréard referred to the initial diffidence of some sections of the Geneva community about the decision of the authorities to set up the Organization on Swiss territory. When the matter was put frankly before the people of Geneva, the authorities and the population were unanimously agreed to it being set up in their midst. The creation of the Organization has inevitably provided various legal problems arising from the need to harmonize the existence of national and international bodies on the same territory. The Swiss experience of various international organizations having their headquarters in Geneva has, however, enabled these problems to be settled without great difficulty, and any others which might arise will certainly be settled in the same friendly spirit. In conclusion, M. Perréard reiterated the welcome given to the Organization by Geneva with the deepest satisfaction, for thereby Geneva herself would be scientifically and intellectually the richer. He expressed the hope that the foundation stone, set in a country miraculously spared the horrors of war over so long a period, would symbolize in the field of science the spirit of mutual aid which should unite all men of goodwill to whatever country they might belong.

Sir Ben Lockspeiser, in thanking M. Petitpierre and M. Perréard, agreed that those present were participating in what was a unique occasion in the history of science. Scientific research has never been confined to any one country, and scientific thought is international in scope and character. Sir Ben stressed that the aim is both to strengthen existing national institutions for learning and research and to build up a focus of study and experiment where groups of scientific workers can together achieve what they would be unlikely, or unable, to do in isolation. It is entirely fitting, he said, that the Organization's laboratory should be established in Geneva, which has particularly the traditional atmosphere of freedom required by scientific research.

Dr. Luther Evans, director-general of the United Nations Educational, Scientific and Cultural Organization, added a personal word of congratulations on the successful progress of the European Organization for Nuclear Research, which had been established with a substantial amount of help from Unesco but which is now in a position to stand on its own feet as an independent body. Unesco, he said, is proud of the new Organization and will continue to maintain close contact with it.

# JUBILEE OF THE UNIVERSITY OF SHEFFIELD

By Dr. D. H. PEACOCK

On June 3, 1905, Mr. (later Sir) George Franklin, chairman of the Council of University College, Sheffield, brought to Sheffield the Royal Charter constituting the University. He was met at the Victoria Station by the officers of the new University and some thirty carriages filled with students and decorated in the College colours. This procession, led by the band of the Hallamshire Rifles, moved off to the old University College building, where an enthusiastic meeting was held to receive the Charter.

The College which was raised then to the status of an independent University had been formed in 1897 by the union of three institutions: Firth College, the Sheffield Technical School and the Sheffield School of Medicine.

Firth College enrolled its first students in 1880 for courses in mathematics, classics, ancient history, modern history, chemistry, physics, mechanics and the theory of music. This forerunner of the University had been founded at his own charge by Mark Firth, head of the firm of Thomas Firth and Sons and lately mayor of Sheffield, whose enthusiasm had been stimulated by the extension lectures conducted in Sheffield in the preceding few years. The eventual provision of technological courses had been envisaged from the beginning, and in 1886, largely as the result of the activity of Sir Frederick Mappin, then representative of Sheffield Corporation on the College Council, the Sheffield Technical School was opened as a branch of the College, though under separate management, and in separate buildings which have ever since remained the centre around which the University's technological departments have grown.

The Medical School had been opened by members of the profession in 1828. For a few years there were indeed two rival medical schools; but one disappeared after its buildings had been sacked by a mob. The early history of the survivor was chequered, and once at least a decision was taken to close it. Its survival was due to the devotion and self-sacrifice of a group of medical practitioners in the town, who, with the help of public subscriptions, raised the money to erect a new building, opened in 1888 opposite Firth College. Thereafter there was a close association between the two institutions, and in 1891 Firth College took over all the teaching of the preliminary sciences. When a charter for a University College was granted in 1897 the Medical School joined Firth College and the Sheffield Technical School to become the new University College's faculty of medicine.

University College, Sheffield, was constituted with the view of admission to the federal Victoria University, but in 1897 that University was already suffering from internal strain. The Sheffield College applied for admission and was refused. Soon after, the Victoria University split up, and in these circumstances Sheffield decided to apply for a university charter—a project which had never been far from the minds of the Trustees of Firth College. New buildings, designed for an extended University College, had just been completed when the charter was granted, and were opened on July 12, 1905, by King Edward VII. Around these buildings in Western Bank (about a quarter of a mile from the applied science buildings in St. George's Square) the subsequent expansion the faculties of arts, law, pure science and medicin has taken place.

The University of 1905 owed much to the schola ship, zeal and organizing ability of the staff University College and its predecessors. They ha remained undaunted by the difficulties and delay attendant upon inadequate financial resources, an had pressed forward determinedly towards standard then not commonly accepted. In some cases th influence of what was accomplished extended wel beyond Sheffield. In particular, W. M. Hicks, pro fessor of physics (1883–1917), principal of Firth College and later of University College, and charte vice-chancellor of the University, had played a important part as the initiator, with Sir William Ramsay (then principal of University College, Bristol) of the campaign for government grants for the English university colleges, the successful outcome of which had saved some of the colleges—Firth College almost certainly—from extinction. In the arrangements made for the administration of these early—and tiny—grants may be traced the outline of the future University Grants Committee and the beginning of a movement which is transforming the civic universities into national institutions.

In the early days, of course, only a very small proportion of students were university students as we know them now. The session 1905–6 began, in fact, with 585 day students of whom only 114 were reading for degrees and diplomas. The teaching staff of the faculties of arts and science also catered for a large proportion of the 250 occasional students, some 200 evening students, and students of the Sheffield Teachers' Training College who came to the University for courses which the Local Education Authority could not then provide. One of the earliest steps taken, under the energetic leadership of J. A. Green (appointed professor of education in 1906), was the establishment of a University Training Department for Teachers, in which, by 1910–11, there were a hundred students. Degree courses in law were made available with the creation of a separate faculty in 1908. In the same year, with R. N. Rudmose Brown (professor of geography, 1931–45) as lecturer, geography was introduced into the curriculum for ordinary degrees in the faculty of pure science. Degree and diploma courses in architecture were instituted in 1913 (though it is only recently that the department has grown into one of the largest in the faculty of arts). Music, though taught since the days of Firth College (during 1890–1920 under the well-known chorus master, Sir Henry Coward), did not become a subject for degrees until 1928, when, the nucleus of a department having been built up under the influence of Sir Henry Hadow (vice-chancellor, 1919–30), F. H. Shera was appointed to a full-time chair.

On the technological side the young University was in a strong position. The equipment and facilities of the applied science buildings were among the best then available. Associateships in engineering and metallurgy, already established by Prof. W. Ripper (professor of engineering, 1889–1923; principal of the Sheffield Technical School, 1889–97; vice-chancellor of the University, 1917–19) and Prof. J. O. Arnold (professor of metallurgy, 1889–1919), were of a high standard, and were held (and have remained to this day, although superseded by degree courses) in great esteem by local industrialists. The degree and diploma courses in engineering and metallurgy ould be completed by either full-time or part-time tudy combined with practical experience. The rly courses for the diploma in mining followed a milar pattern, as did the degree courses instituted 1913 under F. E. Armstrong (professor of mining, 913–21). Since then the necessary practical experience has been gained largely by vacation work. he Department of Glass Technology was instituted s the result of experience gained during the First Vorld War. In October 1914 the University set up Scientific Advisory Committee with W. E. S. urner (professor of glass technology, 1920–45), then cturer in physical chemistry, as its secretary. Turner oon realized the need for the application of scientific ethods to the manufacture of glass, and a full-time ourse for a diploma in glass technology was established in 1916, and a degree course in 1919. Fuel echnology, which had been unequally yoked with pplied chemistry, was made a separate chair in 920 (R. V. Wheeler, professor of fuel technology, 920–39) and degree and diploma courses instituted n 1921.

The growth of the medical faculty between 1905 nd 1945 owed much to the pioneer work of earlier eachers in the Medical School. Arthur Hall (professor of physiology, 1897–98, of pathology, 1899–906, and of medicine, 1915–31) joined the Medical chool as an assistant demonstrator in physiology n 1889 and strove successfully to establish full-time eaching departments in the subjects involving aboratory work. His work on behalf of the school was helped by Christopher Addison (Viscount Addison f Stallingborough, first Arthur Jackson professor f anatomy, 1897–1901). J. B. Leathes (professor of physiology, 1914–33) reorganized the courses, and did much to effect a revolution in the linking of laboratory work with clinical teaching not only in Sheffield but also throughout the country. The first full-time clinical chair was established in 1920 when Edward Mellanby was appointed professor of pharmacology, and with the chair was associated an appointment as physician at the Sheffield Royal Infirmary. When H. W. Florey was appointed to the chair of pathology in 1932, J. W. Edington became the first full-time professor of bacteriology, after having been for more than ten years responsible for both departments. A full-time professor of dental surgery (G. L. Roberts) was appointed in 1935 and a chair of biochemistry (H. A. Krebs) created in 1945. Since 1945, clinical chairs have been instituted in medicine, surgery, child health, obstetrics and gynaecology and social medicine.

The expansion in the range of studies offered at the University was accompanied by an increase in the number of students and a corresponding demand for increased teaching and residential accommodation. The natural expansion in buildings was, however, checked by the First World War and the subsequent depression. Extensions to the technological departments were completed in 1913; but further expansion had to wait until after 1930. Then, under the direction of A. W. Pickard-Cambridge (vice-chancellor, 1930–38) a new wing for the departments of pure science and extensions to the Departments of Mining and of Metallurgy were completed. In 1939 the Department of Glass Technology moved into its new building for which funds had been raised by the glass industry. The Second World War interrupted the building programme. During the War, under the leadership of Sir Irvine Masson (vice-chancellor, 1939–52), the University had made notable contributions to the war effort both in research and in production. As soon as the War ended, plans were drawn up to serve the increased number of students which the University was called upon to train. Extensions to the Department of Mining were opened in 1953, and a large new building to provide expanded facilities in teaching and research in the Departments of Civil, Mechanical and Electrical Engineering was opened by the Minister of Defence in April this year. Post-graduate schools in physical metallurgy were opened in 1950, in applied mechanics in 1951 and in mining in 1952. This expansion in applied science naturally requires expanded provision for teaching and research in the fundamental pure sciences. A new building for chemistry was opened in 1954, and the accommodation vacated has been altered for the use of departments in the faculties of pure science and of medicine. The necessary sites in the neighbourhood of Western Bank have been acquired for a complete University Quarter, and plans for new buildings for the library, arts, law, physics, the Medical School and administration have been drawn up.

All this expansion has provided, and is providing, domestic problems of considerable magnitude. The public spirit of Sheffield ladies was soon stirred to arrange halls of residence for women students. Soon after 1930 three of these small halls were united in one larger hall. At about the same time the first hall of residence for men was built and a Students Union provided by the generosity of J. G. Graves. Additional halls of residence for men were opened in 1947 and in 1952. A full-time warden of lodgings was appointed in 1947, and the student health service set up in 1948 now has three full-time medical officers. Extensions to the halls of residence are planned, as are new buildings for the Students Union, refectories and a staff house. A new playing field near the University has been opened, and the site for another acquired. The material resources planned are impressive; their use will depend on character and ideals.

Universities exist to extend knowledge, to conserve knowledge and to hand on knowledge. Sheffield can claim that it has performed all these functions in the past and can, with some degree of confidence, hope to continue to perform them in the future.

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# COLOUR SPECIFICATION

## POSSIBLE REVISION OF THE C.I.E. SYSTEM

ALTHOUGH the principles of colour-matching with mixtures of three coloured lights were worked out in the latter half of the nineteenth century —notably by Helmholtz, Maxwell, Konig and Abney —it was not until 1931 that an agreed system of colour specification based on these principles was adopted. The essential preliminary was an adequate knowledge of the colour-matching properties of the average colour-normal eye. During 1927–30 excellent investigations of colour-matching by Guild and Wright respectively, using different groups of subjects, gave closely concordant results for a vital part of the information required, namely, the quantities, two positive and one negative, of the three component lights in a mixture to match an unspecified amount of each of the spectral colours. (The negative sign means that in the match the component light has to be mixed with the spectral stimulus.) The Commission Internationale de l'Éclairage had earlier adopted a standard visibility function $V_\lambda$ defining the reciprocal intensities in energy units of spectral stimuli having the same brightness or luminosity for the average eye. A combination of the mean Guild–Wright data with the standard visibility function $V_\lambda$ enabled the Commission to adopt, in 1931, a complete quantitative basis for colour specification, that is to say, a tabulation of the colour-matching functions or quantities of three component lights in a mixture to match unit energy intensity of each of the spectral colours. The component lights for which the Commission agreed the basic data were three spectral stimuli (700·0, 546·1 and 435·8 mμ), but for colour specification it was decided that the data should be transformed to a different set of mixture components, the so-called C.I.E. reference stimuli. The C.I.E. reference stimuli coincide with no actual physical stimuli—their relation to such stimuli is something akin to that between a virtual and a real image in geometrical optics—but this unreality is more than compensated for by the practical advantage of leading to positive colour co-ordinates for all real colours. The C.I.E. system is to-day the one fundamental system of colour specification in all branches of colour technology.

In reviewing the recent discussion by the Physical Society's Colour Group on April 27, it is first of all necessary to emphasize that no grave errors or shortcomings of the existing system have been brought to light, and those who have accepted and used it need not fear that their confidence has been misplaced. But there have been questionings which touch the underlying principles, the experimental data and the choice of reference stimuli. Work by Blottiau (1947) and Trezona (1953–54) suggests that the additive law of colour-matching, as applied to the measurements of a particular subject, is only approximately true. Again, while an indirect determination of the colour-matching functions by way of a $V_\lambda$ function may give correct results, it would appear preferable to use a direct method not involving heterochromatic photometry. As it turns out, doubts about the $V_\lambda$ data incorporated in the C.I.E. system initiated the move towards a revision. There is evidence that at short wave-lengths the values are too low. Considerable attention has been given to the additivity of brightness in heterochromatic photometry. This issue—quite distinct from the additive law in full colour-matching already referred to—would have no bearing on colour specification by the trichromatic method but for the fact that $V_\lambda$ data were used in setting up the present C.I.E. system.

It may be said that any significant defect in the basic data of the C.I.E. system would have shown itself in use before now. Only one serious claim has been made that in a technological application the C.I.E. system gives demonstrably incorrect predictions about colour matches. This fact must not be rated too high. Opportunities for clear-cut tests are not common and, because of the considerable individual differences in colour-matching, any discrepancy between the results of an actual observer and the computed result for the C.I.E. standard observer is likely to be laid at the door of the former. In one group of applications it would appear that the C.I.E. data cannot be giving quite the correct answers. This is when colour-matching of patches subtending considerably more than 2° at the eye are concerned. The standard data refer specifically to a 2° field, and it is known that field-size is a significan factor. Obviously, if only one set of colour-matchin functions is to be standardized, it cannot be completely satisfactory for all practical field-sizes. Bu the best choice of field-size or the best compromi is not easy to determine.

The changes proposed in the C.I.E. referenc stimuli have been mainly directed towards inco porating in the C.I.E. system additional informatio about colour perception. Every colour is chara terized by three numbers—the unit co-ordinates $x$, $y$, of sum unity—and it is customary to represent th colour by a point in a rectangular ($x$, $y$) plot. Exper ments on colour discrimination show that in th C.I.E. ($x$, $y$) diagram the distance apart of two point corresponding to stimuli equally bright but ju perceptibly different in colour varies very widely i different colour regions. No transformation to ne reference stimuli would give a perfect 'unifor chromaticity' diagram, but a considerable improve ment over the C.I.E. diagram is possible. Othe properties of colour perception emerge when we ar concerned with the colour relations of pigmente surfaces viewed, under a suitable illumination, on 'white' background. The representation of thes properties is simpler with some choices of referenc stimuli than with others. At the Physical Society' Colour Group meeting, Dr. R. W. G. Hunt urged th merits of a uniform chromaticity diagram due t MacAdam, while Mr. R. G. Horner favoured a mor radical change in the method of plotting colou co-ordinates, adapted to represent surface colours.

The new experimental material which the Com mission will have considered in discussing revisio of its system in June includes studies of the V function in the blue end of the spectrum mad respectively at the National Bureau of Standards Washington, D.C., by Ishak and Teele, and at th National Physical Laboratory, Teddington, by Burc and Stiles, and a direct determination (that is, no involving the $V_\lambda$ function) of the colour-matching functions for 2° and 10° matching fields with spectra stimuli as the mixture lights. For the latter work, also being carried out at Teddington, the results fo an initial group of ten subjects are now available. The new results for the 2° field show certain interesting, if minor, deviations from the present C.I.E. values, deviations which are not attributable to the use of an inappropriate $V_\lambda$ function in the derivation of the C.I.E. system nor to differences of average eye pigmentation of the various groups of subjects concerned. These are additional to some deviations in the blue end of the spectrum which could spring from the factors mentioned. A difference in the conditions of the new work at the National Physical Laboratory as compared with that of Guild and Wright is the use of a 'blue' mixture light of shorter effective wave-length—about 445 mμ instead of 460 mμ. This should be immaterial, if the additive law for complete colour-matching is strictly true. A direct test of the effect on the unit co-ordinates of changing the 'blue' mixture stimulus from 460 to 445 mμ had already been made for his own eye by Prof. W. D. Wright using his own spectral primary colorimeter, and the results, described at the Colour Group meeting, confirm the implication that the colour-matching functions may not be completely independent of the mixture colours used in their determination*. The results of similar comparisons being made at the National Physical Laboratory will be available shortly. The whole question of individual obedience to the additive law of colour-matching s of the first importance in visual theory. The bearing on colour specification in the C.I.E. system s of a different kind, and the practical outcome is perhaps less disturbing than might at first appear. f, as seems probable, additivity ambiguities are of no higher order of magnitude than individual differnces in colour-matching properties and differences arising from the wide range of practical conditions of colour observation, the extra load on a 'standard observer', who must represent a compromise over all these variations, may not be great. But the problem of the best compromise is changed, and until we have a clearer picture of the additivity difficulties we would be ill-advised to alter the present system. This is so, even though on some points—such as the values of the colour-matching functions in the extreme blue, which are shown by all the new work to be too low in the C.I.E. system—some improvement would be possible now. For colour technology, a change in the C.I.E. system means an upheaval—computations of new tables, adjustments of all kinds of colour specifications, modification of physical colorimeters, etc.—and it would be unthinkable to make an interim change now with the possibility of a further change a year or two later.

* *Note added in proof*. Prof. Wright has made additional measurements which avoid an uncertain interpolation previously involved. He now finds virtually no difference between the unit co-ordinates of the spectral colours obtained by the use of 'blue' primaries 445 and 460 mμ, respectively. The National Physical Laboratory comparisons, since available, also show only slight differences in the unit co-ordinates, although there appears to be a small change in the 'blue' colour-matching function.

W. S. Stiles

# OBITUARIES

## Dr. R. N. Salaman, F.R.S.

In Redcliffe Nathan Salaman, whose death occurred on June 12, aged eighty, the world has lost one of the grand old men of science. He was one of the very few remaining representatives of a world of learning that had not known the spectre of modern specialization, a world where the boundaries between one science and another were scarcely recognized and even those between science and the humanities were comfortably bridged. Dr. Salaman's whole life and work illustrated this.

Born in September 1874, he attended St. Paul's School and became a scholar of Trinity Hall, Cambridge, where, though he was for some unaccountable reason never a Fellow, he was a familiar figure in the combination room for many long years. He began his scientific career in medicine, at the London Hospital, and in 1901 was made director of the Pathology Institute there. But this was the time when the spectacular rediscovery of the Mendelian laws of heredity had given birth to the new science of genetics; Salaman was one of the first in Great Britain to become interested in Mendelism and soon joined William Bateson's original group of British geneticists.

It was characteristic of him that his interest in the Mendelian laws embraced both their direct implication in relation to studies of the origin and relationships of racial groups in man and their indirect use in the improvement of one of man's chief food crops, the potato. In both these fields he published some of the first scientific studies; he was made director of the Potato Virus Research Station at Cambridge on its foundation, and in his work there was the first to make use of a wild relative of the domestic potato, since recognized as the Mexican species *Solanum demissum* or a derivative, in order to introduce resistance to potato blight, *Phytophthora infestans*, into cultivated potatoes. To this day *S. demissum* remains one of the main sources of resistant genes.

Salaman it was who in 1930 recognized the dawn of a new epoch in potato breeding with the Russian discovery of a whole polyploid series of relatives of the potato—some wild, some cultivated—growing in the Andes in South America; he took an active interest in the expedition sent by the British Commonwealth to collect these potatoes and in the foundation of the Commonwealth Potato Collection and the Potato Research Station at Cambridge which resulted from the expedition. Characteristically again, Salaman's imagination was fired by these potatoes just as much for their anthropological as for their genetical and agricultural significance; indeed, his book on the subject, entitled the "History and Social Influence of the Potato", is cited as much by historians and anthropologists as it is by geneticists or plant breeders; for these latter Salaman's researches have thrown light on the origin of the cultivated potato, its early introduction into Europe and its relationship to other, more primitive, potato species. For all readers it serves as an illustration of how an eminent scientist may yet be a master of English literary style—a fact also appreciated by anyone who has attended one of the many lectures that Salaman was so often called upon to deliver.

In 1935 Salaman was elected to fellowship of the Royal Society. In spite of his multifarious activities in the fields of medical pathology, plant genetics, phytopathology and anthropology, he was one of those busy people who always find time for something else. Living as a country gentleman at Barley in Hertfordshire, he was surrounded by a large family, took an active part in local good works, and in the critical years of the Nazi and other persecutions made an energetic contribution to the activities of the Council for the Protection of Science and Learning. In London he was a familiar figure in the rooms of the Athenæum, and there are few men of the present day who can be said to have led a more varied and constructive life, embracing so wide a field of diverse interests and activities.

P. S. Hudson

## Prof. D. B. Blacklock, C.M.G.

The death occurred on June 10 of Donald Breadalbane Blacklock, emeritus professor of tropical hygiene in the University of Liverpool. He was born on January 7, 1879, at Oban, Argyllshire, and was educated at Fettes College and at the University of Edinburgh, where, after a distinguished career both in studies and in sport (he played cricket for the University and rugby for Edinburgh Wanderers), he graduated M.B., Ch.B. in 1902, proceeding to the degree of M.D. in 1909. In 1911 he was appointed to the Runcorn research laboratory of the Liverpool School of Tropical Medicine, where he worked, first as research assistant and later as director, until 1914, when he was appointed lecturer in parasitology to the Liverpool School.

During this early period of his career, Blacklock published a series of twenty-one papers on trypanosomiasis, most of them in his own name, but some in collaboration with Warrington Yorke. They were chiefly concerned with the morphology of trypanosomes; but in one of them the important discovery was recorded that *T. cruzi* could undergo development to the infective stage in the bed-bug.

In 1914, Blacklock and Yorke joined the School's thirty-second expedition, which was dispatched to West Africa, and, while in Sierra Leone, studied the breeding places of *Glossina palpalis* and the various species of trypanosomes transmitted by the fly to man and his domestic stock. By the time that the expedition had returned to England, war with Germany had broken out. Blacklock joined the R.A.M.C. and served with it, both at home and abroad, from 1915 until 1919, actively continuing with research during his period of service, and collaborating with Stephens, Yorke and other colleagues in a symposium of more than thirty papers on the treatment of malaria.

In 1921, when the Sir Alfred Lewis Jones Research Laboratory was opened in Freetown, Sierra Leone, by the Liverpool School, Blacklock was appointed its first director and was given the title of professor of tropical diseases of Africa by the University of Liverpool. The eight years which followed represent the most active and productive part of Blacklock's long scientific career. During that time he published more than forty papers on a wide range of problems concerned with various aspects of schistosomiasis, beriberi, malaria, trypanosomiasis and goitre, the most outstanding of which demonstrated for the first time that *Onchocerca volvulus* was transmitted t man by *Simulium damnosum*—a discovery of notabl importance in the history of tropical medicine. I 1929 Blacklock returned to Liverpool to succeed York in the Walter Myers chair of parasitology, which h held until 1934, when he was appointed the first holde of the newly established chair of tropical hygiene.

During the Second World War, Blacklock, the nearly sixty-five, was sent to Freetown on a Govern ment mission with the rank of surgeon-captain t investigate the malaria situation at the port and t submit recommendations for its control. His repor led to a concentrated attack on the vector anopheline and resulted in the elimination of malaria from th port and the protection of convoys using it. For thi and other notable services he was awarded th C.M.G. in 1942.

He retired from the chair of tropical hygiene i 1945, and in 1949 the Liverpool School of Tropic Medicine presented him with the Mary Kingsle Medal, as a fitting tribute to his work in West Afric and elsewhere.

Blacklock was a man of striking presence, hand some in appearance, gentle and reserved in manner his innate kindliness lit from time to time wit flashes of brilliant wit. His clear incisive mind mad him an excellent lecturer, and his text-book o human parasitology, written in collaboration wit Dr. Thomas Southwell and now in its fifth edition, i proof of his powers as a teacher.

He is survived by his wife, Dr. Mary Georgin Blacklock, C.B.E., who accompanied him on hi many travels and who collaborated in some of hi scientific work.

R. M. GORDON

# NEWS and VIEWS

## Applied Mathematics at Sheffield:
## Prof. D. N. de G. Allen

MR. D. N. DE G. ALLEN, reader in applied mathematics at the Imperial College of Science and Technology, London, has been appointed to the newly created chair of applied mathematics in the University of Sheffield. Mr. Allen is a graduate of the University of Oxford, and received his early training in research under the direction of Sir Richard Southwell at the University Engineering Laboratory, where he became interested in the newly developed relaxation methods as applied to engineering problems. Later, when Sir Richard became rector of Imperial College, Allen accompanied him there and played a large part in the establishment of a research team concerned with relaxation methods. He was appointed lecturer in the Mathematics Department of Imperial College in 1945, and later became reader, then taking over much of the responsibility for the teaching of mathematics to students of engineering. Under his guidance there has grown up at the Imperial College a thriving and productive group of research workers able to apply successfully relaxation techniques to a variety of mathematical problems of engineering interest. In 1949 Allen visited the Massachusetts Institute of Technology to deliver courses of lectures on subjects related to his own field of research, and later, in 1954, he paid a short visit to India for the same purpose. In addition to his interests in teaching and research, Allen has played a full part in the general and social activities at the Imperial College, and though he will be greatly missed by all his colleagues there, he takes with him their very good wishes to his new responsibilities at the University of Sheffield.

## University College of Rhodesia and Nyasaland:
## Prof. E. B. Edney

THE appointment of Dr. E. B. Edney, reader in Entomology in the Department of Zoology and Comparative Physiology, University of Birmingham, to the chair of zoology in the newly created University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia, cannot fail to please those concerned about the future of academic biology in the British Commonwealth. Dr. Edney is an entomologist with a distinguished research record in the field of arthropod physiology and ecology, where his work on water relations and microclimatology has produced results of considerable theoretical and methodological importance. As a systematist, he has specialized in the taxonomy of two widely different arthropod groups, the Chrysididae and Isopods, and has published monographs on both. His past association with academic work in Africa at Rhodes University College, at the National Museum in Bulawayo and at Makerere College, Uganda, has recently been rounded off by a successful research expedition to the Sahara. As a senior member of the teaching staff of the Zoology Department in Birmingham, Dr.

ney has excelled by his wide knowledge and erest in all fields of the subject, including the mplex problems of primate evolution, and by his alities as a teacher of undergraduate and postaduate students. He is also an experienced and pable administrator, and his dispassionate matterfactness has always been greatly appreciated by colleagues in committee. When the foundation of new University College on the African Continent d become a welcome reality, the question of who uld be made responsible for the development of aching and research in the biological sciences was matter of great interest in view of the natural portunities offered at Salisbury. Those responsible r the present appointment are to be congratulated having made a most appropriate choice.

### Prof. A. S. Boughey

In appointing Prof. A. S. Boughey to its chair of tany, the University College of Rhodesia and yasaland has selected a botanist with a wide perience of tropical Africa, and a background hich should prove most valuable in this post. After king a research degree at Edinburgh, Prof. Boughey oceeded to the Sudan, where he spent the war years s plant pathologist in the Department of Agriculture. e returned to Britain to teach botany in the niversity College of the South-West; but when the niversity College of the Gold Coast was established n 1948, he was one of the first appointments to the taff, as professor of botany. During the following ears, he succeeded in building up a strong department which, though in temporary premises, was well quipped and well staffed, and soon became an fficient instrument of teaching and research. While n the Gold Coast, Prof. Boughey gave particular ttention to developing a herbarium as a research ool, and to establishing a large botanical garden. n recent years, his research interests have mainly been in descriptive ecology; he has studied the vegetation types along the Guinea coast, and has given special attention to altitudinal zonation in the mountain massifs of West Africa, particularly the Cameroons Mountain. He will take to Salisbury experience from two other very different parts of the African continent, and a record of success in building up a new botany department from the foundations under similar conditions. This should augur well for the future of botany in Rhodesia.

### Peaceful Uses of Atomic Energy

Further details have recently been announced on the International Conference on Peaceful Uses of Atomic Energy, which will be held in Geneva during August 8–20 (see *Nature*, April 9, p. 615) in association with two exhibitions (see *Nature*, May 28, p. 929). The official delegation from Great Britain will consist of Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell; Sir Christopher Hinton, managing director of the United Kingdom Atomic Energy Authority Industrial Group; Dr. J. F. Loutit, of the Medical Research Council and Agricultural Research Council; Sir George Thomson, of the Royal Society, representing British universities; and Dr. Willis Jackson, of Metropolitan-Vickers Electrical Co., Ltd., representing British industry. Sir Edwin Plowden, chairman of the United Kingdom Atomic Energy Authority, will also attend, and advisers to the delegation will include representatives of the Atomic Energy Authority Research and Industrial Groups, the Chemical Research Laboratory, the Medical and Agricultural Research Councils, the Department of Scientific and Industrial Research, the Ministry of Defence, the Ministry of Fuel and Power, the Institution of Civil Engineers, British universities and a number of industrial concerns. The total number of delegates, advisers and staff for the conference and exhibitions, excluding the industrial representatives attending the exhibitions, will be more than a hundred and sixty. More than a hundred papers were submitted to the United Kingdom Papers Committee, and sixty-seven will be read, the remainder being included in the report of the proceedings which will be published. Including those from Britain, more than a thousand papers were submitted altogether, and, of those selected for reading, more than seventy will be from the U.S.S.R. and about a hundred and seventy from the United States. Other countries presenting papers are: Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Israel, Japan, Norway, Poland, Portugal, Sweden, Switzerland, The Argentine, The Netherlands and Yugoslavia.

### Pan-Malayan Scientific Advisory Council

As a result of a suggestion made by the Commission on University Education in Malaya that a scientific advisory council should be set up, representing the Governments of the Federation of Malaya and of Singapore and the University of Malaya and including experts from the planting and mining industries and the fields of agriculture and medicine, the Pan-Malayan Scientific Advisory Council has been formed, with the Chancellor of the University of Malaya as president. Its functions are to promote the spread of scientific information; to advise on scientific problems relating to Malaya; and to advise on, and assist in, the co-ordination and finance of scientific research, with power to receive and administer endowments, donations and grants. Participation in the work of the Council and its Committees by the Governments of Sarawak, North Borneo and Brunei will be welcomed, if they so desire. The main work of the Scientific Advisory Council will be undertaken by technical committees, six of which have been set up, each under its own chairman, as follows: *Animal and Vegetable Life and Resources*, Mr. D. W. Le Mare, P.O. Box 459, Penang; *Medical and Veterinary*, Dr. J. W. Field, Institute for Medical Research, Kuala Lumpur; *Economic Affairs*, Sir Sydney Caine, University of Malaya, Singapore; *Mineral Resources*, Prof. E. H. G. Dobby, University of Malaya, Singapore; *Physical Sciences*, Prof. R. A. Robinson, University of Malaya, Singapore; *Social Science and Anthropology*, Prof. T. H. Silcock, University of Malaya, Singapore. The chairmen of the six technical committees, together with three representatives from the Government of the Federation of Malaya, two from the Government of Singapore and two from the University of Malaya, form a Central Committee, under the chairmanship of the Assistant Commissioner-General for Colonial Affairs. The technical secretary of the Pan-Malayan Scientific Advisory Council is Dr. Kiang Ai Kim, of the University of Malaya, Singapore.

### *Veterinary Reviews and Annotations*

Veterinarians and all those who are in any way interested in the welfare of domesticated animals will welcome the appearance of the new half-yearly journal, *Veterinary Reviews and Annotations*, published by the Commonwealth Agricultural Bureaux, Farnham Royal, Slough, Bucks (1, Part 1; April 1955; pp. 54; 25*s*. a year). The journal is edited by W. A. Pool, who is also the editor of the *Veterinary Bulletin* and the "Index Veterinarius". The first issue contains three articles, all of which are valuable summaries of knowledge of the subjects with which they deal. Prof. R. Lovell, professor of bacteriology in the Royal Veterinary College, London, contributes a 27-page review on intestinal diseases of young calves, with special reference to *Bacterium coli*. A section of the review deals with acute gastroenteritis of babies. The bibliography covers more than four pages, and reflects the scope and detail with which the subject is treated. The second article, by Dr. C. Horton-Smith, of the Animal Health Trust's Poultry Research Station, Houghton Grange, Huntingdon, is a valuable review, also well documented, of coccidial and other forms of parasitism in their relation to poultry husbandry. He discusses the risks and advantages of the free-range, semi-intensive, intensive (with built-up litter), folding and wire-floored cage systems of poultry management in relation to the infection of chickens with the pathogenic species of Coccidia and with tapeworms and roundworms. Everyone who is concerned with poultry management should read this up-to-date and detailed review. The third article, by Dr. Phyllis Croft, of the Group Laboratory, Mile End Hospital, London, discusses euthanasia. She deals first with the appreciation of pain by animals and then with methods used to produce euthanasia. A feature of this article is the humane spirit evident in the author's discussion of the development of the methods now being used and of the reasons why older methods have been condemned by the British Veterinary Association and others. If succeeding issues of this new journal reach the standard attained by this first issue, the journal will be an indispensable addition to the reorganization of veterinary literature that has been going on during recent years.

## The Mauritius Institute

THE project for an institute in Mauritius began in 1880 with the object of establishing an institute, museum and library for the "purpose of promoting the general study and cultivation of the various branches and departments of Art, Science, Literature and Philosophy and for the instruction and recreation of the people". The present building was completed in 1884 and the Institute is administered by a Board of Directors. Plans have been prepared to make the Institute more or less autonomous, and the necessary legislation is being drafted. A number of local scientific and cultural societies have become incorporated with the Institute, which at the present time comprises a library, an art gallery and a museum. The Natural History Museum is in Port Louis and the historical material at Mahebourg. At the latter the exhibits include furniture, objects connected with the Grand Port battle, and early maps, lithographs and water-colours recording the life, scenery and customs of the people at different periods. The Natural History Museum is now regional in character, and emphasis is centred on Mascarene topics illustrating biological, ecological and economic relationships. A concentrated effort is now being made to modernize the exhibition part of the Museum according to present-day standards. Research has always played an important part in the activities of the Institute, and the annual list of original papers is impressive.

## First Ascent of Mont Blanc

WHEN Mount Everest was finally conquered Edmund Hillary and Tenzing Norkey on May 1953, the event aroused enormous interest, and the resources of ancient and modern methods communication by runner, telegraph and wirele were available to spread the news rapidly all ov the world. It arrived in Great Britain three da later, during the night of June 1–2, and one of first recipients was the Queen. In the *Notes a Records of the Royal Society of London*, Sir Gavin Beer and Max H. Hey show that conditions we very different when Mont Blanc was first ascend by Dr. Michel-Gabriel Paccard and Jacques Balm on August 8, 1786 (11, No. 2; March 1955). T news was carried by messenger from Chamonix Geneva for the information of H. B. de Saussur who received it on the morning of August 10. Ther after the spread of the news was sporadic, uncerta and slow, depending on the private corresponden of de Saussure and his friends and of tourists wh chanced to be at Chamonix at the time. It was fir published in the *Leipziger Zeitung* of August 2 1786; but the first publication in Great Brita appears to have been in the *Scots Magazine* f November of that year. Yet it also was a great an important event, and a small number of persons Great Britain must have learned the news privatel

## Institution of Telecommunication Engineers, Ind

THE Institution of Telecommunication Enginee was inaugurated in India in November 1953, and a the first annual general meeting held recently in Ne Delhi, considerable progress in membership an activities was reported. The Institution comprise all the specialized branches of telecommunications i India, and its membership of more than a thousan is drawn from various government-operated communications agencies, the three defence service research institutes and industry. Like most professional bodies, the Institution prescribes minimum educational qualifications and experience for entr into its several categories; but direct admission int the lower categories is also possible by passing th examinations which are to be conducted by it. Th first issue of a quarterly *Journal* is about to be published. Talks and discussion meetings are arrange periodically in New Delhi, the headquarters of th Institution, and similar activities are being planne in Bombay, Calcutta, Madras, Poona, Bangalore an Jabalpur. Further particulars can be obtained fron the honorary secretary of the Institution at Pos Box No. 481, New Delhi.

## Colorimetry and Theories of Colour Vision

IN an address given to the Physical Society Colou Group on May 18, Dr. D. B. Judd, of the Nationa Bureau of Standards, Washington, D.C., said tha colorimetry can contribute to the understanding o the mechanisms underlying the seeing of colours i three ways: by determining metamers, that is, several groups of different spectral stimuli which when mixed produce identical sensations; by the characterization of the attributes of chromatic sensations, particularly hue sensation; and by determining the spacing of subjective colours. As regards the first, the law of additivity, on which the interpretation of all colour matches is based, is not at present thought to be rigidly valid, although it is certainly a good approximation to the truth. Dr.

dd emphasized that any theory of colour vision ist be so framed that it can be expressed in terms a triple matrix which is necessary to account for tamerism. This is true of the Müller zone theory, nich also predicts correctly the locus of constant turation in a colour chart; its third stage, just as ering's theory, can account for the Brücke–Bézold onstant hue) phenomenon. In describing the unsell colour system, Dr. Judd said that American lorimetrists have recently, and reluctantly, reached e conclusion that it is impossible to devise a single stem for constant hue, saturation and brightness d simultaneously to have equal geometrical spacing. eir present object is to develop a 'homogeneous tropic colour space'. Showing data in which otoelectric measurements and numerous sub- ctive judgments of the appearance of ceramic mples were correlated, he said that in general the rrelation is better for red than it is for buff, and r this colour it is better than it is for brown (red mples reveal a breakdown of the Brücke–Bézold enomenon). Dr. Judd concluded by pointing out at colorimetrists have accumulated a vast body of ta which awaits digestion and treatment on a eoretical basis. Not one of the least tasks of eories of colour vision will be to account for the agnitudes of the sensory differences as encountered the above correlative experiments.

## ora of Egypt: a Further Contribution

WITH the appearance of Vol. 3 of the "Flora of gypt" (published as a Bulletin of the Faculty of cience, No. 30, pp. 1–644; Cairo University, 1954), is ambitious and scholarly floristic study has been ken a stage further. In this volume the authors, ivi Täckholm and Mohammed Drar, deal with ngiospermae, part Monocotyledones, Liliaceae– usaceae. This detailed and thorough piece of work corporates a revision of all the available botanical aterials, together with an extensive reference list. he citation of the localities in which the species and arieties have been recorded should be of value in cological and other researches, while the references the medicinal and other practical uses of species, nd to linguistic, historical and artistic aspects not nly carry their own interest—and in some instances his is a very considerable interest indeed—but also ake a very real and substantial contribution to eneral scholarship. As an indication of the authors' reatment, the account of the genus *Allium* extends ver some seventy-eight pages and includes a general reatment of the genus; a practical diagnostic key; n account of the species, their localities and varieties; otes on the species cultivated in Egypt; records of *llium* in Ancient Egypt (with linguistic notes, *llium* species as food, as used in mummification, tc.); the genus in later historical periods; its use s drugs; and an extensive bibliography.

## read Rolls made with Fish Flour

IN co-operation with the Chilean Government, the ood and Agriculture Organization of the United ations has recently completed successful large-scale rials with a protein-rich fish flour which is free from fishy flavour. One hundred and forty Chilean hildren between five and fourteen years old were iven daily a 90-gm. bread roll containing 10 per cent f fish flour with their school lunch. The bread was lightly darker than ordinary bread, but similar in mell, taste, form and consistency, and was eaten by he children without complaint and with no digestive ill-effects. These tests by the Food and Agriculture Organization are of great importance to technically under-developed countries where diets are low in high-grade animal proteins. Foods to meet these deficiencies must be cheap and be able also to stand transport and storage, often under most unfavourable conditions, without deterioration. Edible fish meal, or fish flour, meets these conditions. It is inexpensive, the protein content is high and processing costs are low. Until recently, however, the fishy flavour has made it unpopular, and efforts have been made to develop a flavourless fish flour. The flour used in the Chile tests was produced by a South African firm which has been working for some time on a secret process. The United Nations Children's Fund has now set aside funds to be spent on similar trials of fish flours in other areas with the assistance of the Food and Agriculture Organization.

## Zoological Nomenclature

THE International Commission on Zoological Nomenclature gives notice that, as from November 31, 1955, it will start to vote on the following cases involving the possible use of the plenary powers for the purposes specified against each entry. Full particulars of these cases were published on May 31 in the *Bulletin of Zoological Nomenclature* (11, Parts 5 and 6; 1955). (1) *Sphenodon* Gray, 1831 (Cl. Reptilia), validation of emendation from *Sphaenodon*; Sphenodontidae Cope, 1870, validation of; (2) *Hemiprocne* (Cl. Aves), validation of, as from Nitzsch, 1820; (3) *Fistulipora* McCoy, 1849 (Cl. Bryozoa), validation of; (4) *Aucella* Keyserling, 1846 (Cl. Lamellibranchiata), validation of; (5) *Muntiacus* (Cl. Mammalia), validation of, as from Rafinesque, 1815; (6) *Scorpio* Linnaeus, 1758 (Cl. Arachnida), designation of *Scorpio maurus* Linnaeus, 1758, as type species of, and suppression of *europaeus* Linnaeus, 1758; (7) *Oxypoda* Mannerheim, 1831 (Cl. Insecta, Order Coleoptera), designation of *Oxypoda spectabilis* Maerkel, 1844, as type species of; (8) *gambianus* Ogilby, 1835 (Cl. Mammalia), validation of, and designation as type species of *Heliosciurus* Trouessart, 1880; (9) *silvestris* Schreber, [1777], validation of, as name for European wild cat; (10) *Phacochoerus* Cuvier, 1826 (Cl. Mammalia), validation of; (11) *Odobenus* Brisson, 1760 (Cl. Mammalia), validation of. Proposals are also made for the adoption of 'declarations' defining (*a*) the expression 'monotypical genus', and (*b*) the combination to be attributed to the specific name for a species described as belonging to one genus, but for which at the same time a second nominal genus is established conditionally. Attention is also directed by the Commission to the proposed rejection of names given to the 'Piltdown Man' as being names given to a fictitious form. Comments should be sent as soon as possible to Francis Hemming, secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

## University of Sheffield

THE following appointments have been made in the University of Sheffield: Dr. G. Porter, to the newly established chair of physical chemistry; Dr. V. R. Pickles, senior lecturer in physiology; Dr. G. M. Leak, lecturer in physics; Dr. W. F. Ford, lecturer in refractory materials; Dr. L. Ainsworth, lecturer in glass technology; and Miss H. G. Medlicott, map-curator and librarian in the Department of Geography.

## Medical Fellowships of the National Research Council, Canada

THE National Research Council of Canada has recently awarded six senior medical research fellowships and twenty-one graduate medical research fellowships, totalling 81,700 dollars in value plus travelling allowances when required. The recipients and the places where they will work are as follows. *Senior Medical Research Fellows:* Dr. W. G. B. Casselman, Banting and Best Department of Medical Research, University of Toronto; Dr. C. N. Crowson, Department of Pathology, Queen's University, Kingston, Ontario; Dr. J. M. Finlay and Dr. R. W. Gunton, Toronto General Hospital and the Department of Medicine, University of Toronto; Dr. P. C. Fitz-James, Department of Bacteriology and Immunology, University of Western Ontario; Dr. J. W. Pearce, University of Western Ontario. *Graduate Medical Research Fellows:* Dr. C. W. Baugh, Department of Physiology, Queen's University, Kingston, Ontario; Dr. S. A. Carter, Dr. W. B. Ewart and Dr. G. F. Winkler, Department of Physiology and Medical Research, University of Manitoba; Dr. R. W. Cornett, Department of Medicine, Harvard Medical School; Dr. J. W. Dawson, Department of Pathology, Banting Institute, University of Toronto; Dr. C. J. P. Giroud, Department of Investigative Medicine, McGill University; Dr. H. Kalant, Department of Biochemistry, University of Cambridge; Dr. Dorothy C. H. Ley, Toronto Western Hospital; Dr. J. Loiselle and Dr. A. E. Malkin, Department of Biochemistry, McGill University; Dr. A. M. Lansing, Department of Physiology, University of Western Ontario; Dr. G. G. Mathieson, Department of Neurophysiology, Montreal Neurological Institute; Dr. J. McGraw, Institute of Experimental Physiology, Laval University; Dr. I. R. McLean and Dr. R. Volpe, Department of Medicine, Toronto Western Hospital; Dr. J. W. Meakin and Dr. J. C. Nixon, Department of Biochemistry, University of Toronto; Dr. J. H. Mowbray, Department of Pathology, University of Toronto; Dr. J. G. J. Pepin and Dr. B. Therien, Department of Clinical Research, Hotel Dieu Hospital, Montreal.

## Nuclear Engineering Courses at New York University

THE College of Engineering of New York University is setting up a number of courses in nuclear engineering for students who already have a bachelor's degree in science or engineering and who wish to proceed to the new degree of master of nuclear engineering. Subject to the approval of the United States Atomic Energy Commission, a sub-critical reactor will be built this autumn at the University at a cost of a few thousand dollars, with uranium lent by the Commission. It will consist of a five-foot tank of water in which two tons of uranium rods are placed; the neutron source, consisting of polonium and beryllium, will be housed beneath floor level and will be hoisted up among the uranium rods by remote control. The power will be 1/300 W., and the neutron intensity of the order of a hundred million neutrons per second. This is enough for such experiments as foil irradiations, Geiger-counter studies, and Szilard–Chambers observations. With this apparatus students can be trained in a realistic and practical manner in the physics of the chain reaction, reactor theory and diffusion theory.

## Announcements

THE Paris Academy of Sciences has elected Pr D. Keilin, lately Quick professor of biology a director of the Molteno Institute, University Cambridge, to be foreign associate; and Prof. Gaussen, professor of botany in the University Toulouse, to be *correspondant* for the Section Rural Economy.

SIR GORDON RADLEY, deputy director-general, a formerly engineer-in-chief, of the Post Office, h been appointed director-general in succession to S Alexander Little, who is retiring.

DR. F. H. K. GREEN, principal medical officer the headquarters staff of the Medical Research Coun since 1949, has been appointed scientific secretary the Trustees of the will of the late Sir Henry Wellcom (The Wellcome Trust, 24 Harley Street, Londo W.1), with effect from October 1; he will according leave the service of the Medical Research Council September 30.

MR. S. CULPIN, director of Gleadthorpe Expe mental Husbandry Farm, Welbeck Colliery Villag Mansfield, Notts, has been appointed director of t Experimental Husbandry Farm which is bei established at Drayton in Warwickshire when th farm is taken over from the Grassland Researc Station in September next.

THE Documentation Committee set up by th Society of Chemical Industry in 1952 is publishing *Chemistry and Industry* periodical lists of amendment to the third edition of the "World List of Scientifi Periodicals", and three have so far appeared. The include certain amendments to library holdings aft 1950. Details of any errors discovered in the lis should be sent to the honorary secretary of th Committee, Miss M. I. Wyatt, Laboratories, J. Lyon and Co., Ltd., 149 Hammersmith Road, Londo W.14, from whom further information can b obtained.

THE Admiralty is arranging a summer school fo university and technical college teachers on scientifi problems which arise at all stages in the develop ment of electronic devices, to be held at the Service Electronics Research Laboratories, Baldock, Hert and Harlow, Essex, during September 20–2 Leading scientific workers from industrial an government laboratories will discuss their problem and practical demonstrations of modern valve an transistor development techniques will be give Further information can be obtained from the Deput Director of Physical Research (C.V.D.), Admiralty 20 Great Smith Street, London, S.W.1.

IN *Nature* of January 1, 1955, p. 26, reference wa made to the work in the United States of the Anima Care Panel. We are informed that the Proceeding of the annual meetings of the Animal Care Panel ca be purchased from the Secretary-Treasurer of th Animal Care Panel, Dr. Robert J. Flynn, P.O. Bo 299, Lemont, Illinois, U.S.A., directly or throug booksellers in the United Kingdom, at the followin prices (plus postage): 1950, 1 dollar; 1953, 3 dollars 1954, 4 dollars, or from the Laboratory Animal Bureau, M.R.C. Laboratories, Holly Hill, Hampstead London, N.W.3, at the following prices (post pai within the U.K.): 1950, 7*s*. 9*d*.; 1953, 22*s*. 9*d*. 1954, 30*s*. Proceedings for 1951 and 1952 are n longer available.

# INTERNATIONAL CONFERENCE ON COAL SCIENCE

PROGRESS in the study of coals as chemical substances, and in the measurement of their ntrinsic physical properties as distinct from mechnical characteristics, has been very slow. Coals form well-defined family of organic substances with eculiar properties that differentiate them clearly om other natural products and render difficult their udy by orthodox chemical methods. Throughout his century small groups of research workers have evertheless attempted this task; and in the years mmediately following the formation of the Coal Research Club by R. Lessing and R. V. Wheeler in 921, it was possible for almost all relevant work to e discussed adequately between those principally nvolved. The situation has now changed radically. There has been an awakening of interest in many ountries, stimulated partly by competition from ther fuels and partly by the shortage of coals suitble for making metallurgical coke, a process basically ependent upon chemical properties. The development of team-work, resulting in a rapid increase in he volume of publications, has coincided with a ecrease in opportunities for its wider discussion. While many of the older views on coal constitution ave been confirmed in principle, definitely established facts date almost exclusively from the past decade or two. Concomitant with this increase in greed knowledge, many apparently incompatible observations have been made, and the need for personal contact between workers in the field was never more evident.

Within the United States, this purpose has been admirably served by the residential Gordon Conferences on Coal, sponsored by the American Association for the Advancement of Science and occupying a full week in each year. The proceedings are, however, private, and European representatives are normally very few. After his return from America o Germany in 1949, Prof. W. Fuchs attempted to meet this need by inaugurating annual *Steinkohlenagungen* at Aachen, where he holds a chair of technical chemistry at the Technische Hochschule. The papers delivered, but not the discussions, were normally published in *Brennstoff Chemie*. These conferences proved most valuable, but a need was felt for placing them on a broader all-European basis. This feeling was given expression after the *Steinkohlentagung* of 1954 by the formation of an international Organizing Committee, with the following membership: Prof. D. W. van Krevelen, president (Netherlands); Dr. I. G. C. Dryden (Great Britain); Prof. W. Fuchs (Germany); M. E. H. Grand'ry (Belgium); M. R. Loison (France); Dr. M. Th. Mackowsky (Germany); and Dr. D. C. Rhys-Jones (Great Britain).

The first International Conference on Coal Science was accordingly held during May 2–3 at Heerlen in the Province of Limburg, Netherlands. It was attended by more than ninety participants from eight countries; interest in Great Britain was attested by the size of the British contingent, which numbered sixteen, and the United States was indirectly represented by two members of European Research Associates (Brussels), a branch of the Carbide and Carbon Chemicals Company. The town hall of Heerlen was placed at the disposal of the Conference, and the municipality gave every assistance to the organizers; at the conclusion of the official sessions, members of the Conference were offered hospitality by the burgomaster, Mr. M. F. G. M. van Grunsven.

On the morning of each day, general lectures each covering a definite field of coal science were delivered and discussed, and the afternoons were devoted to short communications covering special aspects of these fields. An attempt was made to restrict the subject-matter to coal science as distinct from coal technology; but even so a wide range of topics was covered. The theme on the first day was "The Genesis, Constitution and Properties of Coal" (chairmen, Dr. Rhys-Jones and M. Loison); on the second, "Carbonization and Coke Structure" (chairmen, Prof. Fuchs and M. Grand'ry). Discussion of the papers took place during the sessions and at an informal meeting on the evening of the first day.

Lignin is one of the chief materials from which coal has been formed by slow chemical and physical changes. Formation of lignin in the living plant, and its chemical constitution, were discussed by W. Fuchs, who pointed out the wide variety of related substances that can be included under this name. Fuchs also discussed the chemical conversion of lignins and other natural materials into coal, with special reference to his view that the 'redox' potential is an important determinant of the type of product; he adduced evidence suggesting that anaerobic conditions predominated during the early stage of formation of black or hard coal, aerobic conditions during that of brown coal. It is generally considered that the humic acids extractable from peat and humus by aqueous solutions of alkali are intermediates in the process of coal formation. The distribution of humic acids in low-rank coals was discussed by D. J. W. Kreulen, who showed that humic acid content does not necessarily decrease with increasing maturity of brown coals and lignites. Kreulen concluded that the formation of humic acids and the formation of coal are two independent processes; humic acid formation takes place only under conditions of oxidation, and coal can thus be formed either directly or *via* humic acids. It is likely that both processes usually occur simultaneously.

A. Gillet followed, by graphical methods, the changes in elementary composition in passing from plant constituents and peat to high-volatile bituminous coals, and suggested possible structural changes that might be involved.

Several different approaches to the study of the constitution of coal are possible: coal can be converted to simpler materials, for example by hydrogenation and oxidation, and these can then be examined in detail, or alternatively coal itself or primary derivatives such as solvent extracts may be studied directly. S. G. Ward submitted preliminary results of a comprehensive study of oxidized products, intermediate between humic acids and benzene carboxylic acids, produced by oxidizing humic acids with alkaline permanganate, with hydrogen peroxide and with ozone. The humic acids themselves were produced by alkaline permanganate oxidation of deep-mined coal or by alkaline extraction of outcrop coal. Fractions containing between ten and forty carbon atoms in the molecule were obtained by various procedures, including chromatography and methylation; but none could be claimed as a single compound. J. P. Schuhmacher described the solvent fractionation and high-vacuum distillation of fractions obtained by hydrogenating coal in tetralin at 325° C. and 180 atm. The fractions were characterized by physical properties, chemical analyses, molecular weights and infra-red spectra. One of the objectives was the estimation of the mean number of fused aromatic rings in a molecule of product. The results suggested that some of the products were polymeric structures derived from monomers containing a phenanthrene nucleus. I. G. C. Dryden compared knowledge of coal structure derived from infra-red spectra with that from chemical group determinations, and described recent work in the British Coal Utilisation Research Association, in which the two techniques were used for supplementing one another. He showed that the presence, although not the precise amount, of phenolic hydroxyl in lower-rank British coals has now been definitely established by collaboration between W. F. Wyss, working on acetylation of coals, and J. K. Brown, working on the infra-red spectra of coals and their acetylated derivatives. Comparison was also made between the determinations by C. R. Kinney (Pennsylvania State University) of the amounts of acetic acid produced by different coals on oxidation, and the spectroscopic estimation by Brown of the proportion of aliphatic hydrocarbon groups in similar coals. J. Schuyer described the evidence for the existence in coal of what he termed 'complexes', namely, associations of molecules within which charge transfer can occur. A semi-quantitative discussion of this concept, in relation to the type and spacing of the lamellar molecules that are probably present and the semi-conducting properties of anthracites, and to corresponding information derived from the molecular refractivities of coals, gave an encouraging measure of agreement. Only one paper dealt directly with physical properties: G. Heinze described comparisons between various forms of hardness test using continuous or alternating load. A correlation was found between micro and macro Vickers hardness.

On the second day, three papers dealt with aspects of the mechanism of plastic softening of coal, particularly during carbonization. This softening, accompanied by the development of a sticky consistency, is essential to the production of a strong large coke from small particles of coal. The ultra-fine porosity of coal particles is also relevant to its behaviour in carbonization; and mechanical aspects related to the physical effects accompanying the hardening of plastic coal to solid semi-coke, which have great influence on the crack structure and strength of the resulting coke, were also described. The physical examination of cokes by microscopy, other optical methods, and X-ray diffraction formed the theme of further papers; and finally, a test for the reactivity of high-temperature coke to carbon dioxide (an index of its behaviour in combustion and in metallurgical plant) was described.

The plastic softening of coal on heating was discussed at length by D. W. van Krevelen. Measurements of plastic and swelling behaviour were shown to be consistent with the hypothesis that a metastable liquid intermediate is first formed and afterwards decomposed. It was shown that small differences between the activation energies of these two consecutive pyrolytic reactions can account for many of the differences observed between coals. A mixtu of a low-melting polymer, a substance yielding ga on thermal decomposition, and a condensing age to promote further polymerization was found t simulate closely the carbonizing properties of typical coking coal. D. FitzGerald described measur ments with a Gieseler plastometer of the rate hardening of plastic coal at constant temperature—that is, of the second stage of pyrolysis mentione above—which he has fitted to a first-order reactior rate equation, deriving velocity constants. Activatio energies were almost independent of the rank (c maturity) of the coal tested; the values fell in narrow range around 50 kcal./mole. It was als found that addition of a small amount of 9–1 dihydro-anthracene decreased the reaction velocity it was suggested that decomposition of this additive released atomic hydrogen which retarded th cross-linking or hardening of the plastic coa J. W. Phillips discussed plastic flow of coal at room temperature, which can be induced by briquettin and by other well-known techniques, and suggeste that the behaviour of coal in this respect is analogou to that of any other brittle and extensively cracke material, and is not directly related to the plasti softening of coal on heating (which involves decomposition).

Coals have an extensive ultrafine porous structur and have been shown to behave as molecular sieves A study of this aspect, using the measurements o heat of wetting, adsorption and apparent densit as an indication of the extent of penetration of given liquid into a coal particle, was described by R. L. Bond. The structure of bituminous coals i characterized by two modal sizes of constriction both of the order of tens of angstroms, and thi structure is rather surprisingly found to persist with relatively minor changes in dimension up to carbonization temperatures of 600° C. and above. Above 600° C. the structure is less apparent because it i penetrable only by very small molecules such as those of hydrogen and helium, and can only be studied by measurements of adsorption or apparent density. This fine structure is important in determining the ease of escape of volatile pyrolysis products and therefore the degree of their secondary decomposition; it also influences the extent of plasticization achieved by a given amount of fluid decomposition product.

The strength and size of a coke are important in relation to its use in blast furnaces and cupolas, where a heavy metallurgical burden has to be supported, and the voids must not be choked by degraded coke particles. These properties are influenced to an important extent by the fissuring that occurs during and after solidification of the plastic coal mass. Fissuring depends on the temperature gradient near the plastic zone in the coke oven, on the rate of hardening, on the temperature of hardening, and on several other factors. A. F. Boyer discussed the distinction between local mechanical properties of the coke and the strength of larger pieces containing fissures; a laboratory mechanical test depending on the curvature observed when a layer of coal is coked by heating from the underside was described; the microscopic observations of coke in polarized light were shown to emphasize heterogeneity of coke particles. Application of the many principles described to the practical improvement of coke prepared from given coals was then discussed: for example, the importance of the relationship between the temperature of maximum rate of decomposition and that solidification, and of the relative solidification nperatures of the constituents in blends of coal.

M. Th. Mackowsky illustrated the value of micro-pic investigations in studies of coke structure and ength. Proof was adduced that the macropore stem of cokes, which can be studied by this method, nsists of intercommunicating chambers. B. Alpern o contributed to this subject, describing the use of croscopy in reflected polarized light in recog-zing coke constituents of differing optical aniso-py. It was shown that different coals in blends not mix intimately during carbonization. S. Durif mpared cokes by X-ray diffraction measurement of e degree of graphitization after heating to 2,000° ; many factors involved in its formation at lower nperatures were shown to affect this characteristic.

Finally, A. Dahme described a method of determ-ing reactivity of coke to carbon dioxide in terms the reaction velocity at 1,100° C. and the activation ergy of the reaction. He showed that cokes differ the relative extent to which reaction takes place the outer surface of the particles and on the ternal surface.

## CONGRESS OF CELL BIOLOGY

THE Eighth International Congress for Cell Biology was held at Leyden in September 1954. It was ganized by a Dutch Committee including Prof. . Boeke as honorary president, Prof. P. J. Gaillard president, Dr. W. K. H. Karstens and Dr. Johanna . P. Zaaijer as secretaries. The Dutch Committee was ting on behalf of, and with the advice of, the nternational Society for Cell Biology.

As was the case with all the recent congresses in is field, the view was taken that cells constitute one the definitive levels of organization of living matter nd that, for the proper appreciation and discussion cellular phenomena, all cellular and sub-cellular iological phenomena are relevant. Consequently e Congress covered a very wide field. The arrange-ents made by the organizers provided admirably for ose who wished to obtain a general view of the field, well as for those whose interests were more re-ricted. In the afternoons there were a number of arallel sessions, many of them symposia, which pro-ided for detailed discussion in a wide variety of fields. was, of course, impracticable to attend more than ne of these sessions; but the common morning ssions were organized to enable all who wished to o so to obtain a bird's-eye view of many major fields. he morning lectures were upon the following topics: duced enzyme synthesis; intercellular substances; nmunobiological concepts of growth and differentia-ion; biochemistry of gene action; virus synthesis; olated mitochondria; phase-contrast microscopy; -ray methods in histochemistry; microradio-raphy; chromosome structure; thyroid secretion; orphogenetic interaction between cells; cell division nd mitotic poisons; facilitated diffusion and active ransport; electron microscopy of cells. On the whole his scheme worked well; but its success was limited y the failure of some of the lecturers to give broad urveys.

Scientifically, the chief value of the Congress lay artly in the general survey which was made of a arge part of cell biology, and partly in the provision f ample time for informal discussion. One of the ost valuable arrangements was the provision of discussion rooms to which any small group which arose spontaneously could resort to pursue any topic which it wished to consider. As regards subject-matter, perhaps the most striking feature was an indication that the gulf between the students of chromosome morphology and other cell biologists is beginning to narrow.

The able organization of the scientific aspects of the Congress was paralleled by the excellence of the social activities. The Congress was opened in the Pieterskirk by addresses from Prof. Gaillard, from the President of the Board of Curators and the Rector Magnificus of the University. One of the Dutch hosts remarked that the growth of fingers in tissue culture presented those interested in criminal law with some unusual problems. The president of the Society for Cell Biology, Prof. E. N. Harvey, was prevented from attending by illness; but his speech was read by Paul Weiss in a style which was widely appreciated. There were a number of other attractive social functions, of which the most outstanding was the reception given by the Netherlands Government in the Amsterdam Rijksmuseum. Here, in addition to the permanent collection, there was a remarkable exhibition of Indonesian art. From every point of view, the Dutch Committee succeeded in making the Congress an outstanding success.

The Congress was preceded by a meeting of the Cytochemistry Commission of the Society for Cell Biology. The Commission was established in 1950, by the Society, to accelerate the study of cyto-chemical techniques. The Commission held a meeting, lasting two days, in Prof. Gaillard's laboratory. Recent progress in cytochemical techniques for the study of nucleic acids, proteins, polysaccharides and various enzymes was reviewed. The Commission was able to report that much progress had been made since its first meeting (in 1951).

At the end of the Congress it was decided to accept an invitation to hold the Ninth Congress at the University of St. Andrews, Scotland. This will take place during August 28–September 3, 1957. The Executive Committee responsible for the Congress will include Dr. Honor B. Fell (*chairman*), Prof. H. G. Callan (*secretary*), Dr. Robert Brown and Prof. M. M. Swann. The following officers of the Society for Cell Biology were elected: *President*, Prof. P. J. Gaillard; *Past-President*, Prof. E. N. Harvey; *Vice-Presidents*, T. Caspersson, H. B. Fell, P. Weiss; *Secretary*, Prof. J. F. Danielli.

## BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

### RESEARCH PANEL MEETING

THE tenth meeting of the Research Panel of the British Gelatine and Glue Research Association was held on May 17, with Mr. S. G. Hudson (Richard Hodgson and Sons, Ltd.) in the chair. Two papers were presented, and at the close of the meeting those present visited the Association's laboratories at 2*a* Dalmeny Avenue, Holloway, London, N.7.

The first paper, "Recent Research on the Mech-anism of Photographic Sensitivity", was given by Dr. J. W. Mitchell (H. H. Wills Physics Laboratory, University of Bristol). Dr. Mitchell described the recent series of experiments which he and his col-laborators have carried out, aimed at providing definite experimental answers to many of the speculations which have been put forward from time to time to account for the behaviour of silver halide emulsions. The most important step in this work has been the preparation and use of large single crystals of silver bromide in the form of thin parallel slabs. These can be obtained either strained or, by an annealing process, strain-free.

The results of sensitization by immersion in gelatin solutions, by digestion with gelatin solutions which could be modified by the addition of reducing substances, sulphur-containing sensitizers and potassium chloro-iridite, were described. Chemical sensitization appears to arise from silver, gold or silver sulphide produced at strained or roughened regions on the surfaces of the crystals. By direct deposition of silver and gold on the surfaces, it was possible to check this view, and silver films could also be converted to silver sulphide. On exposure of silver bromide to light, halogen atoms are released, and chemical sensitizers function by reaction with the released halogen. The recent results have brought into prominence some of the older theories of sensitivity. A lively discussion, opened by Mr. R. C. M. Smith (Ilford, Ltd.), followed the paper, and gave Dr. Mitchell the opportunity to expand his account of certain aspects of the work.

The second paper, given by Dr. C. H. Bamford (Courtaulds Fundamental Research Laboratory, Maidenhead), was on "Synthetic Polypeptides", and in it the work which has been carried out at Maidenhead was reviewed and related to the behaviour of proteins. The configuration of polypeptide chains can be examined by such physical methods as absorption of polarized infra-red radiation, which enables the directions of the —NH and —CO groups to be determined, by X-ray diffraction spectra, where certain polypeptides give results in close agreement with those to be expected for the 3·7 helical structures proposed by Pauling, and by optical rotation. Synthetic polypeptides occur in two configurations: $\alpha$, referred to above, with intrachain hydrogen bonding; and $\beta$, an extended form with interchain hydrogen bonding. These correspond closely with structures found for natural proteins such as keratin and silk; but an analogue for collagen has not been found yet. The discussion on this paper was opened by Mr. A. G. Ward (British Gelatine and Glue Research Association).

A. G. WARD

# WATER POLLUTION RESEARCH IN BRITAIN

TO those whose work or interest lies in river pollution prevention, water treatment, and sewage and trade wastes purification, the study of the annual reports of the Water Pollution Research Board and of the Director of Research is at once a necessity and a pleasure. The report for 1954[*] easily maintains the interest and information that have characterized previous reports.

A notable event of the year was the completion and occupation of the new laboratories at Stevenage, Hertfordshire, which now house all the staff who were previously working at Watford, Garston, Birmingham, Coventry and Tilbury. Thus for the first time since the formation of the organization in 1927, all the staff are together in one building—a great advantag for future work. The new laboratories have a numbe of novel features; among the many facilities may b instanced a small pumping station, which can delive up to 50,000 gallons of sewage daily to experiment plant (see also *Nature*, June 25, p. 1105).

The largest section of the report comprises a account of the progress made in the complex surve of the Thames Estuary. Here it was found necessa to undertake the fundamental task of redeterminin the values of the solubility of oxygen in water, ove a range of temperatures and salinities, in equilibriu with moist air of normal composition at sea-leve The values so obtained were found to be 3–4 pe cent lower than those commonly accepted hithert Part of this work involved the checking of the well known Winkler titrimetric method for the determination of dissolved oxygen against a referenc gasometric method, establishing that the former without appreciable error. Other studies included statistical examination of the chemical records of th London County Council concerning the condition o the Thames, and the factors controlling the balanc of oxygen in the estuary water—that is to say, th amount of fresh water entering at Teddington, th absorption of oxygen from the atmosphere unde various surface conditions, the effect of syntheti detergents upon the absorption and the rate o oxidation of polluting matter, including the effect o bottom deposits removed by dredging. Both field investigations and laboratory experiments have no been terminated; but the final conclusions await th completion of the many lengthy calculations tha have to be made.

A further section of the report deals with the effect of pollution on fish. The Laboratory has assiste the Ministry of Agriculture and Fisheries in a surve of the River Colne, principally regarding the effect o sewage effluent upon fish life. Laboratory experiments are being continued on the degree of toxicity o ammonia, carbon dioxide and synthetic detergent It appears that the degree of toxicity is frequentl related to the amount of dissolved oxygen present—fish can survive doses of toxic substances in well aerated water that would be fatal in poorly oxygenate water.

In the section on sewage, an account is given o the examination of surface run-off water from housing estate, the conclusion being that this wate was not of a very polluting nature apart from it rather high content of suspended solids. Th biological filtration of sewage is discussed as regard periodicity of dosing and efficiency of filters, and als the work so far done on the effect of synthetic detergents upon sewage treatment, where quantitativ information on the subject is by no means abundant

A useful piece of work has been done in conjunctio with the Government Laboratory: that of reviewin methods for determining concentrations of variou metals in waste waters and effluents down t 0·1 p.p.m. The methods suggested are due to b incorporated in the second edition of "Methods o Chemical Analysis as Applied to Sewage and Sewag Effluents" to be published by the Ministry of Housin and Local Government.

Investigations have been continued concerning th removal of cyanides from industrial waste waters by biological filtration; the organism responsible ha been isolated and described. Biological destructio of cyanide in mixed plating wastes has been show to be a practical method for dealing with suc wastes, and if the information resulting from this esearch is properly acted upon by the industries oncerned, a potent source of pollution will be greatly educed. Experiments on the anaerobic digestion of artially neutralized waste liquor from the kiering f cotton were also continued. This method of reatment is a possible one for pre-treatment before ischarge to a public sewer, having the merit first of equiring less space than a percolating filter to effect he same degree of improvement, and secondly of the bility to treat undiluted kier liquor, whereas for a percolating filter the liquor would require considerable dilution.

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[*] Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research for the year 1954. Pp. vi+65+4 plates. (London: H.M. Stationery Office, 1955.) 3s. net.

The section on water is very brief. Experiments are described on the removal of fluoride from water by passage through a column of activated alumina. The reason for the complete blockage of two slow and-filters was investigated and found to be due to deposited crystals of calcium carbonate which had bound the sand grains together, the deposit having been induced by loss of carbon dioxide from the water during previous aeration.

Lastly the report emphasizes that an important part of the Laboratory's activities is now concerned with the development of automatic equipment. A noteworthy achievement has been the production of an instrument for the continuous recording of the dissolved oxygen content of a stream of water, thus giving valuable information about fluctuations that would usually be missed by the methods of intermittent sampling that otherwise have to be employed.

# STANFORD RESEARCH INSTITUTE, CALIFORNIA

## REPORT FOR 1954

THE annual report for 1954 of the Stanford Research Institute, California*, records an increase of 242 in the staff during the year, and, of these, 165 have professional training and five to ten years of industrial experience. The staff now totals 916, and the revenue has increased by 40 per cent to 7·57 million dollars. Contract research is now being conducted at the rate of 8·5 million dollars a year, and the number of research projects has increased from 382 to 478, of which 297 were for private business, 128 for the Government and 53 were sponsored by the Institute as part of its plan for aiding the technological and economic development of the western part of the United States. In terms of dollars, the ratio of commercial projects to government projects was 54 : 46—an almost exact reversal of the ratio in 1953.

The 53 public service projects include studies of air pollution and high-temperature materials, of industrial water resources in California and of surface tension in solids; research on human engineering in industry; the effect of γ-radiation on high polymers; a survey of industrial land use in the Portland area; and the production of such reference works as the "Western Resources Handbook", "The Chemical-Economics Handbook" and "The Directory of Western Chemical Producers". The Institute also sponsored symposia on the automatic production of electronic equipment, on social science for industry and on area development problems.

In the Engineering Division electronics claims the largest share of attention, particularly the theoretical analysis of antenna systems, the design and manufacture of prototypes and the performance of radiation systems. The Physical Sciences Division has dealt with the production of chemicals from petroleum, utilization of wood waste, tallow, bagasse and fish waste, as well as the properties and applications of polymers, the storage and utilization of solar energy, the effect of infra-red radiation on chemical reactions, the use and control of sound waves and with the weapons-effect programme. The Division is also engaged in biochemical research and on problems in nutrition, microbiology, physiology and toxicology, while expansion into pharmacology is in progress. The Economics Division is concerned with three broad categories of work: the economic analysis of problems for specific companies; the examination of specific functions, such as the application of electronic data-handling equipment to accounting and clerical operations, the application of operational research in management and the industrial application of social science; and the use of economic surveys in area development, including also the location and protection of plant, military logistics and weapons-system evaluation.

In the Poulter Laboratories contributions have been made to the understanding of shock waves and detonations which have increased the effectiveness of explosives both for military purposes and in mining, agriculture and demolition. The Institute's work on defence against nuclear bombs has shown that earth-covered steel-arch structures above ground provide a significant level of protection at economical cost; but that most ordinary structures not specifically designed for the purpose are not significantly strengthened against blast by earth cover. Work on rocket liners has shown that detonation in tubes can be limited by absorbing compression-wave energy at the walls and, in work on graphite nozzles for liquid fuel rockets, a new technique for converting graphite to metallic carbide for an appreciable depth has given promise. A non-destructive test device, called a stub meter, for the plastic-adhesive bonded sandwich has been developed by the Institute physicists. Ten common weeds, grown under controlled conditions, have now been standardized as indicators of atmospheric pollution by hydrogen fluoride, sulphur dioxide, hydrogen sulphide, ammonia, chlorine and oxides of nitrogen. Under a project sponsored by the Southern Pacific Co., the hydrofriction system for freight cars has been developed to distribute the impact of energy more evenly or at a more constant rate by new shock-absorbing mechanisms.

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* Stanford Research Institute: Annual Report for 1954. Pp. 48. (Stanford, Calif.: Stanford Research Institute, 1955.)

# METABOLISM OF RADIOACTIVE SUGARS

H. K. PORTER and L. H. May have followed the uptake and utilization of radioactive sugars by tobacco leaf disks (*J. Exp. Bot.*, 6, 16, 43; 1955). When destarched tobacco-leaf disks were floated on 5 per cent (w/v) solutions of sucrose uniformly labelled with carbon-14 in either the glucose or fructose moiety, and on invert sugar in which one hexose only was so labelled, in an atmosphere of oxygen at 25° C., seventy-five per cent of the sugar lost from the external solutions was recovered as starch, sucrose, fructose, glucose and carbon dioxide.

With sucrose as the substrate, 30 per cent of the material was recovered as carbon dioxide, and 17 per cent each as starch, sucrose, fructose and glucose. With invert sugar as the substrate, 30 per cent was again recovered as carbon dioxide, only 20 per cent as the three sugars together, and 50 per cent as starch.

Whichever hexose was initially labelled and whether the sugar was supplied as sucrose or hexose, the relative specific activities of starch and sucrose in the leaf disks and of the carbon dioxide evolved were equal or nearly equal to that of the sugar supplied.

With sucrose as the substrate the sucrose in the disks retained its asymmetry of label, and free hexoses produced were similarly asymmetrically labelled. When invert sugar was the substrate, the sucrose synthesized was strongly labelled in both moieties, as also were the free hexoses.

It is concluded that fructose and glucose, free or combined in sucrose were equally available for starch synthesis and carbon dioxide formation, and that there can be no question of preferential utilization of one or other hexose. Starch and carbon dioxide must arise from a common source in which readily formed derivatives of the hexoses are rapidly equilibrated. Free hexose cannot participate directly in either sucrose or starch synthesis. Accumulation of sugar not immediately metabolized and inversion of sucrose take place at a site remote from the common pool.

## MARINE BIOLOGICAL RESEARCH

The first number of Vol. 34 of the *Journal of the Marine Biological Association of the United Kingdom* contains ten papers on a variety of marine topics. It commences with an obituary notice of one to whom marine biology owes a very great deal, the late Dr. George Parker Bidder, who died in his ninety-first year last December; he was the last of those connected with the early development and struggle for existence of the Marine Biological Association and its first honorary member. There is a characteristic photograph of him as frontispiece.

In the first of the ten papers, Dr. John R. Baker, working under the auspices of the Universities' Federation for Animal Welfare, describes a method for the humane killing of crabs by piercing the brain with an awl through the sternum of the segment of the first antenna and the ventral nerve mass through the depression at the posterior end of the sternum of the chela-bearing segment. The method can be learned quickly by the fishmonger and canner, and avoids autotomy of the appendages.

Dr. H. A. Cole and Mr. D. A. Hancock record the presence of a small parasitic gastropod in oysters from the River Colne in Essex, *Odostomia eulimoides*, formerly known only from *Pecten maximus* and *Chlamys opercularis*. *Odostomia* attacks the mantle edge of the oyster, causing the formation of a mantle pocket, later of a shell pocket, with thickening of the mantle and shell substance over the pocket, the malformation being visible externally. In severe cases, involving the presence of a number of parasites, the irritation may spread inwards to the adductor muscle, and the deposition of brown shell material on this muscle causes the shell to gape, with resulting suffocation and death. The parasite occurs in the River Crouch in considerable numbers, in other rivers of Essex, and also at Salcombe, Devon, where *Chrysallida obtusa* Brown is here recorded for the first time in oysters. In North Wales, Dr. Knight Jones found *Odostomia scalaris* in mussels. No methods of control are known.

A detailed account of feeding and digestion in terebellids, with special reference to *Amphitrite johnstoni*, and a comparison between this and other members of the family are given by Dr. R. Phillips Dales. Food is collected by ciliary action along the groove on each of the tentacles and, wrapped in mucus, is conveyed to the lips and thence, by an elaborate series of rolling movements, to the mouth. Strong amylase activity, weak protease and lipase activity occur in the fore-stomach, strong enzyme secretion of all three in the fore-intestine and, between the two, mixing of the food by muscular action of the hind-stomach. Absorption takes place in the fore-intestine and anterior part of the hind-intestine. While the structure of the gut and the digestive process are similar in all terebellids, the lips and feeding habits vary in different genera.

Dr. J. E. Morton and Dr. N. A. Holme record the discovery of large numbers of the tectibranch *Akera bullata* in a sea-water tank in the Naval Dockyard at Devonport, the first record for the Plymouth area. The animals were feeding on the thick growth of green algae growing on the sides of the tank and were breeding freely, the majority, however, dying after spawning. A study of its structure leads the authors to the conclusion that *Akera* ought to be removed from the Bullomorpha and placed in the Aplysiomorpha. A good account is given of its swimming habits, with outline diagrams based on a film of the living animal taken by Mr. F. A. J. Armstrong, and Dr. D. P. Wilson adds beautiful photographs of this marine 'ballet dancer'. Dr. Morton also contributes a paper on the structure and ecology of the minute marine pulmonate, *Otina otis*. This limpet-like form lives in the barnacle zone, browsing on small algae, and breathes through the lateral lobes of the foot, for the pallial cavity is very narrow and not specialized for respiration. Few of the characters of *Otina* are specialized; but most, particularly those of the digestive, genital and nervous systems, are primitive.

Dr. R. B. Clark and Dr. A. Milne have worked on the sublittoral bottom fauna of two sandy bays on the Isle of Cumbrae, using the Robertson mud bucket. Their studies were chiefly on polychaetes, molluscs, echinoderms and crustaceans. Few species in this area are gregarious; random distribution is the general rule in the bottom community. Drs. L. R. Fisher, S. K. Kon and S. Y. Thompson contribute their third study of vitamin A and carotenoids in invertebrates, and are here dealing with eleven species of euphausiids. There is considerable variation in the amount of vitamin A stored in the eyes. One small-eyed species, *Thysanopoda acutifrons*, is peculiar in having none. Neritic groups of *Meganyctiphanes norvegica* have higher reserves than those from the open Atlantic; but the fat concentration is highest in northern waters. Astaxanthin is found in all. It is significant that, despite their similar habitat, the euphausiids are biochemically and morphologically distinct from the Mysidacea, and in both respects appear to be related to the Penaeidea. Euphausiids form a link in the food-chains leading to blue and fin whales, sperm and bottle-nosed whales (through decapod cephalopods), herring, cod (at certain times of the year) and halibut. Dr. J. S. Alexandrowicz as extended his study of the innervation of the eart in Crustacea to that of *Praunus*. The three stems of nerve elements—intrinsic neurones (six in *raunus*), a pair of nerves joining the local system o the central nervous system, and nerves to the rterial valves—are represented.

The salinity of Kames Bay sand, Isle of Cumbrae, ith special reference to the distribution of *Nereis iversicolor*, has been investigated by Dr. Ralph I. mith, of the University of California, Berkeley. He ound a zone of relatively stable brackish interstitial water, and the zonation of the polychaete corresponds o this belt of lowered salinity. Whether it prefers he lowered salinity, or whether other competitive ntertidal species shun it, is not yet clear; but Dr. Vera Fretter, working on the same species at Plymouth, shows that it can adjust itself gradually to he more dilute sea water and can maintain a steady tate indefinitely. This it does by taking up water nd losing salts. It achieves equilibrium in normal sea water, but is hypertonic in less salt water. Employing the tracer element sodium-24 obtained rom the Atomic Energy Research Establishment, Harwell, she found that in sea water of 35 per mille salinity, saturated with oxygen, at normal atmospheric pressure and a temperature of 14° C., the *Nereis* was in equilibrium, and the uptake of sodium averaged 250 mgm./hr./gm. wet weight. At half salinity, after accommodation to the dilution, the uptake averaged 160 mgm./hr./gm. wet weight, and at 9 per mille it was 180 mgm./hr./gm., there being an active uptake of salts in this last-named case against the concentration gradient. Oxygen deficiency and temperature changes also affect the rate of uptake of sodium. The integument of *Perinereis cultrifera* is more freely permeable to ions than that of *Nereis diversicolor*, the influx of sodium being about three times greater in normal sea water.

The number under review concludes with abstracts of memoirs recording work done at the Plymouth Laboratory of the Association and published in other journals.

N. B. EALES

# ISOTOPIC COMPOSITION OF METEORITIC HYDROGEN

By GEORGE EDWARDS

**Institute for Nuclear Studies, University of Chicago**

THE deuterium–protium ratio in meteorites is of interest because it is one of few known sources of information about the ratio of these isotopes in space near the time of formation of our planetary system. Their abundances in the sun's atmosphere are calculated from spectrographic measurements; but it is well known that at the sun's temperature deuterium is much more reactive in the nuclear process than hydrogen, and consequently there is extreme depletion of the deuterium as compared to the amount present in space.

The stony meteorites are too porous to retain a representative specimen of hydrogen gas, and if combined hydrogen is present it could rather easily be exchanged with hydrogen from water on the earth's surface after the fall. It appeared possible that hydrogen representative of that in planetary space might be retained in the carbonaceous chondrites (a small group of meteorites—twenty-one known, which contain varying amounts of free carbon and organic matter), and an investigation of the deuterium–protium ratio in this group of meteorites was carried out by G. Boato[1]. Previously, I. Friedman[2] conducted an isotopic analysis of an iron meteorite (Canyon Diablo); but stressed that some fractionation may have occurred during the process of outgassing the sample.

In 1953, I described[3] experiments on the isolation and determination of protium and deuterium in iron meteorites and presented results for two meteorites. Since then a number of other meteorites have been examined by the same method.

The metal is oxidized by heating to 1,100° C. in a stream of pure oxygen gas, the water from hydrogen in the meteorite being collected in a cold trap at −70° C. When the oxidation is complete, any carbon dioxide in the cold trap is pumped away. The temperature of the trap is raised, and the water vapour is passed over zinc granules at 400° C. to regenerate hydrogen. The apparatus is so arranged that any unreacted water may be recycled and complete reaction assured. The hydrogen is compressed with a Toepler pump and its volume measured before isotopic analysis.

To obtain oxygen of the necessary purity for the oxidation, it is passed over a mixture of copper oxide and palladium asbestos at 700° C., the oxidized products of hydrogen-containing compounds being adsorbed on active charcoal at −185° C.

The isotopic composition is measured with a 6-in. radius 60°-deflexion mass spectrometer of the double collector type similar to that described by Nier[4]. The instrument is equipped with two capillary leaks and with magnetically operated valves permitting rapid change-over of the sample and a standard gas (see McKinney *et al.*[5]). Results are expressed as differences, δD per cent, between the deuterium concentration in the sample and standard. The relation between this difference and the absolute ratio is expressed by the equation

$$\delta D \text{ per cent} = \frac{D/H \text{ sample} - D/H \text{ standard}}{D/H \text{ standard}} \times 100$$

and the standard gas is hydrogen of Lake Michigan water, the absolute ratio of deuterium to hydrogen, D/H, being approximately 1/6,500. Compared to this standard, average sea water is + 4·5 per cent. The error in analysis (including deviations introduced during the conversion of water to hydrogen) is ± 0·4 per cent maximum. The results of the analysis of a number of iron meteorites are shown in Table 1.

Meteorites were prepared for analysis as follows. With a diamond wheel in a dental drill apparatus, superficial rust was removed. Where sufficient rust was available, it was collected and the deuterium and protium determined in exactly the same way as for the meteorites. Final traces of rust were removed by sandblasting, after which the metal was washed with carbon tetrachloride. The meteorite was placed in a surface-grinding machine and dry-ground until no original surface metal remained and the specimen was rectangular in form. The meteorite was again washed in carbon tetrachloride and transferred with forceps to a shaping machine where the metal was cut to suitably sized swarf. All parts of the shaping machine around the meteorite were shrouded in

Table 1

| Name | Class | Hydrogen (p.p.m.) | | δD per cent (average) | |
|---|---|---|---|---|---|
| Coahuila | *H* | | 0·7 | | — |
| Charcas | *Om* | | 3·5 | | − 8·5 |
| Canyon Diablo | *Og* | 4·4<br>5·5<br>4·8 | 4·9 | − 7·4<br>− 8·7<br>− 8·1 | − 8·1 |
| Staunton | *Om* | | 5·2 | | − 8·2 |
| Thunda | *Om* | | 6·0 | | — |
| Bethany | *Of* | | 6·9 | | − 9·7 |
| Cranbourne | *Og* | | 7·0 | | − 4·4 |
| Carbo | *Om* | | 9·3 | | − 6·9 |
| Tamarugal | *Om* | | 9·9 | | − 8·1 |
| Arispe | *Ogg* | | 9·9 | | − 9·7 |
| Cape York | *Om* | | 15·4 | | − 13·4 |
| Henbury | *Om* | 28·3<br>28·9<br>29·3 | 28·8 | − 9·1<br>− 8·5<br>− 10·6 | − 9·4 |
| Cosby's Creek | *Og* | | 33·4 | | − 9·7 |
| Toluca | *Om* | 18·0<br>29·8<br>54·4 | 33·1* | − 9·6<br>− 5·1<br>− 9·6 | − 7·1 |
| Mild Steel | | 3·9<br>3·5<br>3·7<br>3·8 | 3·7 | 47·5<br>52·5<br>47·5<br>45·8 | 48·3 |
| Average of meteorites | | | | | − 8·6 |

* Weighted average, see text

heavy aluminium foil which was previously washed with carbon tetrachloride. When about 10 gm. of metal had been cut, *all* cuttings were transferred to a clean bottle. If enough meteorite was available, the cutting process was repeated until a number of samples had been obtained.

During the cutting process, the turnings break into chips because of imperfections in the main body of the meteorite, and dark-coloured dust-like solid separates from the chips and falls to the bottom of the sample bottle. To obtain a representative sample of the whole meteorite it is necessary to collect the cuttings batch-wise as described, and to oxidize each sample as a whole.

In the case of Toluca, this was not done. All the cuttings were collected in a single bottle (26·9 gm.). The individual analyses of Toluca are shown in order in Table 1. The first two analyses are of 10-gm. lots of the turnings and the last analysis is of the 6·9-gm. residue in the sample bottle. It is apparent that the hydrogen is concentrated in the fine solid at the bottom of the same bottle. The difference in the deuterium analysis is not understood.

Table 2 shows the deuterium–protium analysis of surface rust from the meteorites from which a suitable sample was obtained.

It is clear that in general the hydrogen from the rust contains a distinctly higher proportion of deuterium than that in the metal. This, coupled with the fact that extreme care was taken to remove all rust—and, in fact, all superficial metal to an average depth of about 2 mm.—gives fair reason for believing the hydrogen from the samples to be that originally incorporated during the formation of the meteorites. It may be surmised that the hydrogen has been retained in the meteorite since it solidified and is representative of that in the parent body, at the time of solidification of the iron. It seems probable that the stony meteorites and irons were originally part of asteroids and that it was within such bodies that the separation of the phases occurred[6]. The age of two stony meteorites from recent argon–potassium measurements (Wasserburg and Hayden[7]) was found to be $4·7 \times 10^9$ years. This age is that of the solidification of the silicate, and it is probable that the iron also solidified about the same time, and that the hydrogen is of about this age. It is possibl that the irons are in two groups with hydroge contents of 0–10 and 25 p.p.m. (Table 1), althoug many more analyses would be necessary to establis this fully.

The amount of hydrogen found in irons is surprisingly high. The solubility of hydrogen at th melting point of iron is about 0·8 p.p.m. The hydrogen in the iron meteorites is therefore not simpl that in solution in the metal. It would appear tha the hydrogen is contained in solids which are presen in the minute irregular discontinuities throughout al the octahedrites examined. The experiments with Toluca meteorite suggest this. The substance i these discontinuities is thought to be sulphide an silicate not completely removed during the origina separation of the iron in the parent body, togethe with some carbides. It may be that this substanc also contains the large proportion of the uraniur found in iron meteorites by Prof. Paneth and hi co-workers[8]. Urey[9] has directed attention to the fac that the quantities of uranium found in the iron meteorites are distinctly higher than would be suggested from thermodynamic considerations of the distribution of uranium between metallic and oxide or silicate phases. Mr. O. Joensuu recently carried out spectrographic analysis of dust from fissures in Canyon Diablo meteorite, comparing this with metal chips from the same specimen. (The two can be separated moderately well by simply screening the whole sample of cut meteorite as it is obtained from the shaping machine.) He found 10 p.p.m. titanium in the metal and 300 p.p.m. in the fissure material. Uranium is not sufficiently abundant to permit spectrographic estimation, but would be expected to distribute itself between a metallic and oxide or sulphide phase in the same way as titanium[9].

In his study of deuterium in the carbonaceous chondrites, Boato[1b] attached special significance to the three results in which he found deuterium to be more than 25 per cent higher than in Lake Michigan water on the basis that such compositions lie outside the range of natural waters at present known. Since these experiments were made, a number of other facts have come to light which make this evidence less conclusive than was at first thought.

At the time of Dr. Boato's measurements, there was reason to believe that the carbonaceous chondrites might be the most primordial material of all the meteorites. Since then, Dr. Harold C. Urey and I have developed a method of measuring the concentration of certain minor elements in meteorites with a higher precision than was previously possible[10], and have estimated the sodium and potassium in carbonaceous and other chondrites. We have found a relatively great variation in the sodium and potassium in the carbonaceous chondrites. Dr. H. B. Wiik (private communication) has found this to be true for many other constituents also. We conclude that the carbonaceous chondrites have undergone chemical and/or thermal treatment at least as drastic

Table 2. DEUTERIUM CONCENTRATION IN HYDROGEN FROM RUST ON METEORITES

| Name | Hydrogen content (p.p.m.) | δD per cent |
|---|---|---|
| Arispe | 14,600 | − 13·9 |
| Coahuila | 5,300 | − 14·3 |
| Cranbourne | 11,500 | − 11·9 |
| Mount Joy | 19,700 | − 15·3 |
| Staunton | 12,400 | − 13·3 |
| Average | | − 13·7 |

Table 3

| Name | Total water (Wiik) | Total water (Boato) | Deuterium ($\delta D$ per cent) Boato |
|---|---|---|---|
| Orgueil | 19·7 | 11·0 | 20·0 |
| Ivuna | 18·6 | 12·0 | 35·0 |
| Harpura | 13·7 | 9·0 | − 2·3 |
| Meghei | 12·7 | 11·0 | − 5·8 |
| Nawapali | 16·4 | 12·0 | − 7·2 |
| Santa Cruz | 12·1 | 10·0 | − 0·7 |
| Bokkeveld | 15·1 | 10·5 | − 13·0 |
| Murray | 12·4 | 9·0 | 9·6 |
| Mokoia | 2·0 | 1·1 | 25·0 |
| Indarch | 1·1 | 1·0 | − 10·7 |

s that involved in the production of any of the ther groups of meteorites, and that the carbonaceous hondrites have a much more complex history than ve would expect of truly primordial material. The nexpected variability in this group of meteorites eaves us in great doubt at the moment, not only bout the place but also the time of origin of these. Under these conditions it becomes difficult to attach pecial significance to specific results.

In the course of complete analysis of the carbonaceous chondrites, Dr. Wiik has determined the otal water content, and I am greatly indebted to im for permission to quote his results prior to ublication. As shown in Table 3, his values are onsistently higher than those found by Dr. Boato. The reason for the divergence is not understood. There may be some significance in the fact that the greatest fractional divergence in water contents is associated with the deuterium concentrations more than 25 per cent higher than that of Lake Michigan water and to which Dr. Boato attaches greatest significance. J. Godfrey[11] has recently observed that when water of hydrated silicates is incompletely extracted, the deuterium is concentrated in the extracted water and *not* in the silicate, as would be expected in a simple vaporization process. It appears possible, then, that the high deuterium values obtained in Dr. Boato's experiments might be wholly or partly due to incomplete extraction, though it is difficult to see how this could have occurred.

In view of the variable composition of the carbonaceous chondrites and the doubt regarding their history and origin, there does not seem to be any simple way of weighting the results. Seven of the ten results have deuterium concentrations ($\delta D$ per cent) grouped between − 13·0 and + 9·6 (average − 4·7 per cent), and the average of all the values is + 5·8 per cent with respect to Lake Michigan water (+ 1·3 per cent with respect to average sea water).

In these circumstances it appears that the deuterium–protium ratio found in the iron meteorites (− 8·4 per cent with respect to Lake Michigan water or − 12·9 per cent compared to average sea water) may be the most reliable available to us. The comparative consistency of the isotopic composition of hydrogen in the iron meteorites is suggestive of a common origin, different from that which gave rise to the surface rust. If we now suppose that the hydrogen of the iron meteorites is representative of that at or about the time of the earth's formation, then the present oceans are somewhat more abundant in deuterium than the primordial water. This is what we should expect if the earth had at some time lost all its original water except that remaining in hydrated silicates, and that the present oceans represent water evolved from these silicates. Incompleteness of this process of ocean formation would give water enriched in deuterium with respect to that in primordial water, as we indeed find.

I am indebted to Mrs. Jeanne Ingersoll for her assistance in all the practical work reported. My thanks are due also to Dr. Wiik for permission to use his results prior to publication, to Mr. O. Joensuu for spectrographic analysis, and to Prof. Harold C. Urey for useful discussions, advice and helpful criticism.

[Feb. 4

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# CYTOCHROMES OF MICROSOMAL PARTICLES

## Cytochrome $b_5$ of Microsomes from Animal Tissues

A HÆMOCHROMOGEN, showing absorption bands at about 552 and 525 mμ, was observed in 1951 in microsomal particles from cow's milk[1,2]. As part of a general programme of investigation of the nature and properties of microsomal particles, this hæmochromogen has now been studied in greater detail in microsomes, isolated essentially as previously described[2,3], from the mammary gland and milk of the same cow and from calf intestinal mucosa.

Thick pastes of the buff-coloured microsomes from mammary gland and intestinal mucosa show no absorption bands in the visible region when observed with a low-dispersion micro-spectroscope. After reduction with sodium dithionite, strong absorption bands appear in both preparations at about 560 and 525 mμ, as measured with a Hartridge reversion spectroscope. The pink-coloured microsomes as isolated from milk[2] show weak absorption bands in approximately the same positions, and these are only slightly intensified on addition of sodium dithionite. The lower readings previously reported[1,2] for the α-band may have been due to the presence of some adsorbed cytochrome *c* in the original preparation of milk microsomes.

The identity of the pyridine-hæmochromogen of the microsomal pigment with that formed from pure protohæm indicates that protohæm is the prosthetic group. This observation, together with the similarity in the positions of the visible absorption bands with those of cytochromes *b*, $b_1$ and $b_2$, which were simultaneously being studied in this laboratory, led us in 1953 to designate the microsomal hæmochromogen as cytochrome $b_5$[4]. (The normal sequence in the nomenclature of cytochromes of the *b* group was interrupted when the term 'cytochrome $b_4$' was given to a bacterial pigment[5] which appears to be

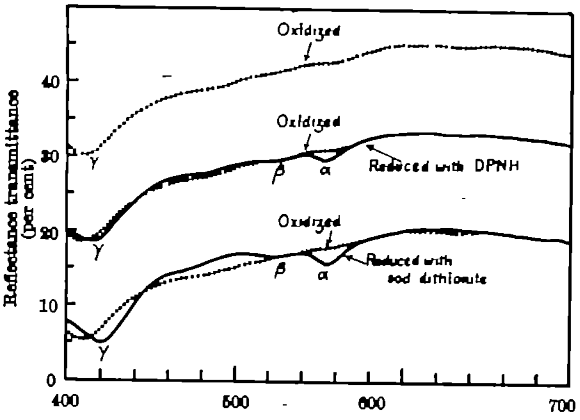

Fig. 1. Absorption spectrum of reflected light from a thick paste of microsomes from mammary gland

more closely related to cytochrome $c$ than to cytochrome $b$. A component of plant chloroplasts has now been described as cytochrome $b_6$ [6].)

Using a specially designed recording spectrophotometer, Dr. F. Moss and Dr. R. G. Giovanelli kindly analysed the spectrum of the reflected light from mammary gland microsomes, as shown in Fig. 1. The bands of cytochrome $b_5$ appear as follows: oxidized, general absorption about 555 mμ and Soret at 412 mμ; reduced, 557 mμ (α), 526 mμ (β) and 421 mμ (γ or Soret).

In 1951 Kun[7] isolated from rat liver a pigment closely resembling cytochrome $b_5$ in absorption spectrum and showed that it was partly reduced by reduced coenzymes I and II (reduced di- and triphosphopyridine nucleotide). The relationship of cytochrome $b_5$ to the oxidases of these coenzymes and to their cytochrome $c$ reductase activities of microsomes was therefore examined.

When about 0·5 μmole of reduced coenzyme I or II is added to about 0·5 ml. of a thick suspension of mammary gland or intestinal microsomes, the α- and β-bands of reduced cytochrome $b_5$ immediately appear. They rapidly disappear in the presence of air due to oxidation, but reappear on addition of further substrate. The process may be repeated several times. If oxygen is excluded from the system, the cytochrome remains reduced. Fig. 1 shows that, under aerobic conditions, cytochrome $b_5$ is only partly reduced by excess reduced coenzyme I, thus indicating the rapid oxidation of the reduced cytochrome by oxygen, possibly due to enzymic catalysis. Oxidation of reduced cytochrome $b_5$ is not inhibited by potassium cyanide ($10^{-3}$ $M$).

The addition of oxidized cytochrome $c$ to microsomes reduced with reduced coenzyme I causes an immediate reduction of the cytochrome $c$. Thus reduced cytochrome $b_5$ reacts, directly or indirectly, with either cytochrome $c$ or oxygen. Table 1 shows that the reduced coenzyme I–cytochrome $c$ reductase activity of milk, mammary gland and intestinal microsomes is closely related to the concentration of cytochrome $b_5$. Incubation of microsomes from mammary gland in milk serum at 38° for 10 hr. causes a marked fall in the reductase activity to that typical of the microsomes from milk. There appears to be a corresponding decline in the cytochrome $b_5$ concentration. The rates of reactions with reduced coenzymes I and II as substrates are substantially the same in intestinal, and presumably also in gland, microsomes. As shown in Table 2, the reduced coenzyme I–cytochrome $c$ reductase activity of microsomes is only slightly inhibited by antimycin $A$.

Intestinal microsomes show a significant cytochrome $c$ oxidase activity which is almost completely inhibited by $10^{-3}$ $M$ potassium cyanide (Table 2). The dithionite-reduced microsomes show a very weak absorption band at approximately 604 mμ, presumably due to cytochromes $a + a_3$, but they have almost negligible succinic dehydrogenase activity. The presence of cytochrome $c$ oxidase implies a cyanide-sensitive reduced coenzyme I–oxidase system. However, no cytochrome $c$ could be detected spectroscopically in either mammary gland or intestinal microsomes. The cyanide-resistant cytochrome $b_5$ oxidase system may provide an alternative pathway from the cytochrome $c$ oxidase, leading to production of energy for synthetic processes catalysed by microsomes.

These results indicate that cytochrome $b_5$ is intimately associated with the reduced coenzyme I (and II)–cytochrome $c$ reductase and reduced coenzyme I (and II)–oxidase activities of microsomes. In this laboratory it has already been shown that crystalline cytochrome $b_2$ from yeast is a flavohæmoprotein having lactic dehydrogenase activity[8]. Cytochrome $b_5$ appears to bear a similar relationship to reduced coenzyme I (and II)–cytochrome $c$ reductase as cytochrome $b_2$ bears to yeast lactic dehydrogenase (lactic-cytochrome $c$ reductase) activity. It is very probable that a flavin or similar moiety mediates the reduction of the hæm of cytochrome $b_5$ by the substrate, as in the case of cyto-

Table 1. COMPARATIVE PROPERTIES OF MICROSOMES FROM INTESTINAL MUCOSA, MAMMARY GLAND AND MILK

| Source of microsomes | DPNH–Cyt. $c$ reductase activity | Cytochrome $b_5$ concentration | Reductase activity / Cyt. $b_5$ concentration |
|---|---|---|---|
| Intestine | 98 | 3·7 | 26 |
| Mammary gland | 53 | 1·8 | 29 |
| Milk | 0·9 | Less than 0·05 | — |

Reductase activities, determined as for Table 2, are expressed as μmoles of cytochrome $c$ reduced/hr./mgm. total nitrogen. Cytochrome $b_5$ concentration is expressed as μmoles hæm/gm. total nitrogen. This was estimated by matching the α-band of the reduced compound with that of a standard preparation of globin hæmochromogen, using a molecular extinction coefficient of $30 \times 10^3$ for the reduced compound.

Table 2. ENZYMIC ACTIVITIES OF MICROSOMES FROM COW MAMMARY GLAND AND CALF INTESTINAL MUCOSA

| Source of microsomes | Substrate | Acceptor | Activity | | |
|---|---|---|---|---|---|
| | | | Control | With antimycin $A$ | With pot. cyanide |
| Cow mammary gland | DPNH | oxidized cyt. $c$ | 26·3 | 23·6 | — |
| Calf intestine mucosa | DPNH | oxidized cyt. $c$ | 49·2 | 40·0 | — |
| | TPNH | oxidized cyt. $c$ | 28·7 | 24·2 | — |
| | Reduced cyt. $c$ | oxygen (air) | 6·7 | — | 0 |
| | DPNH | oxygen (air) | 0·7 | — | 0·6 |

Activities, which were estimated spectrophotometrically, are expressed as μmoles substrate utilized/hour/mgm. nitrogen, assuming that 2 moles of reduced cytochrome $c$ are equivalent to 1 mole of reduced diphosphopyridine nucleotide. For determining reductase activities, the final concentrations of reactants were: oxidized cytochrome $c$, $5 \times 10^{-5}$ $M$; DPNH (or TPNH) approx. $3 \times 10^{-4}$ $M$; potassium phosphate buffer, $5 \times 10^{-2}$ $M$, pH 7·4; potassium cyanide, $10^{-3}$ $M$; and antimycin $A$ (where added), 3 μgm./ml. For determining oxidase activities they were: reduced cytochrome $c$, $5 \times 10^{-5}$ $M$, or DPNH, $1 \times 10^{-4}$ $M$; potassium phosphate buffer, $5 \times 10^{-2}$ $M$, pH 7·4; and potassium cyanide (where added), $10^{-3}$ $M$.

hrome $b_5$. This is seen from Fig. 1, which shows hat reduced coenzyme I and sodium dithionite both ause reduction of a component absorbing in the egion of 460–480 mμ in the oxidized state, presumbly a flavin group. Further work is being carried ut to establish whether this and the hæm group are n different proteins or attached to the one protein, s in the case of cytochrome $b_2$ [3].

Cytochrome $b_5$ of cow mammary gland and calf ntestinal mucosa appears to be very similar to, if not dentical with, a cytochrome in liver described by Kun[7], alled cytochrome $b'$ by Yoshikawa[9] and cytochrome m by Strittmatter and Ball[10,11], who recognized its nicrosomal localization. The name 'cytochrome $b_5$' as independently been given to this liver hæmohromogen[12] as well as to a similar pigment in the nidgut of *Cecropia* larvæ[13]. The recent publication f the latter papers[11–13] has prompted us to make n early report of our independent investigations. Whether the cytochrome $b_5$ components of cow nammary gland, calf intestine, *Cecropia* midgut and at liver are identical can only be established by urification studies. The microsomal-bound alkaline hosphatases of cow mammary gland and calf ntestinal mucosa, for example, have similar enzymic pecificity and action but are, in fact, different proteins[1,14].

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## Cytochrome $b_3$ of Microsomes from Plant Tissues

THE microsomal fraction isolated by differential centrifuging from homogenates of white petiole of silver beet (*Beta vulgaris*) appears as a yellow-coloured pellet, as distinct from the buff-coloured mitochondrial fraction. When examined with a low-dispersion micro-spectroscope, the microsome pellet shows a broad absorption band in the blue (485–500 mμ) but no other bands in the visible region. However, after reduction with sodium dithionite, strong absorption bands appear at 560 and approximately 525 mμ, as measured with a Hartridge reversion micro-spectroscope. The α-band (560 mμ) is very sharp but shows an intensification toward the red end, suggesting an asymmetrical absorption band. The band at 485–500 mμ does not change on dithionite treatment. Microsomes isolated from onion bulb and from the spadix of *Arum* species show essentially the same absorption spectrum.

The absorption bands of the reduced compound are close to those of cytochromes $b$, $b_1$ and $b_5$. Moreover, the pyridine hæmochromogen of the microsomal pigment appears to be identical with that from pure protohæm, suggesting that protohæm is the prosthetic group. These facts indicate that the microsomal pigment is a cytochrome of the $b$ group. Table 1 compares the properties of this cytochrome with those previously described for cytochrome $b_3$, a pigment recognized in plant tissues by Hill and Scarisbrick[1]. There is reasonable agreement in properties, and therefore the microsomal cytochrome is referred to as cytochrome $b_3$. While it appears that microsomal cytochrome $b_3$ is very similar to the cytochrome $b_3$ of Hill and Scarisbrick, identity can only be established by purification studies.

Table 1. PROPERTIES OF CYTOCHROME $b_3$

| | Cytochrome $b_3$ of Hill and Scarisbrick (ref. 1) | Cytochrome $b_3$ of microsomes |
|---|---|---|
| Source | 'Soluble' extracts of growing tips of broad bean, cotyledons of broad bean and potato tubers | Microsome fraction sedimented from homogenates of petiole of silver beet, onion apical stem and spadix of *Arum* species |
| Absorption bands of reduced compound | 558·6 mμ to 559·7 mμ (α-band) 529·3 (β-band) (Soret band not determined) | 559·5 mμ (α-band) approx. 525 mμ (β-band) 425 mμ (Soret band) |
| Reaction of reduced compound with air | Autoxidizable | Rapidly oxidized |
| Effect of carbon monoxide | Does not combine with reduced compound | Does not combine with reduced compound |
| Absorption bands of pyridine hæmochromogen | | Broad bands at about 557 mμ (α) and 530 mμ (β) |
| Effect of ethanol and acetone at room temperature | Rapidly denatured | Slowly destroyed |

Cytochrome $b_3$ of silver beet petiole and onion bulb is localized entirely in the microsome fraction. It represents about 10 per cent of the total hæm compounds of the petiole homogenate. Petiole microsomes contain about 1·5 μmoles hæm per gm. nitrogen. No detectable amount of cytochrome $b_3$ occurs either in the mitochondria or in the supernatant remaining after centrifuging beet or onion homogenates at 50,000 $g$ for 1–2 hr. In contrast, Hill and Scarisbrick[1] found cytochrome $b_3$ in solution in extracts of leaves of broad beans and other plants. Since these workers held the tissue dispersions for about twelve hours at room temperature in order to clarify them, it is probable that the cytochrome was released from the microsomes by autolysis. Autolysis liberates other bound enzymes, such as alkaline phosphatase, for example, from microsomes of animal tissues[2]. Moreover, when a preparation from silver beet leaf and petiole was treated as described by Hill and Scarisbrick[1], the fraction obtained between 50 and 100 per cent saturation with ammonium sulphate contained both cytochromes $c$ and $b_3$. Neither of these cytochromes occurs in solution in dispersions of fresh tissue.

The spectrum of the reflected light from a pellet of microsomes from silver beet petiole was kindly determined by Dr. F. Moss and Dr. R. G. Giovanelli, using a special recording spectrophotometer, and is shown as Fig. 1. When reduced with dithionite, maxima appear at 676, 560, 482, 444 and 425 mμ. It is considered that the peaks at 560 (α) and 425 mμ (γ or Soret) are those of cytochrome $b_3$, the β-band (at approximately 525 mμ) not being detected. The

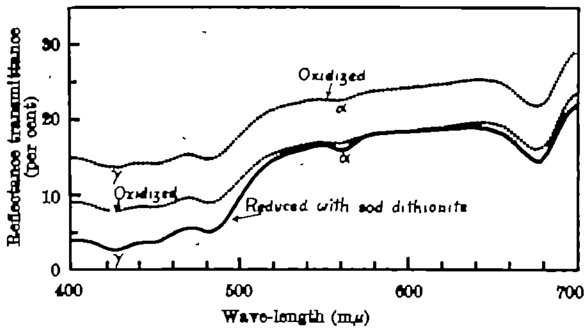

Fig. 1. Absorption spectrum of reflected light from a thick paste of microsomes from beet petiole. The preparation contained a small residual amount of cysteine (from the dispersion medium). This caused partial reduction as shown in the 'oxidized' curve. Addition of reduced coenzyme I caused no significant change in the absorption spectrum

peak at 444 mμ is possibly the Soret band of cytochrome $a_3$, especially since some preparations of beet microsomes in the reduced state show a very weak band at about 605 mμ (probably due to cytochromes $a$ and $a_3$). The broad band with a peak at 482 mμ is that referred to previously as observed spectroscopically. The nature of the compound giving rise to this peak is not known. The band at 676 mμ may be due to slight contamination of the preparation with chlorophyll. Silver beet microsomes show no detectable peroxidase activity.

In view of the marked cytochrome $c$ reductase activity of the plant microsomes with reduced coenzyme I (DPNH) and reduced coenzyme II (TPNH) as substrates, it seemed possible that reduced coenzyme I might reduce cytochrome $b_3$. Under aerobic conditions, addition of quite large amounts of reduced coenzyme I to the microsomal pellet caused no appreciable reduction of cytochrome $b_3$. However, when either reduced coenzyme I or II was added under strictly anaerobic conditions, there was rapid, and apparently complete, reduction of cytochrome $b_3$. The bands of the cytochrome disappeared immediately on exposure to air.

The very rapid rate of oxidation of reduced cytochrome $b_3$ by air suggests that this is unlikely to be due merely to autoxidation, but that the reaction may be enzymically catalysed by a cytochrome $b_3$ oxidase.

The microsomes contain no detectable amount of cytochrome $c$. However, when heart muscle cytochrome $c$ is added to the microsome suspension followed by reduced coenzyme I, the bands of reduced cytochrome $c$ rapidly appear. This occurs under aerobic conditions. These observations suggest that cytochrome $b_3$ may be related to the reduced coenzyme I and II cytochrome $c$ reductase and to the reduced coenzyme I and II oxidase activities of plant microsomes.

Hill and Scarisbrick[1] observed that cytochrome $b_3$ of leaves was reduced in light and oxidized in the dark. Since there is accumulating evidence that coenzymes I (and II) are reduced by plant chloroplasts in the presence of light[2], this observation is consistent with the finding that reduced coenzymes I and II are substrates of cytochrome $b_3$. Cytochrome $b_3$ of plant microsomes thus appears to be the analogous hæmochromogen to cytochrome $b_5$ of microsomes from animal tissues[4]. Moreover, the ratio of the reduced coenzyme I cytochrome $c$ reductase activity (about 26 μmoles cytochrome $c$ reduced/hr./mgm. nitrogen) to the concentration of cytochrome $b_3$ (approximately 1·5 μmoles hæm/gm. nitrogen) is 17, and thus of a similar order to the ratio of the reductase activity to the cytochrome $b_5$ concentration in animal microsomes[4]. As in the case of cytochrome $b_5$, it seems likely that a flavin or similar moiety may mediate the reduction of the hæm group of cytochrome $b_3$ by reduced coenzyme I. It is hoped to establish this by purification studies, particularly as it has been found in this laboratory that yeast cytochrome $b_2$ is a flavohæmoprotein[5].

Antimycin *A*, a powerful inhibitor of reduced coenzyme I cytochrome $c$ reductase activity in animal tissues[6], fails to inhibit this activity in microsomes from silver beet petiole, as shown in Table 2. Table 2 also indicates that the cytochrome $c$ reductase activity of beet microsomes is substantially the same with either reduced coenzyme I or II.

Table 2. REDUCTASE AND OXIDASE ACTIVITIES OF MICROSOMES FROM THE PETIOLE OF SILVER BEET

| Exp. | Fraction | Enzymic activity | | |
|---|---|---|---|---|
| 1 | Microsomes | DPNH–cyt. $c$ reductase | Control | 13 |
| | | | Antimycin *A* | 14 |
| | Mitochondria | DPNH–cyt. $c$ reductase | Control | 4 5 |
| 2 | Microsomes | DPNH–cyt. $c$ reductase | Control | 10 |
| | | TPNH–cyt. $c$ reductase | Control | 18 |
| | | | Antimycin *A* | 14 |
| 3 | Microsomes | DPNH–cyt. $c$ reductase | Control | 11 |
| | | DPNH–oxidase | Control | 8·0 |
| | | | Cyanide | 8·5 |
| | | TPNH–oxidase | Control | 11 |
| | | | Cyanide | 11 |

Activities, which were estimated spectrophotometrically, are expressed as μmoles substrate utilized/hr./mgm. nitrogen, assuming 2 moles of reduced cytochrome $c$ are equivalent to 1 mole of reduced coenzyme I. For determining reductase activities (at 550 mμ) the final concentrations of reactants were: oxidized cytochrome $c$, 5 × $10^{-5}$ *M*; reduced coenzyme I (or II), 3 × $10^{-4}$ *M*; phosphate buffer, 0 07 *M*, *p*H 7 4; potassium cyanide (where added), $10^{-3}$ *M*; and antimycin *A* (where added), 6 μgm./ml. For determining oxidase activities (at 340 mμ) the same concentrations of reactants were used, omitting cytochrome $c$.

Microsomes from silver beet show only slight cytochrome $c$ oxidase activity, and the reduced coenzyme I oxidase is not inhibited by potassium cyanide (Table 2). The microsomes thus could provide an antimycin *A*-resistant cyanide-resistant pathway for oxidation of reduced coenzyme I (and II). It is possible that this pathway may provide energy for the synthetic processes catalysed by microsomes. Certain plant tissues are known to have a cyanide-resistant 'basal' respiration, as well as a cyanide-sensitive 'salt-linked' respiration[7]. It may well be that microsomal cytochrome $b_3$ and the associated reduced coenzyme I oxidase system are involved in the pathway for 'basal' respiration in such tissues. The spadix of *Arum* species, in particular, has a very active cyanide-resistant respiration[8]. Preliminary examination indicates that this tissue has quite a high concentration of cytochrome $b_3$. Further studies on the relation of cytochrome $b_3$ to plant respiration are in progress.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Genetical Effects of Radiation from Products of Nuclear Explosions

SIR JOHN COCKCROFT[1] has given a reassuring answer to the question of the genetic hazards of radiation from the products of nuclear and thermonuclear explosions disseminated to large distances. I think that he, or his biological advisers, have greatly over-estimated the simplicity of the problem. It can be attacked by several different methods. First we can fix a rough upper bound to the effect.

If an average human being has received 3 roentgens before becoming a parent, then a mean extra dose of $x$ roentgens spread over the world's population will increase the number of mutations arising in the next generation as the results of radiation by $\frac{1}{3}x$, provided $x$ is small.

In *Drosophila melanogaster* almost all mutations arise by a process with a temperature coefficient, and therefore presumably chemical. Isotopically labelled atoms are rarely incorporated into deoxyribonucleic acid except when it is replicated. This mutational process therefore probably occurs only or mainly during gene replication. Man has about twice as many nuclear replications per life-cycle as *Drosophila*, and a somewhat higher temperature. The chemical component in human mutation is therefore likely to be of the order of ten times that of *Drosophila* per generation. On the other hand, a human generation is about 1,000 times longer than a *Drosophila melanogaster* generation, so the component due to radiation may be expected to be about 1,000 times greater in man than in *Drosophila*. Man may have become adapted to longer generations by reducing mutation-rates; but he may also have a larger number of mutable genes. On the basis of such arguments, I suggested[2] that "it is quite possible that radiation may account for most human mutation". If so, the dose of radiation needed to double the human mutation-rates is a little more than 3 r. per generation, and not 50 r. as Cockcroft suggests. In fact, the effect of radiation is about ten times as serious as he believes.

It is also more serious for another reason. Cockcroft points out that since most British people spend most of their time indoors, the effective dose of radiation received by them is reduced to about a tenth of the outdoor dose. However, about half the human race is engaged in outdoor work, and most of the population in such countries as India live in very flimsy houses. Allowance for this fact raises the expected effect by a factor of two or three.

We do not know how much of human mortality is due to the action of natural selection in eliminating mutant genes. Haldane's[3] suggested figure of 10 per cent may be a good deal too high. But if this figure were accepted, an average dosage for the world of 0·01 r. (corresponding to Cockcroft's figure of 0·003 r. for Britain) could be responsible for about one three-thousandth of the $10^9$ or so deaths which occur in a generation, say, 300,000 deaths transferred from the ages later than the mean age of parenthood to the ages before it.

This figure is probably an upper bound. We can obtain an approximate lower bound as follows. Suppose men to have no more radiosensitive genes than *Drosophila*, as against the usual estimate of five to ten times as many, then we expect one lethal and two to four sublethal mutations per 10,000 r. The latter, which cause invalidism and death after some years of life, are the more serious. If they are all fully recessive, which again is optimistic, this implies about 2 deaths per 10,000 r., or about 2,000 deaths from the $10^7$ r. received by a generation of $10^9$ people receiving 0·01 r. on an average.

The true number is probably somewhere between 2,000 and 300,000. I doubt whether the experiments carried out on mice up to now allow of any great precision. Those whose results have so far been published were not so designed as to allow a calculation of the rate of production of lethal mutations; and had they been so designed, the argument from mice to men is of dubious validity. It may be possible to validate this argument by experiments on human and mouse tissue cultures.

The problem is not insoluble. The figures given above could, I think, be improved. I have, however, deliberately used estimates made before the question of the genetic effects of experimental explosions was raised. Estimates made later may have been influenced by conscious or unconscious political or ethical bias. Research on this problem requires extremely careful planning, including the realization that apparently hopeful projects may prove useless.

Until the results of such research have been published, many biologists will find it hard to share Sir John Cockcroft's optimism.

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IN my lecture to the Parliamentary and Scientific Committee, I said that the Oak Ridge experiments suggested a doubling dose of about 50 r. for mice, but that the extrapolation to men was obviously an uncertain one. Dr. H. J. Müller has used a figure of 80 r. with similar qualifications.

I also emphasized the uncertainty of the biological data and the need for long-term genetic studies.

Since a Committee of the Medical Research Council has been appointed to study these problems, I will not pursue the matter further.

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## Insulin Activity of Cord Plasma

IT has been shown by histological methods[1] that the islets of Langerhans form a much larger proportion of the pancreatic tissue in fœtuses and newborn infants than they do in adults, and Fisher and Scott[2] extracted relatively more insulin from the pancreas of the fœtal and newborn calf than from the same organ in later life. Hartmann and Jaudon[3] found that the injection of insulin into newborn human infants led to a moderate fall of blood sugar, and Villee[4] has stated that the fœtal tissues of man respond *in vitro*, like those of adults, to the presence of added insulin by an increased utilization and oxidation of glucose. The newborn infant, therefore, would appear to have abundant islet tissue and to respond normally to insulin; and in keeping with all this is the well-known fact that newborn infants may have very low fasting blood-sugars[5].

Newborn rats and cats, however, and fœtal dogs, sheep and goats have been shown to exhibit relatively little fall in blood sugar and to survive doses of insulin which were many times those lethal for adults of the same species[6]. An insulin inhibitor was invoked to explain this. The difficulty of reconciling these seemingly contradictory findings led us to make a new approach and to try to obtain further evidence by an altogether different method.

We have accordingly compared directly the insulin activity of cord plasma, and maternal plasma withdrawn at the same time, by a method based upon the glucose uptake of the isolated rat diaphragm[7,8]. The procedure described by one of us (P. J. R.) was followed exactly[8]. Five mothers and infants were investigated, and they were all clinically normal; the results are given in Table 1. Maternal plasma, like the plasma of adult people not recently pregnant, exhibited highly significant insulin activity. No insulin activity could be detected in the cord plasma, and this difference between cord and maternal plasma was highly significant.

Table 1. INFLUENCE OF CORD AND MATERNAL PLASMA UPON THE GLUCOSE UPTAKE OF THE ISOLATED RAT DIAPHRAGM

| Incubation medium | No. of patients | Glucose uptake (mgm. glucose/gm. of wet diaphragm/hr.) Mean ± S.E. of mean |
|---|---|---|
| Buffer | – | (a) 2·43 ± 0·13 (27) |
| Buffer + cord plasma (25 per cent plasma) | 5 | (b) 2·30 ± 0·11 (28) |
| Buffer + maternal plasma (25 per cent plasma) | 5 | (c) 2·99 ± 0·11 (28) |

$t$ for (a) v. (b) is 0·80, whence $P > 0·50$
$t$ for (a) v. (c) is 3·62, whence $P < 0·001$
$t$ for (b) v. (c) is 4·60, whence $P < 0·001$

Figures in parentheses are total number of hemidiaphragms. Samples of cord and maternal plasma taken at the same time.

It has yet to be shown unequivocally that the rat diaphragm technique detects only insulin in plasma[9]. Nevertheless, these results suggest the possibility that the cord plasma contained less insulin than the maternal plasma. If that be the case, it looks as though the islets, although numerous, are not secreting enough insulin before birth to sustain a level of plasma insulin comparable to that found in the mother.

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## Deoxyribonucleic Acid Content of Nuclei in Tail Mesenchyme of *Rana pipiens* Tadpoles

LINDAHL[1] has suggested the occurrence of reduction division of chromosomes in the micromeres of the 16-cell stage in the embryos of two species of sea-urchins. This interpretation was based on the observation of haploid chromosome counts in anaphases and early telophases, while metaphase counts showed diploid numbers. Afterwards one of us[2] reported haploid counts from mesenchyme cells of the tail in *Rana pipiens* tadpoles. These were observed in whole mounts of stained tail tips, and occurred in stages resembling prometaphases. Other evidence, however, fails to support the suggestion of somatic reduction in the mesenchyme cells of these forms. Makino and Alfert[3] failed to find haploid numbers in micromere divisions of the sea urchin *Strongylocentrotus purpuratus*, from California; while the cytophotometric measurements of deoxyribonucleic acid in developmental stages of the sea urchin *Lytechinus* made by McMaster[4] do not reveal reduction of chromatin in the micromeres or their derivatives. In *Rana pipiens*, the cytophotometric deoxyribonucleic acid measurements of Moore[5] show the normal diploid chromatin condition in mesodermal elements.

Another possible explanation of the cytological findings of haploidy is suggested by the recent observations of Boss[6]. In cultured cells of the newt, pairing of chromosomes takes place during the anaphase movement, giving rise to apparently haploid anaphase groups.

In order to determine whether the amount of deoxyribonucleic acid per cell in the tail mesenchyme corresponds to a haploid or a diploid condition, material comparable to that examined by Green[2] has been studied by cytophotometric measurement of Feulgen-stained interphase nuclei. Material for measurement of the Feulgen reaction was prepared by the technique of freezing substitution[7]; tail tips were frozen at – 78° C. in ethyl alcohol, and substituted with the same solvent at – 30° C. After post-fixation at 60° C. in 95 per cent ethyl alcohol, the whole tips were stained with the Feulgen reaction, using 12-min. hydrolysis in $N$ hydrochloric acid at 60° C. After bleaching and rinsing in water, the tips were softened in 25 per cent acetic acid, and squashed under siliconed coverslips. The coverslips were removed from the preparations by the technique of Rudkin *et al.*[8]. After clearing in xylol, the preparations were mounted in oil of closely matching refractive index (R. P. Cargille Co., N.Y.) as determined by minimal dark-field scatter.

In preparations of this type, the interphase nuclei are greatly flattened, and circular to elliptical in outline. Light absorption by the dye was measured by use of a cytophotometer similar to that described by Pollister[9]. The amount of dye per nucleus was calculated as the product of the extinction at 546 mμ and the area of the nucleus in square microns (total extinction). Absorption measurements were made of a 'plug' just smaller than the smaller whole axis of the nucleus; the area was computed from the two axes measured in the image plane. The distribution of absorbing material in preparations of this type is sufficiently uniform to ensure that errors due to this cause are small, as determined by use of a photographic scanning technique[9]. Since high extinction values were encountered, glare error was minimized by illumination of an area of minimal diameter in

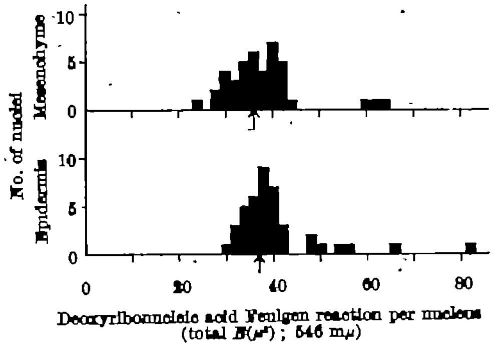

Fig. 1. Arrows indicate means at 35·74 (above) and 36·95 (below)

he plane of the object (10 per cent greater than the aximum plug size). Experiments with opaque bjects of appropriate size indicated a maximum lare intensity 1 per cent of the incident intensity n the image plane.

The frequency distributions of deoxyribonucleic cid contents for groups of mesenchyme and epi- ermal nuclei are shown in Fig. 1. The means of the wo populations do not differ significantly. Scattered alues with high deoxyribonucleic acid content are onsidered to arise from cells in which synthesis of eoxyribonucleic acid is occurring prior to mitosis. he apparent concentration of deoxyribonucleic acid n the mesenchyme nuclei is, however, markedly igher than in the epidermal nuclei. As may be seen rom Fig. 2, the relation between concentration extinction) and area in the squashed cells falls along he calculated curve $E.A = k$, where $k$ is the observed ean total extinction. Scattered values above the urve approach $E.A = 2k$ as a limit. Thus the ifference in staining of nuclei of the two types of ell is to be accounted for purely on the basis of the ilution of a constant amount of deoxyribonucleic cid.

Cytological examination of squash preparations hows epidermal metaphase figures that are large and well spread, and that yield the diploid number of hromosomes, namely, 26. Metaphase and anaphase figures from the mesoderm are small and tend to remain clumped. No anaphase counts have been feasible. Metaphase plates which it has been possible to analyse show 26 chromosomes. Occasional mesodermal figures of intermediate size show a tendency to somatic pairing.

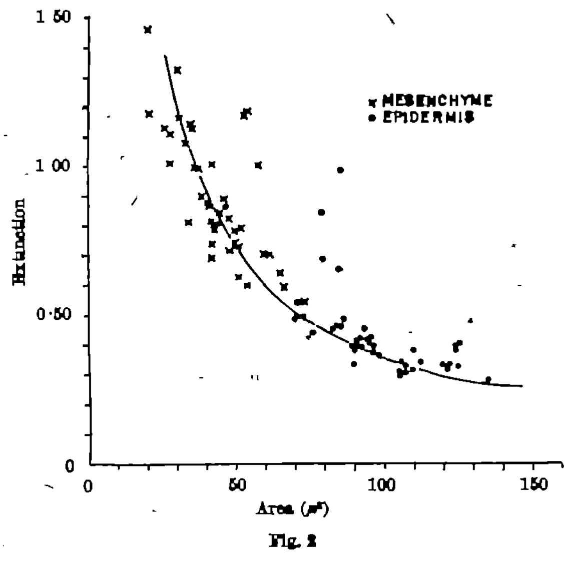

Fig. 2

The appearance of haploidy in the 'prometaphases' in whole mounts must be regarded as a transient phenomenon, rather than as evidence of somatic reduction. Since anaphases here also show haploid counts[9], it is possible that pairing of the type observed by Boss occurs. It should be noted that instances of homologous synaptic pairing in prophase have been described by Duryee and Doherty[10] in cultured kidney and adenocarcinoma cells of *Rana pipiens*. A paired orientation of the chromosomes persisting through the interphase may account for an apparent haploidy in the prophase stages of the succeeding division.

This work was supported by a research grant (C1613) to Dr. Jack Schultz from the National Cancer Institute of the National Institutes of Health, Public Health Service, and by an institutional grant from the American Cancer Society. We would like to acknowledge the help of Constance B. Herdeck in making the cytological preparations.

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## A Source of Ammonia and Changes of Protein Structure in the Rat Brain during Physical Exertion

WE have already shown that functional activity of the brain associated with diffuse neuromuscular activity (physical exertion by swimming) influences numerous biochemical processes in the brain. Certain metabolic processes in the brain are probably used for meeting the energy requirements of the nervous tissue during increased functional activity of the brain connected with the carrying out of physical exertion. This is shown by the fall of the actual concentration of glycogen, glucose and lactic acid in the brain[1]. Since, during increased functional activity of the brain, an increased amount of ammonia is produced, which is toxic to the nervous tissue, processes of detoxication of ammonia bound by free glutamic acid to free glutamine occur in the brain[2]. An extensive literature shows that functional activity and various modes of excitement of nervous tissue are always connected with the formation of ammonia[3]. The sources of ammonia, and the biochemical and physiological significance of the process of ammonia formation in nervous tissue during functional activity, however, have not been definitely established. The present investigation was undertaken to contribute to the clarification of this question.

Seventy-two rats weighing 150–200 gm., in six experimental series, were used. Each series contained

Table 1. Influence of Physical Exertion on Concentration of Amido-Nitrogen in the Protein Fraction of Rat Brain. (Each figure represents the average of six brains. Results are given in µmole/gm. fresh weight)

| Series | Normal | After 4½ hr. swimming | Difference |
|---|---|---|---|
| 1 | 92·4 | 89·0 | − 3·4 |
| 2 | 92·7 | 81·7 | −11·0 |
| 3 | 106·9 | 98·2 | − 8·7 |
| 4 | 82·9 | 75·8 | − 7·1 |
| 5 | 92·2 | 87·4 | − 4·8 |
| 6 | 104·9 | 99·9 | − 5·0 |
|  | 95·3 | 88·7 | − 6·6 ± 1·2 |

$P < 0 \cdot 01$

twelve rats of approximately the same weight and age, which were divided into two groups of six animals each. One group swam for 4½ hr., under conditions previously described[1,2]. Swimming served as a model of diffuse neuromuscular activity. After cessation of swimming, the rats were thrown into liquid air and frozen *in vivo*. The frozen brains were taken out, homogenized at low temperature by crushing into fine powder and put into a weighed flask containing 100 ml. of 12 per cent trichloracetic acid. All six brains of animals from one experimental group were put in a single flask. The brains of the control animals were put in a second flask. The fresh weight of the brains was established by differential weighing.

The brain tissue was extracted twice with trichloracetic acid, then with water, and afterwards the extraction of lipids followed, which was carried out successively with 30 volumes of acetone and then alcohol–ether mixture (3 : 1 v./v.) and chloroform–methanol mixture (2 : 1 v./v.), on a water-bath under reflux. The brain tissue, freed of the acid-soluble fraction and lipids, was hydrolysed for 24 hr. with 30 vol. of 20 per cent hydrochloric acid[4]. In the hydrolysate, the total nitrogen and amido-nitrogen of the protein fraction in the brain were determined by Dawson's method[4] with small modifications. From Table 1 it can be seen that in each experimental series the concentration of amido-nitrogen in the protein fraction of rat brain is always lower in the group of rats that swam. The average decrease of amido-nitrogen is $-6 \cdot 6 \pm 1 \cdot 2$ µmole/gm. ($P < 0 \cdot 01$).

This decrease of amido-nitrogen in the protein fraction of the brain is specific; that is, it is not caused by general degradation of brain proteins, since we did not observe in the protein fraction of the brain any statistically significant changes of the Kjeldahl-nitrogen during the physiological process described. In accordance with this, we observed a statistically significant increase of the ratio of Kjeldahl-nitrogen to amido-nitrogen in the protein fraction of rat brain. Whereas the normal ratio of Kjeldahl-nitrogen to amido-nitrogen is 10·80 (average for thirty-six brains), this ratio has a value of 11·28 after 4½ hr. of swimming. The difference is $+0 \cdot 48 \pm 0 \cdot 12$ ($P < 0 \cdot 02$).

These figures indicate that during physical exertion a splitting off of amido-nitrogen from the polypeptidic chain of brain proteins takes place. This amido-nitrogen originates mainly from the bound glutamine[4,5]. This bound glutamine is therefore one of the sources of ammonia in the brain. As a result of this process, the chemical and physico-chemical nature of some proteins in the brain must necessarily change, as in the polypeptic chain the bound glutamine is changed into bound glutamic acid. The electropositive amidic functional group of the protein molecule is changed into the electronegative carboxylic group.

It may be of interest to direct attention here the marked energy content of the amidic bond the peptides, containing about 5840 cal./mol.[6]. Th amidic bond is actually a 'semi-macroergic' bon The disintegration of this bond is apparently relate to the increased functional activity of the brai nervous tissue during diffuse neuromuscular activit

The existence of structural changes in the protei of the nervous tissue during functional activity h been assumed by other authors[7] on the basis changes in the sorption of vital dyes. Similarl Koshtojanc and co-workers[8] have pointed to th significance of the functional groups of proteins the nervous tissue; their work was, howeve directed especially to functional —SH groups in th proteins of the nervous tissue. We believe we hav shown the significance of the amidic group of pr teins of the nervous tissue of brain for the functiona activity of this tissue.

A full account of this work will be publishe elsewhere.

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## Antibiotically Active Amino-Acid Copolymers related to Gramicidin *S*

The chemical structure of the antibiotic peptid gramicidin *S* has been established as cyclo-(-L-Va L-Orn-L-Leu-D-Phe-L-Pro)$_2$[1]. In the attempt elucidate the relation between its chemical structu and the antibacterial activity, a number of relate di-, tri-, penta- and deca-peptides have been sy thesized, and their antibacterial activity tested These synthetic peptides contain some or all of th five amino-acids present in gramicidin *S* in the prop sequence. Appreciable antibacterial activity wa exhibited only by the linear decapeptide.

Mixtures of N-carboxyanhydrides of α-amino-acid can be easily copolymerized to yield α-amino-ac copolymers containing a predetermined ratio of th various constituents in an undefined sequence. W were thus able to prepare polyamino-acids containin the amino-acid residues present in gramicidin *S*, well as related copolymers, and to check their ant bacterial activity. The amino-acid copolymers liste in Table 1 were obtained as follows: α-N-carbox anhydrides of L-valine, L-leucine, L-proline, L-(D- an DL-)-phenylalanine, δ-carbobenzoxy-L-(and DL-) ornithine, DL-alanine and sarcosine were prepared the required monomers were mixed in the desire molar ratio and copolymerized in dioxane usin diethylamine as the initiator; the carbobenzox groups of the copolymers containing ornithine wer removed by means of anhydrous hydrogen bromid The number average of amino-acid residues pe

Table 1. ANTIBACTERIAL ACTIVITY OF AMINO-ACID COPOLYMERS RELATED TO GRAMICIDIN *S*

| opolymer No. | Molar ratio of amino-acids present in copolymer<br>Ala | Leu | Orn | Phe | Pro | Sarc | Val | Average number of residues per molecule | Minimal inhibitory concentration (μgm /ml.)<br>*E. coli* | *Staph. aureus* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | — | 1 (L) | 1 (L) | 1 (D) | 1 (L) | — | 1 (L) | 30 | 5 | 5 |
| 2 | — | 1 (L) | 1 (L) | 1 (L) | 1 (L) | — | 1 (L) | 40 | 10–15 | 15 |
| 3 | — | 1 (L) | 1 (DL) | 1 (DL) | 1 (L) | — | 1 (L) | 40 | 10–15 | 10 |
| 4 | — | 1 (L) | 1 (L) | 1 (D) | — | 1 | 1 (L) | 25 | 5–10 | 10 |
| 5 | — | 1 (L) | 1 (DL) | 1 (DL) | — | 1 | 1 (L) | 20 | 25–50 | 10 |
| 6 | — | 1 (L) | 1 (L) | 1 (D) | — | — | 1 (L) | 20 | 5 | 2·5–5 |
| 7 | 2 (DL) | 1 (L) | 1 (DL) | — | — | — | — | 25 | 2·5 | 5–10 |
| 8 | 2 (DL) | 2 (L) | 1 (DL) | — | — | — | — | 20 | 2·5–5 | 10–15 |
| 9 | 1 (DL) | 3 (L) | 1 (DL) | — | — | — | — | 40 | 5–10 | 15 |
| 10 | — | 4 (L) | 1 (DL) | — | — | — | — | 25 | 15–25 | 15–25 |
| 11 | 4 (DL) | — | 1 (DL) | — | — | — | — | 20 | 25 | 10–15 |
| 12 | — | 2 (L) | 1 (DL) | 2 (L) | — | — | — | 30 | 25–50 | 15–25 |
| 13 | — | — | 1 (DL) | — | — | 4 | — | 30 | 25–50 | 25–50 |
| 14 | 1 (DL) | — | — | — | — | — | — | 35 | >150 | >150 |
| 15 | — | — | 1 (DL) | — | — | — | — | 18 | 10 | 5 |
| 16 | — | — | — | — | 1 (L) | — | — | 35 | >150 | >150 |
| 17 | — | — | — | — | — | 1 | — | 30 | >150 | >150 |
|  | Gramicidin *S* |  |  |  |  |  |  |  | 5 | 1 |

lypeptide molecule was calculated from end-oup analysis. The molar ratios of the amino-acids the copolymers were determined chromato-aphically after acid hydrolysis. Table 1 gives e minimal concentrations of the polypeptides sted at which no apparent growth appeared within ghteen hours on incubation of an inoculum of :0,000 organisms/ml. of *E. coli* in a synthetic, or *aph. aureus* in a semisynthetic, medium at 37°.

Table 1 shows that copolymer '1', composed of e amino-acids of gramicidin *S* in the proper ratio d steric configuration, has, under the experimental nditions used, an antibacterial activity similar to at of the natural antibiotic. The growth-curves *E. coli* in the presence of gramicidin *S* and of the nthetic copolymer '1' at equal concentrations, ven in Fig. 1, were found to be nearly identical.

A comparison of copolymers '1', '2' and '3' shows at changes in the steric configuration of the phenyl-anine and ornithine caused little difference in anti-cterial activity. The inactivity of polymers '14', 6' and '17' proves that the ornithine residue con-ining a free δ-amino group is essential for anti-cterial activity. This result is in accord with the servation[3] that acetylated or deaminated gramicidin is inactive. When the other amino-acids present gramicidin *S* are omitted or exchanged by DL-anine or sarcosine the antibacterial activity is re-ined to a considerable extent. In one case (No. 7) it even exceeded that of the natural product (cf. Fig. 1).

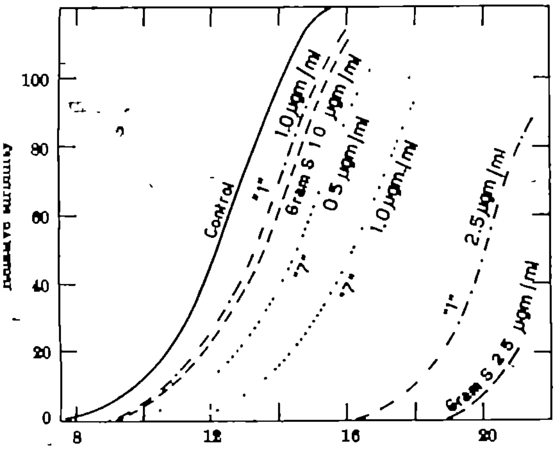

Fig. 1. Inhibition of *E. coli* (1·2 × $10^{6}$ organisms/ml. of synthetic medium at 37°) by gramicidin *S* (– – – –), copolymer '1' (—·—) and copolymer '7' (……)

As all the polyamino-acids investigated have an open-chain structure, it seems that a cyclic structure is not essential for antibacterial activity in the range of molecular weights indicated in Table 1.

The mode of antibacterial action of various amino-acid copolymers in synthetic as well as in more complex media is under investigation.

This investigation is supported by a research grant (*PHS.G*-3677) from the National Institutes of Health, Public Health Services, U.S.A. We want to express our thanks to Profs. H. Theorell and R. L. M. Synge, who kindly provided us with samples of gramicidin *S*.

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## Antitubercular Effect of an Extract of *Adhatoda vasica*

THE report of Gupta and Chopra[1] on the anti-tubercular activity of the volatile principle of *Adhatoda vasica* prompted us to investigate the matter further.

2 lb. of undried leaf of *Adhatoda vasica* was coarsely chopped and distilled in steam to give about five litres of steam distillate. This was saturated with salt and extracted with chloroform, the extract dried over sodium sulphate and evaporated at room temperature. The brown viscid oil (3 gm.) was dried *in vacuo* below 30° C.

For the *in vitro* investigation the distillate was taken up in alcohol and serial dilutions were made in a medium of the Proskauer and Beck type. Growth of the *H37Rv* strain of *M. tuberculosis* (inoculum 0·03 mgm.) was inhibited at a dilution of 75,000 for 14 days. With a similar medium incorporating 5 per cent human serum, no inhibition was observed at a dilution of 10,000. Gupta and Chopra (*loc. cit.*)

quoted an inhibitory dilution of 500,000 for a human strain of *M. tuberculosis* (inoculum 0·01 mgm.).

The volatile principle was evaluated in 25-gm. Parkes albino mice. These were infected intravenously with the *Ravenel Rv* strain of *M. tuberculosis* (0·1 mgm.). Treatment was started on the day of infection and continued for 14 days, the drug being administered in the diet. The measured daily drug intake was approximately 340 mgm./kgm. mouse weight up to the seventh day. Median survival times of mice, with 19/20 limits of probability, were 14 (12·8–15·3) days for the treated mice compared with 16·3 (15–17·7) days for the untreated controls. This decrease in median survival time is just significant and may indicate toxicity. The pulmonary lesions, however, in the treated mice were indistinguishable from those in the controls.

It may be concluded from these results that the volatile principle of *Adhatoda vasica*, as prepared by us, has no antituberculous properties in mice on oral administration.

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## Effect of Isolated Cerebral Hypoxia and Hypercapnia on Sodium Excretion

The healthy organism, as is well known, reacts to a number of influences (such as work, etc.) by decreased sodium excretion. In such cases a relative hypoxia occurs: in pathological sodium retention (cardiac decompensation, famine œdema, anæmia, etc.) an absolute hypoxia (arterial, stagnating or anæmic) can be demonstrated.

It is to be supposed that in all these states a causal relation must exist between the hypoxia and the decreased sodium excretion. We have therefore investigated, in a series of experiments on dogs, the effect of hypoxia on sodium excretion. In these experiments the rate of glomerular filtration was estimated by endogenous creatinine clearance, the sodium was determined by flame photometry, the oxygen content according to Issekutz, and the carbon dioxide according to Van Slyke.

(1) In fifteen experiments we dealt with the effect exercised on sodium excretion by hypoxia of the entire body. The dogs were under chloralose anæsthesia. The hypoxia was induced by inhalation of a nitrogen mixture containing 10 per cent oxygen. In fourteen cases the sodium excretion decreased significantly, to an average of 16 per cent. The sodium excretion occurred in some cases with unchanged sodium filtration, proving the effect to be of tubular origin.

(2) We have also investigated the question whether the fall in sodium excretion could be brought about by isolated cerebral hypoxia. For this purpose we made a preparation in which only neural connexion was maintained between the head and the body.

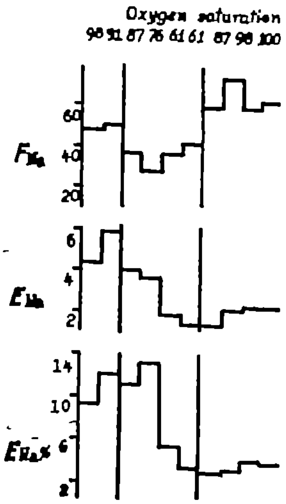

Fig. 1. F(Na), filtered sodium (m.equiv.); E(Na), excreted sodiu (m.equiv.); E(Na %), excreted sodium as a percentage of filtere sodium

Circulation in the isolated head was maintained by Dale–Shuster pump. In all cases the vertebral arteri and veins were ligated and in some instances t spinal veins also. In some cases the sinus carotic was denervated. In fourteen of sixteen experiment there was a definite decrease in sodium excretic as an effect of the cerebral hypoxia (Fig. 1). It al occurred in animals in which the spinal veins we ligated, as well as in those with denervated sin caroticus. Hypercapnia brought about the san results.

The same effect was obtained when stagnati hypoxia was induced in the brain by reducing th perfusion pressure of the Dale–Shuster pump. I these cases, too, the sodium excretion fell to 21 p cent of the original.

Finally, during some of these experiments, v considered the effect exercised on sodium excretic by hypoxia of the isolated body. In parabiosis, th head of the acceptor animal was perfused throug the carotids with blood (100 per cent oxygen satur tion) from the donor dog. Hypoxia of the body the acceptor animal was induced by inhalation of a oxygen–nitrogen gas mixture with reduced oxyge content. Sodium excretion decreased here, too, as i isolated head hypoxia.

From these experiments the conclusion is draw that isolated cerebral hypoxia and hypercapnia lea to a decreased sodium excretion. We believe th volume-regulating phenomenon to be of importanc Our results, which show that the effect also occurs i body hypoxia, indicate that there are recepto sensitive to hypoxia not only in the brain but al throughout the whole organism. It is still a questio however, which of these receptors are the mo sensitive.

This work will be published in detail in *Ac Medica Hungarica.*

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## Genetic Recombination in *Streptomyces*

THE Actinomycetes have properties intermediate tween those of the fungi and those of the bacteria. in practically all bacteria and in many fungi, exual cycle is not known to occur in the Actino- ycetes. In some bacteria and Fungi Imperfecti[1], wever, there are parasexual processes[2], that is, ocesses leading to genetic recombination otherwise an via sexual reproduction. The present com- mication reports the discovery of a recombination ocess in an Actinomycete, *Streptomyces coelicolor* einer-Müller.

The two starting strains used were kindly supplied Dr. A. Tonolo. One of them produces a deep blue gment[3] diffusing into the agar ; the other, a mutant om the first, does not produce it. Both grow well a chemically defined minimal medium[4] containing ly glucose and inorganic salts.

Two multiple mutants were isolated by successive tra-violet irradiations of spores : one with require- ents for methionine and histidine and producing ue pigment (5 *me hist*) from the first strain, and e with requirements for proline and glutamic id and not producing the blue pigment (14 *pr u pigm*) from the second strain. The mutants ew well either on the minimal medium sup- emented with the respective requirements, or a 'complete medium'[5] containing peptone, yeast tract, etc.

The two multiple mutant strains, 5 *me hist* and *pr glu pigm*, were streaked separately and together slants of agar media made up of mixtures of the inimal and the complete media (in proportions arying from 3 : 1 to 1 : 1). Separately the two rains grew very little in these mixtures ; but the ixed inoculum produced abundant growth in two three days, with intense blue pigmentation of the gar and abundant sporulation. A suspension in istilled water of spores from the mixed culture was ltered, and the spores, washed by centrifugation, ere plated on the minimal medium. For 'viable ounts' part of the same suspension was also plated, fter suitable dilution, on the complete medium. An nexpectedly large number of the spores produced rowth on the minimal medium. The time for which e mixed culture was grown before harvesting the ores and plating them on the minimal medium as varied from three to nine days with the results own in Table 1.

As a control of the experiment reported in the first ne of the table, $12 \times 10^6$ spores of strain 14 *pr glu igm* alone, plated on the minimal medium, produced o growth ; neither did $24{\cdot}7 \times 10^6$ spores of strain 5 *e hist* alone. Even a mixed suspension of spores of e two strains ($34 \times 10^6$ spores) obtained from parate cultures produced no growth. Clearly a eriod of mixed growth is necessary for spores pro- ucing prototrophic colonies to arise.

Table 1

| Mixed culture medium (min./complete) | Age of mixed culture (days) | No. of spores from mixed culture plated on the min. medium (corrected for viable counts) | Colonies growing on the min. medium ('prototrophic') | Prototrophic colonies per cent of spores plated |
|---|---|---|---|---|
| 1/1 | 4 | $46 \times 10^6$ | 10,800 | 0·023 |
| 3/1 | 3 | $3\ 4 \times 10^6$ | 200 | 0 008 |
| 3/1 | 4 | $4 \times 10^6$ | 0 | 0 |
| 3/1 | 6 | 580 | 250 | 43 |
| 3/1 | 7 | 7,000 | 910 | 13 |
| 3/1 | 9 | 4,000 | 780 | 19 |

Table 2

| Mixed culture medium (min./complete) | Age of mixed culture (days) | Supplements added to the min. medium for plating spores from mixed culture | Rate of recombination (per cent) | No of colonies tested | Recombinant types obtained No. | Type |
|---|---|---|---|---|---|---|
| 1/2 3 | 7 | proline, histidine | 3·1 | 36 | 3<br>4<br>29 | *pr*<br>*hist*<br>+ |
| 1/2·3 | 7 | glutamic, methionine | 1 4 | 482 | 1<br>481 | *me*<br>+ |
| 1/1 | 16 | histidine, glutamic | 19 | 168<br>– | 9<br>7<br>136 | *hist*<br>*pigm*<br>+ |
| 1/1 | 16 | methionine, proline | 4·6 | 300 | 34<br>2<br>264 | *pr*<br>*pr me*<br>+ |

The symbols indicate the requirement or the absence of blue pigment (*pigm*). + indicates the wild type, that is, no requirement and presence of blue pigment.

Recombinant strains presenting requirements of one or both of the parent strains were identified and selected by the following method. Spores from mixed cultures were plated on the minimal medium partially supplemented with the substances required by the parent strains. All the possible combinations of substances required by the parent strains were tried except those which would permit the growth of either or both parent strains.

A number of colonies showing growth on these media were tested for their nutritional requirements, and the presence or absence of the blue pigment noted. Table 2 gives details of the results.

Thus, three types of recombinants occurred among the strains isolated : (*a*) with all the 'wild' characters of the starting strains ; (*b*) with some 'wild' characters of one strain and some mutant characters of the other strain ; (*c*) with mutant characters from both strains (*pr me*).

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## Rate of Metabolism in Tardigrades during Active Life and Anabiosis

SOME species of tardigrades are noted for the ability to survive complete desiccation[1]. When dried, the animals are able to withstand extreme temperatures and lack of oxygen. The experiments described here were made with the purpose of contributing to the knowledge of the metabolism of tardigrades during the period of anabiosis.

First, the rate of metabolism during anabiosis was measured and compared with that during active life[2]. Two species were used : *Macrobiotus hufelandi* Schultze, a moss-inhabiting species, able to survive

Table 1. Oxygen Consumption at 20° C.

| Species and life-stage | Oxygen (μl. × $10^{-6}$) per hr. per individual |
|---|---|
| *M. dispar* | |
| Active | 1,000 |
| Cyst | 240 |
| *M. hufelandi* | |
| Active | 980 |
| Dried | 1·6 |

lack of water, and *Macrobiotus dispar* Murr.; a fresh-water form, able to encyst. The oxygen consumption was measured at 20° C. by the Cartesian diver micro-gasometer, as developed in the Carlsberg Laboratory, Copenhagen, except with dried animals, when a minor modification was introduced to increase sensitivity[3]. The results are summarized in Table 1; they show clearly the difference between encystment metabolism and true anabiosis.

In the second series of experiments the relation between rate of metabolism of dried *M. hufelandi* and humidity of the air was investigated[4]. Both the 'standard' and the 'sensitive' type of the Cartesian diver were used. The humidity of the air was kept constant by placing in the divers droplets of sodium chloride or calcium chloride solutions of appropriate concentration. The divers were charged with 300 or 30 animals, according to the rate of metabolism. The results are shown in Table 2.

Table 2. Oxygen Consumption by Dried *M. hufelandi* with Different Relative Humidities of the Air, at 25° C.

| Relative humidity (per cent) | Oxygen (μl. × $10^{-6}$) per hr. per individual |
|---|---|
| 25 | 0·4 |
| 48 | 0·4 |
| 59 | 1·1 |
| 75 | 2·4 |
| 83 | 2·9 |
| 90 | 4·8 |
| 93 | 7·6 |
| 95 | 27 |
| 96 | 57 |
| 97 | 89 |
| 98 | 160 |
| 99 | 340 |
| 100 | 690 |
| Water | 1,130 |

The results show a logarithmic increase of metabolic rate with increase in humidity of the atmosphere. At the lowest humidities (25 and 48 per cent) the respiratory rate is very slow, and the error involved accordingly large; the results show merely that there is some oxygen consumption at these humidities. Respiration in water recorded in Table 2 differs slightly from the results in Table 1; it was measured with the same animals which were used in the investigation of the effect of humidity on respiratory rate.

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## Location of Enzymes in Mitochondria Fractions

It appears from several published works duri recent years that a large number of enzymes ha been located in the mitochondria fractions by mea of differential centrifugation of tissue homogenat especially of animal cells. Duve and Berthet[1] ha tried to standardize the conditions of centrifugati in different types of instruments so that the resu may be reproduced, and they urge that some attenti should be paid to such factors as diffusion- and co vection-currents and also to the manner of decantatio Some errors are, however, possible with this ty of work, as have been pointed out by Brachet[2] whi discussing the nuclear control of enzymic activitie during homogenization and differential centrifugatio soluble enzymes can no doubt be adsorbed on particle but the microsomes (submicroscopic cytoplasm granules) may release enzymes which are normal bound to them just as in the case of crushing t cell constituents in different media. By this meth it is scarcely possible to get information on the inte actions occurring between the different fractions in normal living cell and to be sure that the vario particles obtained by differential centrifugation a really the ones which pre-existed in the intact ce In this connexion, Holter[3] has also discussed the pr found changes that the process of homogenizatio involves; he points out that the hyaline groun plasm of most cells is not miscible with water an that a certain degree of autolysis is indispensable i order to set the cytoplasmic particles free and th this autolysis must have far-reaching consequenc with regard to enzyme yield and enzyme distributio

By growing fungi (*Polyporus durus*, *Polystict sanguineous*, *Daedalea flavida*, *Phoma casuarinae*, etc separately in fatty acid medium, 4 per cent gluco and 2 per cent peptone medium, I[4] obtained synthes of fat drops, glycogen granules and protein granul respectively around the vacuoles in growing hyph tips. My attention[5] was first directed to this kin of work following the deposit of starch grains i various algae (*Spirogyra*, etc.) around the pyrenoid which show vacuoles at their centre. By followin the successive stages of plasmolysis of a health fungal cell one can observe how the vacuolar mem branes act as seats of hydrolysis as well. From th experimental facts I formed the conclusion that th plant vacuoles (especially in fungi) most probabl function as store-houses of enzymes. The late Prof Guillermond[6] discarded the idea that the mitochondri are the means by which every synthesis in plan cells takes place. To get satisfactory evidence, "th mitochondria must be broken down into less organize units and finally the enzymes should be isolated an characterized" (cf. Davies[7]).

It should be noted, however, that young health green plant cells in the growing state always contai a number of vacuoles and two types of mitochondri (cf. Sorokin[8])—'active' mitochondria which becom transformed into plastids and which do not colou with vital stain (Hoechst's Janus green *B*), an 'inactive' ones which remain as such and specificall colour blue with Janus green *B*—but in the majorit of fungi 'active' mitochondria (that is, plasts an plastids) are lacking.

According to Cowdry[9], normal healthy animal cells which are devoid of plastids, contain very few or n vacuoles, and since highly vacuolated cells die o more rapidly than the non-vacuolated ones, th uoles have been called by Cowdry degeneration-uoles. Hence, it may be possible that in animal s mitochondria are structurally associated with ymes within the living cell; but recent studies Duve *et al.*[10] on rat liver cells show that this clusion is not necessarily warranted.

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## Plane of Bilateral Symmetry in Plant Cilia

HIS fact of bilateral symmetry in cilia has been ch more easily demonstrated than the plane of mmetry itself. The fact is implicit in the numerical ations of the component fibrils[1] (a ring of nine und a central pair); but unless there are external pendages or some other criteria with respect to ich the orientation of the whole organ can be erpreted the median fibril cannot be recognized. is difficulty was encountered by Fawcett and rter[2], who interpreted their very fine sections of mal cilia in terms of a plane of symmetry passing ough and not between the two central strands, l a similar interpretation was given by Manton, rke and Greenwood[3] for the seaweed *Dictyota* on basis of external morphology. In neither case, wever, was the possibility excluded that the plane symmetry might in fact be at right angles to the e joining the two central strands, and Fawcett and rter's outline diagrams do indeed somewhat ggest this.

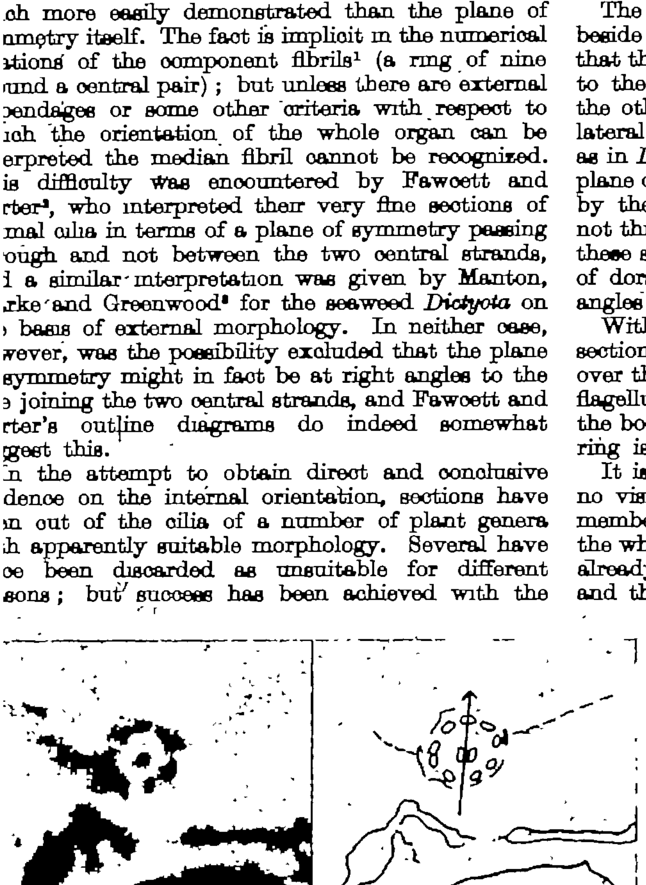
n the attempt to obtain direct and conclusive dence on the internal orientation, sections have n cut of the cilia of a number of plant genera h apparently suitable morphology. Several have ce been discarded as unsuitable for different sons; but success has been achieved with the spermatozoids of the brown seaweed *Fucus*. For this[4] it is already known that the front flagellum has two rows of lateral hairs and that there is a peculiar and highly characteristic membranous organ (the 'proboscis') at the base. The smooth hind flagellum, which is without appendages, is held in a fixed position where it passes over the eyespot. Sections through either of these two special regions would give the desired information.

Sections of these and other levels will be published in detail elsewhere; but one sample is reproduced in Fig. 1. It is part of the front end of a longitudinally cut spermatozoid in the region of the upturned proboscis and front flagellum, both of which are cut approximately transversely. The mutual relations of the flagellum and proboscis make it quite certain that they belong together and that the section is not far above their point of union. The plane of section is such that the hairy appendages (Flimmer) are visible on both sides of the flagellum. Since there is no precise correspondence between the levels at which the hairs emerge on the two sides the slight obliquity of the section is a prerequisite to locating both lateral lines simultaneously. The interpretation of the section is further assisted by the fact that dismemberment of the cilium has begun to take place, the ciliary membrane being partially disrupted and the fibrils, except for two on the left-hand side, being spaced farther apart than would otherwise be the case.

The critical details are shown in an outline diagram beside the photograph. As in *Dictyota*, it is found that the odd (median) fibril lies outwards with respect to the cell body. If this fibril is numbered 0 and the others 1, 2, 3, 4, on each side, the origin of the lateral hairs is in close proximity to fibril 2, again as in *Dictyota*. It is quite obvious, however, that the plane of bilateral symmetry of the outer ring (marked by the arrow in the diagram) passes between but not through the two central strands. The line joining these strands is therefore in, or parallel to, the plane of dorsiventrality of the whole organ but at right angles to the plane of bilateral symmetry.

With this information it is possible to interpret sections of the smooth hind flagellum where it passes over the eyespot, and it is found that, as in the front flagellum, the plane of dorsiventrality is parallel to the body, and the odd median fibril of the peripheral ring is outwards.

It is thus fully apparent that, even when there is no visible structural differentiation among the nine members of the peripheral ring, the orientation of the whole organ is by no means at random. This was already indicated from Fawcett and Porter's sections and their observation that, when cilia are arranged in rows as in the gill epithelium of *Mya*, the central pair of fibrils in every cilium is in a plane at right-angles to the row. It may now be suggested that this plane is likely to be that of dorsiventrality, the plane of symmetry in *Mya*, as is *Fucus*, being at right-angles to this and therefore parallel to the direction of the row.



ig. 1. Electron micrograph (MX18.13) of a section cut near the base of the ront flagellum of the spermatozoid of *Fucus serratus*; part of the cell ody and membranous proboscis visible below the flagellum. For further explanation, see line diagram and text. Magnification × 30,000

All this supports strongly the view put forward on previous occasions by us and no doubt by other workers that bilateral symmetry in cilia is likely to be of primary functional significance for the mechanism of their movements.

The micrograph reproduced was taken on the Philips' electron microscope in the research laboratories of Tootal Broadhurst

Lee Co., Ltd., of Manchester, whom I have to thank for giving me hospitality at a time when our own instrument was too heavily loaded with other work to be available. I have specially to thank Dr. P. Chippindale for making this arrangement possible.

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## Behaviour Differences in Two Strains of *Aëdes aegypti*

Attention has recently been directed to differences in the hatching response between eggs of a West African strain of the mosquito *Aëdes* (*Stegomyia*) *aegypti* (L.) from Lagos, Nigeria, and those of an East African strain of the same species from Newala, Tanganyika[1]. Further work on these two strains now discloses differences affecting behaviour of the adults: in the Lagos strain, unmated females usually lay eggs within five days of taking a blood meal; in the Newala strain, unmated females rarely lay eggs within this period (Table 1).

Table 1. Proportion of *A. aegypti* laying Eggs within Five Days of taking a Blood Meal

| Lagos strain | | Newala strain | |
|---|---|---|---|
| Mated | Unmated | Mated | Unmated |
| 61/67 (91 per cent) | 74/86 (86 per cent) | 48/54 (89 per cent) | 4/53 (8 per cent) |

The relation between mating and ovulation has been noted by various workers in certain Anthomyid and Tachinid flies[5-7] and in *A. aegypti* by MacGregor[8], who claimed that ovulation was dependent on the presence of sperm in the spermathecæ and of blood in the stomach. Whatever the male's contribution is, in this species, it is clear that in the Lagos strain the female is largely or wholly independent of it. The following preliminary experiments provide some additional information on this subject.

When unmated females of the Newala strain were afterwards mated at varying intervals from 3 to 23 days after a blood meal, 61 out of 76 (80 per cent) of them laid their eggs on the second or third day after fecundation. Thus, while blood in the stomach is necessary for activation of the ovaries, it is clearly not necessary for ovulation, which appears in this strain to depend on mating only. It is apparent, however, that the act of mating is itself not the effective stimulus, since ovulation did not follow when females were mated to infertile males. Evidence for this was obtained by mating groups of eight females, one at a time in quick succession, to single males. Each male was able to cope with the eight females one after another; but only the first three or four females were successfully fertilized (Table 2). Repeated feeding of these groups of females at 6-day intervals did not alter the overall picture; after each feed, fertile eggs were laid by the first three or four mates, a few infertile eggs were laid by some of the fourth and fifth mates, but no eggs were l by any of the sixth, seventh or eighth mates.

Table 2. Combined Results of mating 5 Groups of 8 Fema each (*A. aegypti* Newala Strain) to Single Males (see T

| ♀♀ (8/♂) in order of mating | No. of ♀♀ laying eggs | | No. of eggs laid | | Mean day of laying | |
|---|---|---|---|---|---|---|
| | Fertile | Infertile | Fertile | Infertile | Fertile | Infer tile |
| 5 first mates | 5 | — | 399 | — | 2·0 | |
| 5 second mates | 5 | — | 335 | — | 2·4 | |
| 5 third mates | 5 | — | 325 | — | 2·4 | |
| 5 fourth mates | 2 | 1 | 177 | 17 | 3·0 | 3·0 |
| 5 fifth mates | — | 1 | — | 3 | — | 5·0 |
| 5 sixth mates | — | — | — | — | — | — |
| 5 seventh mates | — | — | — | — | — | — |
| 5 eighth mates | — | — | — | — | — | — |
| Totals | 17 | 2 | 1,236 | 20 | | |

While these results seem to support the first p of MacGregor's claim, that it is the presence of spe in the spermathecæ which stimulates ovulation, t following observations suggest that it may in f be the presence of seminal fluid rather than sper Males of the Newala strain, apparently exhausted sperm by three or four consecutive matings, w again able to fertilize females after a rest of 36 When, however, apparently exhausted males w rested for shorter periods, mating resulted in the l ing of infertile eggs. Thus even sixth and seven mates were induced to lay batches of 84 and infertile eggs on days 3 and 4 respectively. It see possible that females of the Newala strain ovul when they receive spermless seminal fluid, and t may perhaps account for small numbers of infert eggs laid by some of the fourth and fifth mates, th is, when sperm is exhausted but fluid is neverthel introduced into the spermathecæ.

When these experiments were repeated using t Lagos strain, the results were entirely differe Females mated to infertile males resembled normal mated females in usually laying their eggs within t to five days of taking a blood meal (Table 3). T number of infertile eggs, however, laid by such femal was usually less than the number of fertile eggs la by normally mated females, and they were usual laid some 12 hr. later. Unmated females of t Lagos strain, or females mated to infertile mal continued to lay batches of infertile eggs with two to five days after each of ten successive blo meals.

It is suggested that females of the Lagos stra produce some substance which stimulates ovulatio and that extra production of this substance follo impregnation by the male. This substance seems

Table 3. Combined Results of mating 7 Groups of 8 Femal each (*A. aegypti* Lagos Strain) to Single Males (see Text)

| ♀♀ (8/♂) in order of mating | No. of ♀♀ laying eggs | | No. of eggs laid | | Mean day of laying | |
|---|---|---|---|---|---|---|
| | Fertile | Infertile | Fertile | Infertile | Fertile | Infertile |
| 7 first mates | 6 | 1 | 404 | 52 | 2·5 | 4·0 |
| 7 second mates | 7 | — | 454 | — | 2·9 | — |
| 7 third mates | 5 | 2 | 323 | 79 | 2·6 | 3·0 |
| 7 fourth mates | 6 | 1 | 304 | 80 | 2·7 | 3·0 |
| 7 fifth mates | 5 | 2 | 245 | 49 | 3·4 | 3·5 |
| 7 sixth mates | 2 | 5 | 51 | 248 | 3·0 | 3·2 |
| 7 seventh mates | — | 7 | — | 298 | — | 3·6 |
| 7 eighth mates | — | 7 | — | 280 | — | 3·7 |
| Totals | 31 | 25 | 1,781 | 1,086 | | |

| | | | |
|---|---|---|---|
| Average No. of eggs/fertile female | — 57·5 | Mean laying time of fertile eggs | — 2·9 d |
| Average No. of eggs/infertile female | — 43·4 | Mean laying time of infertile eggs | — 3·4 d |

ranting in females of the Newala strain, but ars about two days after impregnation by the ı. Such a substance might be a product of the us allatum or of the neurosecretory cells in the n[9], production of the substance depending, in the ala strain, on a stimulus resulting from filling of spermathecæ.

series of crosses between these two strains is now g undertaken, in the hope that further light will hrown on this subject.

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## Cell Surface and Fertility in *Escherichia coli*

'ERTILE or $F^+$ strains of *Escherichia coli* have been ned[1,2] as those which are productive of recom- ants even when crossed with sterile strains; other ins, $F^-$, are defined as those which are productive recombinants only if crossed with fertile strains. tility is transmissible from $F^+$ to $F^-$ cells by ection' due to an agent ($F$) which is not separable n the cells[1,2].

The screening of strains and clones for fertility ends upon these definitions, namely: (1) capacity recombine with test strains of known $F$ polarity; ability to transmit fertility to sterile strains. h methods, even in the most skilful hands, are time suming and discourage the undertaking of large- le experiments. Unfortunately, no changes, either rphological or physiological, have been correlated far with the $F^+$ state, other than the strictly etical ones already mentioned[3].

Nevertheless, it seemed worth while to investigate surface of cells endowed with opposite $F$ polarity. h investigations, which are in progress in this titute, on different lines of work, have already lded some consistent results which are here sented.

Eight strains of *E. coli K* 12 (kindly supplied by . L. L. Cavalli) were chosen which allow of factorial- tion of: (1) two groups of markers, including chemical deficiencies, sugar fermentation and us resistance; (2) sensitivity and resistance to antibiotic (streptomycin); (3) fertility and rility. Cells of such strains, from standardized tures, were washed twice in distilled water and re suspended in a buffer (citric acid/disodium drogen phosphate) adjusted for $p$H values ranging m $p$H 2 to 5, at intervals of $p$H 0·2, in order to termine for each strain at which $p$H suspended ls are precipitated. The results and their analysis ow that the factor which has by far the most effect the $p$H-precipitability of the strains studied is the polarity, the precipitating $p$H for $F^-$ strains being hly significantly more acidic than that for $F^+$ ains. In addition, analysis of the results shows at a minor but significant effect is due to the rkers already mentioned.

Secondly, on staining the same strains at different $p$H values, by means of a mixture of an acid and a basic dye, like methylene blue and acid fuchsin[3], $F^-$ strains show a greater affinity for the basic dye than $F^+$ strains.

Thirdly, the nephelometric study of the growth pattern in liquid medium (*I.S.M.* nutrient broth, $p$H 7·3) shows that there is a greater spontaneous instability of broth-cultures of fertile strains, compared with that of the corresponding sterile strains. In fact, both $F^-$ and $F^+$ strains grow at the same rate for the first few hours, up to a population density at which $F^+$ cells are spontaneously precipitated, but $F^-$ cells do not. In other words, the greatest density of growing cells which can remain stably suspended in the culture medium is far greater for sterile strains than for fertile ones.

As a whole, these results suggest a difference in surface charge between the strains studied, due to a difference in $F$ polarity. This conclusion is supported by an electron microscopic investigation on the same strains, which showed no morphological equivalent of fertility at the level of the cell surface. Indeed, presence or absence of an outer membrane, of cilia, filaments[4], etc., seems to be unrelated to $F$ polarity. But a not irrelevant by-product of this investigation is the demonstration that, while all the eight strains are ciliated, only the four bearing markers for deficiency for biotin and methionine and resistance to phage $T_1$ are endowed with filaments, while the four strains bearing the other group of markers, namely, deficiency for threonine, leucine and thiamine, inability to ferment lactose, galactose, maltose, arabinose, xylose and mannitol, are completely devoid of filaments. This conclusion has promoted other investigations using such a 'morphological marker' to study the phenology of the $F$ transmission and to detect the biochemical pattern correlated with production of filaments by the bacterial cell.

Determination of the $\zeta$ potential on cells with opposite $F$ polarity will be the logical development of experiments quoted above; but results on electrokinetic mobility can be very misleading, unless they are based on a substantial knowledge of the morphology of the cell surface[5]. This is one reason why an electron microscopic investigation was carried out at this point in our researches. On the other hand, it seems that the finding of a chemico-physical property and a cultural pattern associated with fertility, at least so far as the eight strains studied are concerned, supplies a simple and, therefore, useful technique for studies on the transmission of the $F^+$ state. In fact, recombination tests applied to forty clones from each of two $F^-$ strains, infected with two different $F^+$ strains, have yielded results fully consistent with a previous screening of the same clones for growth pattern in *I.S.M.* nutrient broth.

Further, the description of the eight original strains, by means of the nephelometry of forty clones of each, has given quantitative results very suitable for thorough statistical analysis, which has supplied information in perfect agreement with that given by the $p$H-precipitability experiments.

What is more important, the same technique permits a detailed study of the kinetics of infection and has already produced results completely confirming and integrating what is known on the transmission of the $F$ agent. Further investigations are being carried out.

Fertility and sterility in bacterial cells may thus be nothing more than an epiphenomenon of their surface charges; on the other hand, the observed differences of surface charge may be a minor effect of the *F* agent which is supposed to transmit fertility. Our results make the first hypothesis no more unreasonable than the second one.

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## Herpetichthyes, Amphibioidei, Choanichthyes or Sarcopterygii?

During recent decades, our ideas on the classification of fishes have changed greatly. In the early years of the century, it was believed that among the higher bony fishes (Osteichthyes), the ray-finned forms and crossopterygians were closely allied, and that the lungfishes were remote from the two, representing a presumably primitive if aberrant group. As an expression of such beliefs may be cited Goodrich's work on fishes in the Lankester "Treatise on Zoology"[1], in which the Osteichthyes are divided into two subclasses, one for the Dipnoi alone, the other, the Teleostomi, including both Crossopterygii and the Actinopterygii. In succeeding decades, however, a radical change of opinion occurred. Principally due to the work of Goodrich himself and of Gregory and Watson, it became clear that the primary dichotomy of the Osteichthyes was of another sort, one major subdivision including the Actinopterygii alone, the other both Crossopterygii and Dipnoi. Huxley, in 1880[2], coined the name Herpetichthyes to describe the sub-tetrapod evolutionary stage represented by *Ceratodus*, and Smith Woodward, in 1931[3], suggested the expansion of the term to include (*contra* Huxley) the crossopterygians. Hubbs, in 1919[4], proposed Amphibioidei for Dipnoi plus Crossopterygii, and other writers have suggested an expansion of Crossopterygii to include the Dipnoi as well. Säve-Söderbergh, in 1934[5], in an unorthodox essay in classification, proposed a major subdivision of the vertebrates, including all the tetrapod classes plus the two fish groups concerned, to be named the Choanata, in reference to the presence of internal nostrils. I have (like others) rejected this classification, but in 1937[6] suggested that Choanichthyes would be appropriate as a designation for the included fish groups. None of the three terms previously suggested has met with any marked degree of acceptance; Choanichthyes has been adopted by a number of recent writers.

The deadening hand of legal 'priority' fortunately does not (and should not) extend to systematic categories on this high level. Names of this sort should be meaningful and, if possible, diagnostic—particularly in such a group as that under consideration, which is of such importance that it merits mention and discussion on even the most elementary levels of zoological and geological teaching. From this point of view, I feel dubious as to whether term Choanichthyes should be retained. The lu fishes have internal narial openings, to be sure, it seems certain that the crossopterygian ancest of the tetrapods had choanæ. But in coelacant choanæ were lost at a very early stage, if ever pres at all. The internal narial openings of the lungf do not function as choanæ, for they are passa for water, not air, and Jarvik[7], among others, raised doubts as to their homology with true choa

But despite my doubts about the use of the te Choanichthyes, no better case can be made alternatives which have been proposed. As rega the use of Herpetichthyes or Amphibioidei, the fis concerned are related to amphibian ancestry; the only living member of the group, *Latimer* is as un-amphibian as any fish can be. To Crossopterygii in the expanded sense proposed wou distort the meaning of the term so greatly as create confusion.

A name which is highly appropriate and didact ally useful can, however, be derived from fin structu In contrast to the typical Actinopterygii, crossopterygians and lungfishes have fleshy, lob fins, covered with scales and with a well-develop internal skeleton of archipterygial type. May suggest, for discussion, the possibility that, contrast to the 'ray-finned fishes', the forms he considered be termed 'fleshy-finned fishes' Sarcopterygii?

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We are glad to see Prof. A. S. Romer's authori withdrawn from the unhappy term Choanichthye but we do not think it necessary or desirable to co a new one to cover the Rhipidistia, Actinistia a Dipnoi. We would revert to calling them Crossopterygii.

The name Crossopterygii in its original for (Crossopterygidae) was introduced by T. H. Huxle to include members of all of the above-named group as well as *Polypterus*, which to-day is excluded fro the Crossopterygii in whatever sense the term is use In Huxley's Crossopterygidae were *Osteolepis*, th Coelacanthidae, *Dipterus*, *Phaneropleuron* and th fossil *Ceratodus* (the last with a query, since it w known only from dental plates). Huxley furth directed attention, "without wishing to lay too mu stress upon the fact", to the resemblance betwe *Lepidosiren*, the only living dipnoan then know and *Dipterus*, *Phaneropleuron* and the coelacanth mentioning the paired fins and the endoskeleton an comparing the teeth with those of *Dipterus* and th "stiff-walled lung" with the ossified air bladder one of the fossil coelacanths.

In 1881, in the work referred to by Prof. Rome Huxley was thinking as a comparative anatomis and gave the name Herpetichthyes to *Ceratod* (= *Neoceratodus*) and its hypothetical ancestor *todus* was, he wrote, "an extraordinarily little-lified representative of that particular stage of ution of which both the typical fishes and the phibia are special modifications". He did not elate this conception with his earlier study as a pontologist, and his term does not suit our present pose.

/e now know of the close relationship between *ceratodus* and the fossil Dipnoi among Huxley's ssopterygidae. The classifications which set the noi apart from the Rhipidistia were first those 1 as Goodrich's of 1909[2] and Berg's of 1940[3], ch grouped the Rhipidistia and Actinistia with Actinopterygii as Teleostomi. In so doing, drich did away with the term Crossopterygii; in 1930[4] he revived it for Rhipidistia and Actin-, though still as a division of Teleostomi.

ome authors (Stensiö[5], Romer[6,7]) who have not mitted the major cleft between Dipnoi and Teleo-ni have still used Crossopterygii for the Rhipidistia l Actinistia only; hence their need for another ne under which to unite them with the Dipnoi. ers (Regan, 1929[8]; Moy-Thomas, 1939[9]; Tre-vas and White, 1950[10]) have used Crossopterygii in in Huxley's sense, purged only of *Polypterus*. s latter course we believe to be the most useful.

Vestoll[11], in a closely reasoned comparison of moi and Rhipidistia, concludes (p. 159): "The dence of Devonian forms shows very clearly that early Dipnoi were very closely related to the temporaneous Rhipidistia". It is generally epted that the Actinistia (Coelacanthini) were an ly offshoot from the Rhipidistia, and such adum-tions of the soft anatomy of *Latimeria* as we have far received[12] show that the two "living fossils", *timeria* and *Neoceratodus*, have retained many tures of a common archaic organization.

These facts all support the classification of Regan 1 Moy-Thomas, that is:

OSSOPTERYGII

Rhipidistia (Osteolepidoti).
Actinistia (Coelacanthini).
Dipneusti (Dipnoi).

There is much, however, to be said for indicating closer relationship of Osteolepidoti and Coel-anthini to each other than to the Dipnoi[13,14]. This uld well be done in the following classification, ich we now propose:

bclass CROSSOPTERYGII

Order Rhipidistia.
  Suborder Osteolepidoti.
  Suborder Coelacanthini.
Order Dipnoi.

The meaning of Rhipidistia ('fan-sails') is appro-iate to both its suborders. The term Actinistia well lost in favour of its familiar synonym elacanthini. Those who have used the text-books Stensiö, Romer[7] or Forster-Cooper[15] have no new rms to learn, but need only note that Crossopterygii used in its old, wider sense and Rhipidistia in a wly expanded sense. The roots of the subordinal mes could be used, if desired, with endings uniform ith those of any system (Osteolepidoidea, Coela-nthoidea for Regan's classification).

To conclude, we advocate reversion to the use of ossopterygii in the sense of Regan and Moy-iomas as a subclass of the class Osteichthyes Pisces *sensu* Regan), to include the Rhipidistia Osteolepidoti + Coelacanthini) and Dipnoi. In support of this we plead: (i) continuous though not universal usage, only slightly modified from that of its original proposer, (ii) a suffix which corresponds to that of the equal-ranking Actinopterygii, and not to the words Dipnoi or Dipneusti, (iii) an appropriate meaning, (iv) conformity of the resulting classification with the results of recent research and (v) the possibility it provides of discarding redundant terms rather than coining new ones.

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## *In vitro* Stimulation of Incorporation of Formate-$^{14}$C in Surviving Uterine Segments by Hydroxylated Œstradiols

RECENT studies in this laboratory have demonstrated that the incorporation of formate-$^{14}$C into protein by surviving uterine segments is an early and sensitive indicator of œstrogen action (unpublished work with A. M. Herranen). Six hours after a single intravenous injection of 10 μgm. of œstradiol-17-β, the incorporation of formate *in vitro* by uterine horn segments is accelerated 250 per cent over the controls. The addition of the natural hormones directly to the *in vitro* incubation media has little or no effect on formate metabolism. In contrast, it is shown in this communication that the addition of the 2-hydroxy or 4-hydroxy derivatives of œstradiol to the reaction mixture results in a significant acceleration of the incorporation of formate-$^{14}$C into the proteins of the uterine segments.

The 2-hydroxy and 4-hydroxy derivatives of œstradiol (2,3,17β-trihydroxy œstratriene and 3,4,17β-trihydroxy œstratriene) were synthesized by a route involving the nitration of œstrone, chromatographic separation of the positional isomers, reduction of the 17-keto group, reduction of the nitro group and the photodecomposition of the diazonium salts. In addition, the 4-hydroxy œstradiol was synthesized by an alternative route through the 4-phenyl azo compound. Details of synthesis and proof of structure will appear elsewhere (unpublished work with M. E. Mills).

Assay of these compounds for their ability to induce uterine growth in 21-day old mice demonstrated that the 4-hydroxy œstradiol derivative possessed 10 per cent of the oestrogenic potency of oestradiol-17β, whereas the 2-hydroxy oestradiol retained less than 1 per cent of the activity of the unsubstituted oestrogen. Similar results were obtained in ovariectomized adult female rats.

For the *in vitro* tests, uterine horns were removed from adult female rats (Holtzman strain) which had been ovariectomized two months prior to the experiments. After immediate cooling of the tissue in iced Robinson media[1], each horn was opened lengthwise and cut into four equal segments. Twelve segments were selected at random and transferred to iced reaction flasks containing 2 ml. of media. The latter was composed of 0·005 *M* sodium formate-$^{14}$C (0·55 × 10$^{6}$ counts/min. per μmole), 0·005 *M* glycine and 0·022 *M* glucose dissolved in Robinson media. Where indicated, 10 μgm. of a natural oestrogen or a hydroxylated derivative was added to the flask in an ethanol solution and the ethanol evaporated prior to the addition of the reaction mixture. All experiments were conducted in duplicate.

The incubations were carried out in an atmosphere of 100 per cent oxygen at 37·5° C. with constant shaking for a period of 3 hr. The reaction was terminated by the addition of perchloric acid to yield a concentration of 4 per cent. The uterine segments were removed, frozen in liquid air, and pulverized in a stainless steel mortar. This residue was suspended three times in 5 ml. of 10 per cent trichloracetic acid to remove acid-soluble radioactive contaminants. Lipoidal materials were removed by suspension in 70 per cent ethanol, followed by two hot extractions with absolute alcohol (20 min. at 70–75°) and two washes with ether. The nucleic acids were extracted from the protein with 4 per cent perchloric acid at 90° according to the method of LePage[2]. After washing successively with cold perchloric acid, ethanol and ether, the protein residue was spread on tared aluminium disks for counting. The dried samples were counted in gas-flow proportional counters. The results are expressed as counts per minute per milligram of protein residue corrected for self-absorption and counting efficiency.

A comparison of the effects of 2-hydroxy and 4-hydroxy oestradiols with the natural oestrogens, oestradiol, oestrone and oestriol, is illustrated in Table 1. It is apparent that both ring *A* hydroxylated oestradiols stimulate the incorporation of radioactive formate, while the natural oestrogens are essentially inactive.

Table 1

| Addition | Counts/min./mgm. protein |
|---|---|
| None | 224 |
| Oestradiol-17β | 241 |
| Oestriol | 222 |
| Oestrone | 200 |
| 2-Hydroxy oestradiol | 365 |
| 4-Hydroxy oestradiol | 356 |

10 μgm. of a hormone was added per flask.

Hydrolysis of the protein and chromatographic isolation of the serine accounted for approximately 50 per cent of the incorporated radioactivity in all cases; previous studies have shown that methionine also contains a large portion of the radioactivity.

Whether or not this oestrogen-like action of the 2- and 4-hydroxy oestradiols *in vitro* is mediated in the same manner as the *in vivo* stimulation of this system by oestradiol remains to be determined. In any event it appears useful as a tool in duplicating *in vitro* conditions within the tissue achieved by *in vivo* action of the natural hormone.

I thank Mrs. Grace Bowman for valuable techn assistance throughout this work, which was ported by grants from the Alexander and Marg Stewart Trust, the U.S. Public Health Ser (1897-C2) and the American Cancer Society.

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## Germanium in Some of the Waste-Products from Coal

IT is well known that many of the trace eleme of coal are enriched in certain of the waste produ such as flue dusts, resulting from the utilization the coal. Crawley[1], and Forrest, Smith and Wa have recently commented on the value of produ of this type as raw materials for the recovery germanium. In the course of work on the behavi of germanium and other trace elements during utilization of coal, we have obtained results sugge ing conclusions rather different from some of concepts implied in the note of Forrest *et al.*

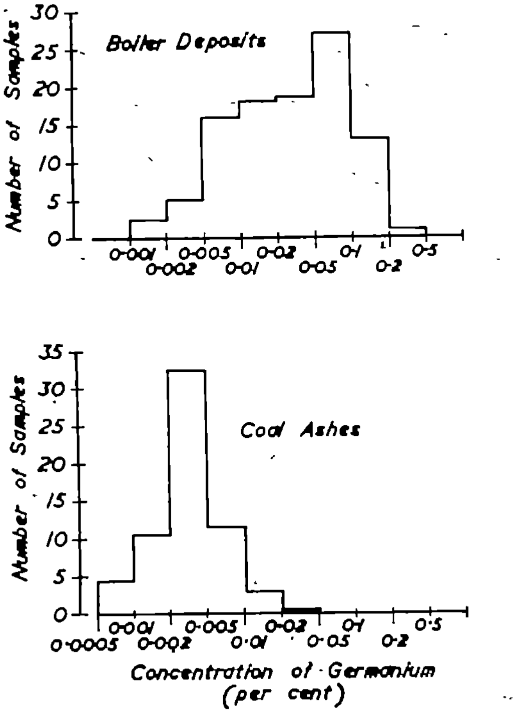
Samples of residual ash from the grates of stok fired boilers have been found to contain only relativ small quantities of germanium, ranging from l than 1 p.p.m. to about 12 p.p.m., with a mean va of about 3 p.p.m. On the other hand, coal samp similar to those being burnt in power stations ha been ashed under laboratory conditions where appreciable loss of germanium occurs, and the me germanium content of these ashes is much greate of the order of 50 p.p.m. It thus appears that duri the combustion of coal in stoker-fired boilers, t greater part of the element is volatilized from t fuel bed. The problem of obtaining germanium-ri material from such a combustion therefore seems be not so much the difficulty of volatilizing t element, as the means of collecting the volatili element at a sufficiently high concentration.

Our results also suggest that germanium is m likely to be incorporated in external boiler depos and flue dusts by the collection, or trapping, of ve small germanium-rich particles than by the co densation *in situ* of a volatile compound. For e ample, analyses of some hundred samples of exter deposits and flue dusts have shown no evidence any consistent fractionation of germanium wi respect to the general position of the deposit in t boiler system (see Table 1).

There is a tendency for deposits from the upp deck of steam-generating tubes to furnish a somewh richer material; but, on average, the deposits fro all regions in the flue system exhibit the same ord of enrichment of germanium. The frequenc

Table 1. AVERAGE ENRICHMENT OF GERMANIUM IN DEPOSITS FR VARIOUS ZONES OF A POWER-STATION BOILER

| Zone | Enrichment factor (relative to coal ash) | Average germaniu content (per cent |
|---|---|---|
| Lower deck steam-generating tubes | 10 | 0·05$_{8}$ |
| Superheater tubes | 10 | 0·05$_{7}$ |
| Upper deck steam-generating tubes | 20 | 0·1$_{1}$ |
| Economisers | 10 | 0·06$_{8}$ |
| Air heaters | 10 | 0·04$_{8}$ |



ig. 1. Frequency-distribution of germanium concentrations in power-station boiler deposits and in coal ash

tribution of the concentration values for these
ndred deposits compared with that for laboratory-
epared ashes from commercial grades of coal shows
similar effect; histograms for these two types of
terial are shown in Fig. 1, and indicate that
actically all the deposit samples show enrichment
their germanium contents, the most frequently
curring, lower, values for coal ash being virtually
represented in deposits. Incorporation of ger-
anium in deposits does not seem, therefore, to be
arkedly selective, and hence is more likely to consist
a physical trapping of solid particles than a
mperature-dependent condensation directly into
e deposit.

More evidence on this point has been obtained in
e examination of dusts taken from the waste-gas
ies of the built-in producers used for heating coal-
rbonization plant. It may fairly be assumed that
similar mechanism of transfer of germanium oper-
es in such plant, although the two cases differ in
at gas velocities are higher in boiler plant than in
ilt-in producer plant. It has been found that the
ry fine dust suspended in the chimney gases of a
ilt-in gas-works producer can contain up to 2 per
nt of germanium, and that this represents an
preciable proportion of the germanium originally
esent in the fuel. The presence of a germanium-
ch suspension, or smoke, in the flue gases resulting
om the high-temperature oxidation of coke appears,
erefore, to be established. A similar condition can
e inferred for stoker-fired furnaces.

It is possible that in power-station boilers the higher
te of gas-flow would decrease the chance of this
ne material being deposited on the flue surfaces,
nd that the proportions of germanium lost to the
tmosphere would be correspondingly greater than
ccurs in gas-works producers. Some of our results
pport this possibility; but the question is being investigated further. This consideration, however, is not likely to be the only reason for the lower concentrations encountered in power-station boiler deposits, as compared with deposits from the waste-gas flues of producer-gas plant. At the Fuel Research Station, maximum concentrations of 0·2 and 3 per cent respectively have been noted for these two types of material. Such differences may be due, in part at least, to different degrees of dilution of germanium by inert fly-ash particles: the higher gas velocity in the power-station boiler might be important in this respect also, by causing a greater deposition of larger ash particles which would of necessity have a relatively high diluting capacity.

This work forms part of the programme of the Fuel Research Board of the Department of Scientific and Industrial Research and is published by permission of the Director of Fuel Research.

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---

## Abnormal Freezing Nuclei in the Atmosphere

Freezing nuclei in the atmosphere are characterized by a critical threshold temperature below which, and only below which, they initiate the freezing of water droplets with which they may be associated. I have devised a simple method of testing whether or not there is at least one freezing nucleus in a given sample of air (about 200 c.c.) which is active at any given temperature; it is similar to that described by me in 1947[1], except that expansions are performed more slowly (lasting about 1 sec., and allowing droplet growth to follow the cooling).

During the past ten years, a very large number of measurements have been made with a similar apparatus in many parts of the world. The general result is that there are few nuclei which have a threshold temperature above − 32° C., but there are a fairly large number of nuclei which are active at this temperature or a little below.

In the winter of 1954–55, similar measurements were carried out in Panama. During the first six weeks these measurements indicated rather few nuclei and those with threshold temperatures about − 32° C. or little lower as found elsewhere. On January 13 a very large number of nuclei (more than $10^5$/m.$^3$) were suddenly found, and these with threshold temperatures as high as − 18° C. Such abundant freezing nuclei, active at this temperature, had never been observed before. These nuclei were continuously present until January 18, when nuclei with a threshold temperature of − 13° C. were found. These nuclei were present for another day, after which the threshold temperature gradually dropped to − 17° C. on January 30, and then there was a secondary maximum with nuclei present having a threshold of − 15° C. Thereafter the threshold gradually decreased until the normal value of − 32° C. was reached on February 17.

Experiments showed that the abnormal nuclei were large, since they were easily stopped by a short cotton-wool filter.

The appearance of the unusual nuclei was accompanied by prolonged, continuous rain, which is abnormal in these latitudes at this season. On January 14 the rain changed to showers; but heavy rain fell on January 17 and 18. The secondary maximum on January 30 was accompanied by many thunderstorms, after which the rains gradually died out.

Aircraft observations indicated that some of these rains were of 'warm' type; thus it appears that though the nuclei have been detected due to their exceptional freezing ability, they can also serve as efficient warm rain nuclei.

At first it was suspected that the abnormal nuclei were residues from the hydrogen bomb explosions, and the results were communicated privately to a number of scientific centres. As a result, Vincent J. Shaefer and Dr. E. G. Bowen reported that they had also found exceptionally heavy ice nucleation on Mount Washington and in Australia respectively on January 13. This apparent world-wide increase in nuclei agrees strikingly with the dates expected from Bowen's[2] meteoritic hypothesis and would seem to confirm it.

It would seem most desirable that regular measurements of ice nuclei having various threshold temperatures and of condensation nuclei should be made at a number of observatories widely distributed over the world, in view of their importance if Bowen's hypothesis is found to be correct.

*Note added in proof.* On May 23, 1955, nuclei with the threshold −13° C. were observed again and were present for two days. These nuclei correspond to the meteoric shower of Lyrids (April 21).

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Physics Dept., University of Panama,
Panama. May 3.

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## Isotope Shifts in the Spectrum of Helium

Experiments on various line series in helium[1,2] show that Hughes and Eckart's treatment[3] of the 'specific' isotope shift in this case is inadequate. Their wave functions take no account of configuration interaction, to which the specific effect is very sensitive.

The specific shifts of the $2^1S$, $2^3S$ terms of helium have now been calculated in the usual first-order perturbation treatment, using the wave functions of Hylleraas and Undheim[4] and Huang[5]. These wave functions include configuration interaction in an adequate manner. The constants for the Hylleraas–Undheim triplet function were kindly supplied by Prof. E. A. Hylleraas. The coefficients in their singlet function were calculated from the original data.

The results of the calculations are compared with experiment in Table 1. Some approximations were made in the calculation with the Huang triplet function; but it is estimated that the specific shift is accurate to the two significant figures given in the table. The results disagree with those found by Hamermesh and Eisner using the Huang wave functions and quoted by Fred *et al.*[1]. The experimental values are taken from Bradley and Kuhn[2], who estimated the term shifts by extrapolating the observed shifts of lines $2S$—$nP$ to the series limits. Fred *et al.*[1] found a residual shift of about 0·135 cm.$^{-1}$ for the $2^1S$ state, which agrees well with the value 0·13 cm.$^{-1}$ given by Bradley and Kuhn.

Table 1

| Shift | Term | Wave function | | | Ex |
|---|---|---|---|---|---|
| | | Hughes and Eckart | Huang | Hylleraas and Undheim | |
| $A$ | $2^1S$ | 0 | 0·159 | 0·149 | 0·1 |
| $A$ | $2^3S$ | 0 | 0·076 | 0·0758 | 0·1 |
| $B$ | $2^1S$ | 1·436 | 1·595 | 1·585 | 1· |
| $B$ | $2^3S$ | 1·728 | 1·799 | 1·799 | 1· |

$A$ = total term-shift minus normal term-shift (cm.$^{-1}$).
$B$ = total term-shift (cm.$^{-1}$).

The total term-shifts obtained from the calculat are all close to the experimental values. It is c cluded that nuclear motion makes by far the m important contribution to isotope shift in heli Further details will be published elsewhere.

I wish to thank Dr. H. Kuhn and Dr. J. A. Sp for their interest in this work. I am indebted to Department of Scientific and Industrial Research a maintenance grant.

A. P. Ston

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Oxford.
May 16.

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## Time Interval between Nucleogenesis and the Formation of Meteorites

While determining the radiogenic argon-40 conte of the Beardsley chondritic meteorite[1], a mass spect metric search for xenon-129 produced by decay iodine-129 was made. The total amount of xen which was observed was 5 × $10^{-9}$ c.c. (s.t.p.) fr a 29·86-gm. meteorite sample. Within the limits experimental error, this xenon had a normal isoto composition[2]. The ratio of xenon to argon-36 w in essential agreement with that found in air, dicating that this xenon was due to atmospheric co tamination. Since a 30 per cent increase in t abundance of xenon-129 over that observed in norm xenon would have been observable, this indicat that radiogenic xenon-129 was present in th meteorite to less than 1·3 × $10^{-11}$ c.c. (s.t.p.)/g H. E. Suess and M. G. Inghram (personal communic tion) have suggested that if the meteorites had be formed soon after the formation of the element they would contain an excess of xenon-129 due decay of iodine-129.

A lower limit for the time-interval $t$ between t formation of the elements and the last crystallizati of the meteorites may be calculated by assumi that iodine-129 and iodine-127 were originally ma in equal abundance, and that there has been no lo of xenon due to diffusion since the meteorite w last crystallized. The iodine-127 content is take to be 1 p.p.m. by weight, based on the values reporte by Fellenberg[3] for other stony meteorites. Th equation for $t$ is

$$t = \frac{T_{1/2}}{0{\cdot}693} \ln \frac{^{129}\mathrm{I}}{^{129}\mathrm{Xe}}$$

where $T_{1/2}$ is the half-life of iodine-129, $^{129}$I is th amount of iodine-129 originally formed and $^{129}$Xe the amount of xenon-129 now present in th meteorite due to the decay of iodine-129.

from the limit of detectability presented above, may conclude that $t/T_{1/2} > 23{\cdot}7$. Using the ue[4] of $1{\cdot}7 \times 10^7$ yr. for $T_{1/2}$, we obtain $t > 0{\cdot}41 \times$ yr. I. Noddack and W. Noddack reported a value $\cdot5 \times 10^{-2}$ p.p.m. by weight of iodine in meteorites[5]. is value is considerably lower than that reported Fellenberg. It is very doubtful whether the iodine tent of meteorites is any lower than the value of $\times 10^{-2}$ p.p.m. reported by the Noddacks. Using s lower value, we obtain $t/T_{1/2} > 17{\cdot}4$. It is clear t this calculation is very insensitive to such a nge in the iodine abundance. The critical effect of course, that of xenon diffusion. H. C. Urey rsonal communication) has pointed out that the line in stony meteorites may be bound on the surces of the mineral grains, and hence, the loss of non by diffusion might be greatly facilitated. This ect would cause the calculated lower limit for $t$ to too large.

The $^{40}$A—$^{40}$K age reported for the Beardsley teorite is $4{\cdot}8 \pm 0{\cdot}2 \times 10^9$ yr.[1]; thus, a lower it of $5{\cdot}0 \times 10^9$ yr. for the time since the formation the elements is obtained.

If the assumptions mentioned above are valid, and the Earth and the meteorites are cogenetic, all radioactive elements with half-lives short comred to $4 \times 10^9$ yr. would have decayed in the ne interval between nucleogenesis and the forman of the Earth and would, therefore, not contribute the heating of the primeval Earth.

We thank Prof. M. G. Inghram and Prof. H. C. rey for several stimulating discussions. This work s performed in part under the auspices of the .S. Atomic Energy Commission.

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Wasserburg, G., and Hayden, R., *Phys. Rev.*, 97, 86 (1955).
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## Distribution-in-Speed of Fading of 150-kc./s. Waves

A CONSIDERABLE amount of work has been done the 'speed of fading' of radio waves[1-5]. This antity, often referred to as $v_\tau$, denotes the change the amplitude in a certain time, $\tau$, expressed as fraction of the root mean square amplitude of e wave. The first-order theory indicates that the stribution-in-speed should be a normal one reprentable by:

$$p(v_\tau) = \frac{\exp(-v_\tau^2/4\varepsilon)}{\sqrt{4\pi\varepsilon}}$$

It has, however, been pointed out[4,5] that, if the lag used for the computation of $v_\tau$ be large, the firstder theory breaks down and the distribution sumes a form:

$$p(v_\tau) = \frac{\exp(-v_\tau^2/4\varepsilon)}{\sqrt{4\pi\varepsilon}}\,\varphi(\varepsilon_1 v_\tau)$$

where $\varphi$ is a monotonically decreasing function of $v_\tau$, the rate of decrease depending on the parameter $\varepsilon$. This leads to a distribution narrower than normal, which we will denote as the modified Gaussian distribution.

The value of the lag $\tau$ for which the breakdown becomes appreciable is greater the smaller the frequency of the radio wave. Hence it can be expected that the deviation from the normal form of the distribution will be evident more readily at higher frequencies than at lower frequencies.

Workers at Cambridge[2,3], using short waves, found distributions significantly narrower than normal. An extension of the analysis to lower frequencies has been made by us at the Pennsylvania State University, using the fading of 150 kc./s. waves. The slow rate of fading of these waves made it necessary for us to use much larger time lags than those used by the Cambridge School. However, no significant deviation from normality has been found. Fig. 1 indicates a typical distribution-in-speed. We have superposed the corresponding normal and modified Gaussian distributions on the histogram. It will be seen how the histogram is statistically indistinguishable from the normal. Also, the expected theoretical deviation is so small that a statistical distinction would not be possible. This seems to bear out the previous prediction that the similarity to the normal distribution would be more pronounced with long waves than with short waves.

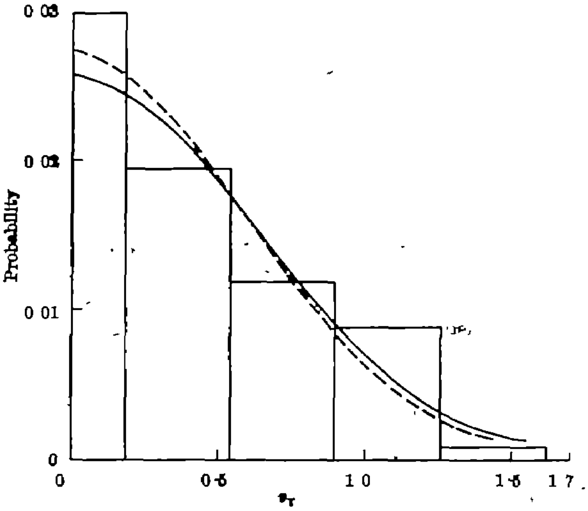

Fig. 1. Histogram for speed of fading with a lag of 20 sec. on March 8, 1952, at 0000. The normal distribution with $\varepsilon = 0{\cdot}19$ is shown superposed as a solid line. The dotted line shows the modified Gaussian distribution

This work was carried out with the support and sponsorship of the Geophysical Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command, under Contract AF19(122)-44.

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Jan. 8.

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# FORTHCOMING EVENTS

### Sunday, July 17—Friday, July 22

University of London (at Wye College, near Ashford, Kent)—Third International Conference on "Plant Growth Substances".

### Monday, July 18—Saturday, July 23

International Association of Applied Psychology (in the Beveridge Hall of the Senate House of the University of London, and Birkbeck College, Malet Street, London, W.C.1)—12th Congress.

### Tuesday, July 19—Friday, July 22

Association of Applied Biologists (at Oxford)—Summer Meeting.

### Thursday, July 21

Royal Society of Tropical Medicine and Hygiene (at the Hospital for Tropical Diseases, 4 St. Pancras Way, London, N.W.1), at 7.30 p.m.—Clinical Meeting. Chairman: Prof. R. M. Gordon, O.B.E.

### Thursday, July 21—Saturday, July 23

Royal Meteorological Society (at Ashburne Hall, University of Manchester, Fallowfield, Manchester)—Symposia on "Some Aspects of Turbulence in the Atmosphere" and "Oceanographic Topics".

### Saturday, July 23

Association of Clinical Biochemists, Southern Region (at the Central Laboratory, Milton Road, Portsmouth), at 11 a.m.—Scientific Papers and Demonstrations.

### Saturday, July 23—Sunday, July 24

British Psychological Society, Northern Branch (at the University College of North Staffordshire, Keele, Stoke-on-Trent, Staffs)—Scientific Papers.

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Chemistry at the College of Further Education, Grimsby—The Director of Education, Education Office, Eleanor Street, Grimsby (July 23).

Tutorial Student in Theoretical Physics—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (July 23).

Lecturers (2) in Electrical Engineering—The Secretary of University Court, The University, Glasgow (July 25).

Assistant Lecturer or Lecturer (with qualifications in physical and inorganic chemistry) in Chemistry—The Registrar, The University, Hull (July 30).

Assistant (preferably with qualifications in physical geography) in Geography—Joint Clerk to the University Court, Queen's College, Dundee (July 30).

Chair of Mathematics at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (July 30).

Lecturer or Assistant Lecturer in Botany—The Registrar, The University, Birmingham (July 30).

Scientific Officer (with a first- or second-class honours degree in engineering or applied science with a knowledge of soil mechanics, or equivalent qualifications) at the Road Research Laboratory (D.S.I.R.), Harmondsworth, Middlesex, to act as Assistant to the Colonial Road Research Liaison Officer, and visit Colonial territories to assess road problems suitable for research, advise on road works, disseminate information and answer inquiries, and undertake research into problems relating to Colonial roads—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.378/5/A (July 30).

Assistant Professor or Professor in Mathematics, and an Assistant Professor in Physics, at the Higher Teachers' College, Baghdad, Iraq—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7 (July 31).

Lecturer or Assistant Lecturer in Mathematical Statistics in the Department of Applied Mathematics—The Registrar, The University, Liverpool (August 8).

Lecturer (with a university degree or equivalent qualification, and preferably some teaching and industrial experience) at the Ministry of Supply School of Electronics, to teach electronics and mathematics to H.N.C. standard—The Principal, School of Electronics (Ministry of Supply), Malvern, Worcs (August 8).

Research Assistant (with experience in practical microscopy) in the Department of Metallurgy—The Registrar, The University, Manchester (August 8).

Lecturer in Education at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 12).

Lecturer (with qualifications in chemistry or biochemistry and a wide experience in the biochemistry of steroids) in Pathological Biochemistry at the Royal Infirmary—Secretary of University Court, The University, Glasgow (August 13).

Lecturer in Applied Mathematics at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 15).

Senior Lecturer in Zoology at the University of Sydney, Aust —The Secretary, Association of Universities of the British Comm wealth, 36 Gordon Square, London, W.C.1 (Australia, August 15

Lecturer (preferably with special qualifications in micro- semi-micro analytical techniques) in Chemistry—The Secretary, University, Aberdeen (August 20).

Lecturer (with special qualifications in physical chemistry) Chemistry—The Secretary, The University, Aberdeen (August 20

Lecturer in Philosophy at the University of Melbourne, tralia—The Secretary, Association of Universities of the Bri Commonwealth, 36 Gordon Square, London, W.C.1 (Austr September 5).

Deputy Director (with high academic qualifications and rese experience in one or more of the cognate sciences: biochemis chemistry or pedology, together with administrative ability)— Secretary, Macaulay Institute for Soil Research, Craigiebuck Aberdeen (September 15).

Chemist (with at least H.S.C. in science subjects, or equival qualifications, and preferably experience with thermal diffusion, B heaters and radioactive gases), to work in gas handling with vacuum apparatus—Establishment Officer, United Kingdom Ato Energy Authority, Atomic Energy Research Establishment, Harw Didcot, Berks, quoting 2/103/353.

Demonstrator (with qualifications in bacteriology and an inte in the physiology of bacteria) in the Department of Botan The Registrar, The University, Nottingham.

# REPORTS and other PUBLICATION

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

No Man is an Island: a Re-statement of an Historic Testim Against War. By Reginald A. Smith. Pp. 7. (London: Friends Pe Committee.) 4*d*.

Department of Scientific and Industrial Research. Report of Pest Infestation Research Board, with the Report of the Director Pest Infestation Research for the year 1954. Pp. iv+54+4 pla (London: H.M. Stationery Office, 1955.) 3*s*. net.

Ministry of Agriculture and Fisheries. Bulletin No. 149: Fa Grain Drying and Storage. Pp. iv+121+12 plates. (London: H. Stationery Office, 1954.) 5*s*. net.

British Coal Utilisation Research Association. Annual Report, 19 Pp. 66+4 plates. (Leatherhead: British Coal Utilisation Resea Association, 1955.)

University of Leeds. British and American Policies in the Far E Since 1900. By G. F. Hudson. (Thirteenth Montague Burton Lect on International Relations.) Pp. 18. (Leeds: The Univers 1955.) 6*d*.

### Other Countries

Connecticut Agricultural Experiment Station. Bulletin 578: So Insects and Their Control. By J. C. Schread. Pp. 23. Bulletin 57 Report on Inspection and Analysis of Commercial Fertilizers, 19 By H. J. Fisher. Pp. 64. Bulletin 580: Significance of Sand Gravel on the Classification, Mapping and Management of So Coarse-Texture Soils. By C. L. W. Swanson and A. Ritchie, Jr. 46. Bulletin 581: Preservation of Wood by Simple Methods. By Hen W. Hicock and A. Richard Olson. Pp. 66. Bulletin 582: Report Inspection—Commercial Feeding Stuffs, 1953. By H. J. Fish Pp. 116. Bulletin 583: Studies of Soil Fauna, with special refere to the Collembola. By Peter F. Bellinger. Pp. 67. Bulletin 584: T Morphology, Mineralogy and Genesis of Two Southern New Engla Soils. By G. A. Bourbeau and C. L. W. Swanson. Pp. 59. Circul 185: Birch Leaf Miner Control. By John C. Schread. Pp. 6. Ci cular 186: Control of the Gypsy Moth. By Neely Turner and C. Cooke. Pp. 6. Circular 187: Commercial Peat and Native Orga Materials in Connecticut. By H. G. M. Jacobson and C. L. W. Swans Pp. 5. Circular 188: Ants as Pests. By John C. Schread and Nee Turner. Pp. 4. Circular 189: The Toxicity to Plants of Wood Pres vatives and their Solvents. By Henry W. Hicock and A. Rich Olson. Pp. 4. (New Haven, Conn.: Connecticut Agricultural Expe ment Station, 1954.)

Companhia de Diamantes de Angola. (Diamang.) Servicos Cu turais. Dundo—Lunda—Angola. Publicacoes Culturais No. 2 Museu do Dundo—Subsidios para o Estudo da Biologia na Lund Estudos Diversos (X). Pp. 135. (Lisboa: Companhia de Diamant e Angola, 1955.)

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# SOCIAL IMPLICATIONS OF AUTOMATIC CONTROL IN INDUSTRY

HE broadsheet "Towards the Automatic Fac-
tory", issued by Political and Economic Planning
. 380; June 13, 1955), appeared almost simul-
ieously with a conference at Margate, June 17–19,
anged by the Institution of Production Engineers,
ich has given wide currency in Britain to the term
tomation', coined by the Americans to cover
velopments towards automatic operation and
ntrol. This conference, which was the first expert
thering in Britain to approach the subject com-
hensively and systematically, was attended by
re than a thousand engineers, scientists and factory
nagers, and both the broadsheet and the con-
ence have done something to clarify ideas as to the
tinction between mechanization and 'automation',
d also to indicate both the practical possibilities
d the limitations of the automatic factory, and the
man, as well as the technical, problems that are
volved. They indicate the possibilities which the
pid technological developments of the post-war
ars have opened up and something of the impli-
tions not merely for industry, but also for science,
education and for society in general.

'Automation' was defined by R. K. Geiser at a
nference on automation and industrial develop-
nt at Syracuse, New York, in May 1954, as "the
complishment of a job by an integrated mechanism
th a minimum of assistance of any kind". Full
tomation, in this sense, does not yet exist, though
may be achieved in a suitable industry before the
d of this century. Any technical development that
ables a machine or instrument to dispense with
bour is a step in this direction; but whereas
chanization has largely displaced physical effort,
e new developments are making automatic some of
e work that was formerly done by the human
ains. The real distinction, the broadsheet points
t, is between automation that displaces muscle and
tomation that displaces brain, and it is roughly the
me distinction as that between automatic operation
d automatic control.

The industrial revolution of the nineteenth century
s a change towards automatic operation; but
chanization was limited to individual processes,
d only in a few suitable trades was it possible to
ovide automatic links between processes and
ganized production as a continuous flow. Not until
e twentieth century was the idea of producing
ods in a continuous flow rather than in batches
dely applied, and then at first it was confined to
dustries in which the movement of materials is
raightforward. By the 1920's, some automatic
struments were introduced into most processing
dustries, and since 1945 the rate of change to auto-
ation has quickened, partly because of technical
velopment during the Second World War and
rtly under the stimulus of the shortage of labour.
Of these developments two are outstanding: the
chanization of the handling of materials in factories by new devices such as fork-lift trucks, and the introduction of transfer machines which perform two or more operations and automatically pass materials from one to the next. The developments in automatic operation, however, while extending the area of application, particularly to the transfer and handling of materials, are not revolutionary but part of a well-established trend. Those in automatic control have been considerably more drastic, and arise largely from the recent and sudden application of electronic methods of control, although electro-mechanical, pneumatic and hydraulic as well as electronic devices have also contributed. The electronic devices, however, are rapidly gaining in importance and hold out exceptional promise for development in the future.

These devices can plan and control the operation of a machine tool with high precision. They can detect faults in a processed part, and by means of a closed-loop circuit (known as 'feed-back') can communicate the error to the machine and adjust its operation so as to correct the fault. They can integrate the work of individual machines, and the more complex devices can select alternative courses of action according to the instructions fed into them, while finally the possibilities of remote control are extended.

The ability of new devices to detect, communicate and control can greatly reduce the amount of routine brainwork performed in factories, and it is the prospect of rapid technological advance reducing the part played by human labour in the factory to skilled supervision and maintenance that is responsible for excitement about the possibilities of automation. Both the broadsheet and the conference at Margate should dispel any illusions as to the pace with which automation is likely to speed. Not only is much more hard work required before automation becomes general, apart from the limitations set by the availability of the machine tools or the trained engineers required; but also automation has already gone a long way and the number of industrial processes that are ripe for it is limited. More important still, rapid progress with automation depends on complex economic factors to which little thought has yet been given.

It is these economic problems and the social and human implications that require most consideration, and the conference and the broadsheet help to balance and counteract some of the more sensational pictures of the robot factory which have received currency. It is true that, as PEP notes, generally speaking, automation presents no economic problem that has not been created already by the mechanization of processes. There is no conclusive evidence that automatic devices are much more costly to buy than most non-automatic machines; but automation nearly always calls for a large initial outlay and for major changes in production planning.

Computers, for example, have two main advantages: a 'memory' which stores a very large number of facts and gives access to them, or makes computations with them, much faster than is possible with a punched-card system; and secondly, the possibility of automatic links with other office machines, which enable the computer to control the operation of these machines and the passage of information from one machine to another. Continuous research and experiment with computers may make possible all manner of improvements in factory and office methods that so far have been precluded by the inability of human brains to compute the data fast enough or extensively enough. At the same time, it may well be found that the potential saving of labour is limited to firms with large staffs engaged on lengthy mathematical routines. Medium and small firms are scarcely likely to adopt automatic techniques much faster than at present, unless capital costs are greatly reduced by simplification, standardization and other means.

A second problem concerns labour and productivity. As the broadsheet remarks, the post-war trend towards automation would have been much less pronounced but for full employment and the high cost of labour. According to the report of the Committee on Economic and Financial Problems of the Provision for Old Age, the British labour force can be expected to increase only from 23·3 million in 1954 to 24·4 million in 1979. Any substantial increase in living standards must therefore arise from higher productivity, and if the Chancellor of the Exchequer is right in his forecast that the standard of living in Britain can be doubled in that period, the gross national production must be raised by 110 per cent, or allowing for a 10 per cent reduction in working hours, by 123 per cent per man-hour, or 3 per cent a year compared with the present 2·3 per cent and a best long-run increase of only 1·5 per cent a year. If Britain embarks on rapid economic expansion, only a very rapid increase in productivity can avert an acute shortage of labour.

Leaving for the moment the disturbing evidence of the recent strikes that the trade unions are, to say the least, reluctant to face the implications and are looking backwards rather than forwards, the adoption of automatic operation and control may be retarded not merely by hesitancy on the part of firms to invest capital in machinery and equipment which will not be fully or efficiently used, but still more by the shortage of scientists, engineers and technicians competent to undertake the research, design and development that automation will need and will make possible. It was stated at the open day on June 24 of the Culcheth Laboratory of the Atomic Energy Authority that at present the Authority has on its staff only one-tenth of the scientists it needs competent to take charge of a research programme involving direction of the work of a dozen or more juniors. Recruitment for the junior grades is easier, and the director of the Research and Development Section, Mr. L. Rotherham, believes that the difficulty will disappear after some years as existing staff acquire experience.

That, however, is only one example of a short of scientists and technologists which is believed to already hindering the full development of our ind trial capacity and which may well be intensified a continued increase in automation. Since the tc population and the labour force of Britain will rem fairly constant, the quantity and variety of scient and technological skill in the country can only increased if a much higher proportion of you people qualify in that way than at present. Ap from the diversion of interest among suitable you men and women, this implies an immediate expans of training facilities, making a heavier demand wh shortage is already most acute—in teachers of scien

That is one aspect which makes the question science teachers and the expansion of technologi and technical education in Britain matters of natio policy to which the Government should be giving first priority. Unless this is done, and unless it done in balance with the expansion of secondary a university education, it is improbable that there w be in the foreseeable future an adequate supp either of newly trained scientists and technologi for such exacting and specialized work, or of tec nicians and operators generally of the flexibility a adaptability necessary to ensure that full use made of the services of the more highly train scientist and technologist.

Automation thus raises the question of educati for an era of technological change in the broad possible context, from that of general education that of the highly specialized scientist or technologi from the school to the university or institute technology, and from the manager to the operat Nor should the implications in respect of leisure a its use be overlooked. As already noted, increas productivity is likely to be accompanied by increase in leisure, and this can only be detriment to a community that is unprepared or unable make profitable use of that leisure.

No less acute are the problems raised in respect power. The increase in the consumption of pow results chiefly from replacing human energy machinery, and automatic devices will not direct add much to the demand for power. Indirectl however, like other means of increasing productivit they force up the demand for power because th enable the same labour force to produce more goo Moreover, until nuclear power contributes appreciab to total energy supplies, industrial expansion c only be rapid if supported by large imports of co and oil; this has been emphasized in the nin annual report of the National Coal Board, and confirmed by the decision of the Central Electrici Authority to convert seven of its power stations fr coal- to oil-firing and by the warnings given by Claud Gibb and Mr. J. Eccles at the British Electric Power Convention on June 29.

Here again we are dependent to some extent the supply of scientists and technologists, for if imports are seriously expanded, domestic refine capacity must be expanded accordingly, with concomitant demand for technicians and techi sts. The over-riding human problems, however, those of management and labour. Automation severely test the flexibility of modern manage- it and will involve radical changes in attitude to blems of production engineering and factory lay- . There were, indeed, no more promising features the Margate conference than the awareness of ineers there of the social implications and of their cern to minimize any strain which the change- r might involve for the work-people.

ir Walter Puckey in his opening address to the ference suggested that work-people would be ter off and anticipated no considerable unemploy- nt: more skilled workers would be needed, and ) better facilities for technological education and nore effective application of scientific innovations industry. He emphasized, however, that more cibility would be required and greater readiness move from unskilled to skilled occupations. Mr. C. Woolland and Lord Halsbury were also re- uring on the point of unemployment; but Lord lsbury was concerned about possible misfits, and of. B. R. Williams stressed once more the import- e of education, urging that our present educational ilities are inadequate.

iven, however, this sense of social responsibility the part of management, scientist and techno- ist, what of the attitude of labour? Here the ference was a little more hopeful than the recent f-yearly report from the General Council of the des Union Congress to the Unions, which has ely begun to face the issues. Mr. Eric Fletcher ite rightly emphasized the need for giving the de unions full and early information of impending nges, and said that "the Trade Union Congress uld co-operate if there was a background of good tions, consultation and redundancy procedures, luding control of intakes". Re-training, he said, a responsibility of management. Apart from ognizing that an increasing amount of shift-work l be necessary, however, Mr. Fletcher gave little lication that the trade unions are thinking deeply out what contribution they can make to a common oblem, and how far their own restrictive practices archaic methods may prevent the community joying the full benefit of the new potentialities.

Redundancy, or rather the threat of it, is almost tainly the main cause of alarm and hesitancy iong the trade unions, although, as PEP points t, the facts do not suggest there will be serious employment. More than half the British labour rce is engaged in construction, agriculture, mining, stribution, personal services or self-employed cupations, which are unlikely to become highly tomatic in the near future. Local unemployment, wever, may well occur, depending on the speed of chnical change; and if, as is probable, the change mes slowly, the problem may be solved by slowing wn recruitment. National policy, too, could help scheduling the towns affected as development eas, by persuading firms short of labour to set up anches there and by fostering re-training schemes id greater mobility of labour.

The decisive factor, however, may well prove to be the attitude of the trade unions. It may involve not only open-mindedness to automation and a readiness to recognize the benefits it can bring to labour itself, but also less rigidity to changes in union structure and relations. Apart from the effect of migration of labour to service trades from the general and industrial unions, new unions may perhaps be required to meet the needs of new types of worker. Apart from this, wage-structures are likely to be outdated by automation, and the question of differentials between skilled and unskilled labour could well become acute.

The crucial issues, as PEP emphasizes, are in fact likely to be economic, social and administrative rather than technical; but the key to the solution of all the major problems is in education. In the unions no less than in management, there must be a readiness to look at the problems and issues not from a sectional point of view but from that of the public interest, and to look forward rather than backward. If they are faced responsibly by both sides and there is readiness to work together constructively, discarding obsolete and restrictive practices no longer appropriate in the social welfare State or consonant with the prospect that automatic methods and controls offer the community, the change may well be made without serious unemployment or creating dissatisfaction among the workers.

Clear understanding of the problems on all sides is essential, and the Margate conference should only be a prelude to further discussions and to more carefully planned research. The Department of Scientific and Industrial Research is already collecting information and assessing trends over a wide field of industrial activity, and the report on its findings will be eagerly awaited. Its joint committee with the Medical Research Council, on Human Relations in Industry, has sponsored a small pilot research project in the University of Cambridge into some human and social aspects of introducing automatic control techniques into industry. With this research, however, should go also interpretation and constructive thinking about the many complex issues involved, so that the way may be prepared for effective, enlightened and responsible action. That is a task in which many scientists who are alive to the implications of scientific advance for industry and society could well share.

# RADIO TECHNIQUES IN METEOR ASTRONOMY

Meteor Astronomy

By A. C. B. Lovell. (International Series of Monographs on Physics.) Pp. xiv+463+8 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 60s. net.

THE derivation of precise information of meteor paths and velocities by direct visual observation is a task rendered peculiarly difficult by the transient nature and feeble brightness of the luminous paths produced by meteors as they enter the earth's upper atmosphere. Except during the major meteor showers, comparatively few meteors can be seen per hour in the clear night sky. It is much to the credit of the visual observers that so much should have been learnt in past years of the characteristics of meteors. It is also understandable, with the uncertainties of visual observations and the difficulties of analysis, that controversy should have arisen about the celestial mechanics of meteors.

The mainspring of dispute has been concerned with the sporadic meteors which continue their activity throughout the year. If these meteors move in orbits within the solar system, their velocities at the distance of the earth from the sun must not exceed 42 km./sec., at which limiting velocity the orbits become parabolic; if the velocities are higher, the orbits are hyperbolic and interstellar origin is indicated. There has long appeared to be evidence favouring hyperbolic velocities and culminating in the Harvard–Cornell meteor expedition in Arizona during 1931–33, which led Öpik to infer that at least 60 per cent of sporadic meteors have velocities in excess of the parabolic limit. The evidence has been criticized on the grounds that the observational data were too uncertain, and Prentice and Porter concluded from British meteor data that very few meteors have hyperbolic velocities.

Whereas it might well have been forecast before the Second World War that photographic methods, which had hitherto lacked sensitivity, might be so improved as to provide an important means of obtaining precise data, a result which is now being achieved by Whipple and others at Harvard with the aid of super-Schmidt cameras, it could scarcely have been foretold that the most striking advance would come from radio. Although the meteoric origin of spasmodic increases in ionospheric reflexions had long been suspected, it was the development of radar during the War which enabled Hey and Stewart to prove conclusively that the short-duration echoes seen on long-range radar at metre wave-lengths were from the ionized trails of meteors. Since then, tremendous progress has been made in this field by Prof. A. C. B. Lovell and his group at the University of Manchester. Important contributions have also come from McKinley and Millman in Canada. The radio methods have a great advantage in that observations are unrestricted by weather or daylight. The ascendency of radio techniques could not be more clearly demonstrated than by the fact that Prof. Lovell should be the author of this new book on the measurement of the paths, velocities and mass distribution of meteors, and the derivation of their orbits.

After introductory chapters describing observational principles, Prof. Lovell sets his account of the impact of radio methods on meteor astronomy in the first half of the book against the background of the sporadic meteor problem. The various stages of the controversy are described, with details of methods of analysis and numerous tables from the original papers. Prof. Lovell leads up to recent visual and photographic work and the extensive radio data which have confirmed that very few meteor velocities exceed the parabolic limit. It is feasible that a few may acquire hyperbolic velocities as a consequence of planetary perturbations. It is now almost generally accepted that sporadic meteor orbits are within the solar system.

The second half of the book deals with the less controversial topic of the major meteor showers. It is thirty years since the publication of Olivier's "Meteors", and not only has much new material from direct visual observations since been obtained, l also recent radio and photographic data have grea refined the determination of meteor stream orb: Only the radio method is capable of detecting d time meteors, and a most notable discovery has b the exceptional summer daytime activity. Pr Lovell's concluding chapters deal with theoreti work on the dispersive influences of planetary p turbations, and cosmological problems of the ori of meteors and the relation between the orbits meteors and comets.

Prof. Lovell's book is a comprehensive up-to-d account of meteor astronomy. Parts of it are ı easy reading; this is largely because the author l included much of the analysis of the original pap in condensed form. The book is clearly set ou there is no difficulty in following the general ar ment, and one can return later to particular sectic for detailed study. As in other branches of scien progress is rapid and there is a profusion of publish work. In these circumstances there is much ne to have available surveys which co-ordinate pa achievements. Especially where there is controver is it necessary to put the differing views into p spective. The book admirably fulfils this requiremei

J. S. HEY

## CAMBRIDGE MONOGRAPHS IN EXPERIMENTAL BIOLOGY

### The Physiology of Insect Metamorphosis

By Prof. V. B. Wigglesworth. (Cambridge Mon graphs in Experimental Biology—No. 1.) Pp. viii 152+4 plates. (Cambridge: At the Universit Press, 1954.) 12*s*. 6*d*. net.

### The Genetics of *Paramecium aurelia*

By G. H. Beale. (Cambridge Monographs in Exper mental Biology—No. 2.) Pp. xi+179. (Cambridg At the University Press, 1954.) 12*s*. 6*d*. net.

THESE two little books are timely, readabl scientifically apt and of just the right length f those who want to know what is going on in a fiel without being fuddled with technical details. Bo authors and editors are to be congratulated on t excellence of these first two volumes of a new seri of monographs.

Prof. V. B. Wigglesworth's book contains an intr ductory chapter on polymorphism and metamo phosis, followed by three chapters on histologic changes during moulting and metamorphosis; th physiology of growth and moulting; and th physiology of metamorphosis. The concludin chapter is on differentiation and polymorphism The approach to metamorphosis is made mainly b a lucid analysis of the humoral mechanisms involve The hormones "release, control and direct" the in herent capacities of the cells of the tissues, and ult mate understanding of the nature of metamorphos must depend upon an understanding of the cellula substrate upon which these hormones act. Thi matrix may perhaps be regarded as a cytoskeleto which may to some extent be continuous even a the supracellular level. Polymorphism is due t alternative reactions of this substrate to alternativ humoral (or other) stimuli, and metamorphosis i regarded as a special case of polymorphism.

Dr. G. H. Beale's introductory chapter is concerned with the general importance of nuclear an plasmic inheritance. He goes on to present ain characteristics of *Paramecium aurelia* which important from a genetical point of view. He describes successively the data on 'killer' and sitive' stocks, on the antigens of paramecium on mating types. His concluding discussion is *attempt* to evaluate the general importance of eritance which is not due to chromosome genes. subject-matter of the book arises mainly from work of T. Sonneborn, and Dr. Beale's own estigations have greatly illuminated the genetical blems.

Among the many interesting phenomena, none eeds in importance the observation that, with a en set of nuclear genes, alternative sets of surface igens may exist. These sets are mutually exclusive, that only one set may be found in any given ividual. Which set does exist depends upon the vious history and present environment of the mal.

The subject-matter of these two books is quite ferent; the authors mention neither one another one another's most favoured research material. t despite this, both books are important con- butions to the general problem of differentiation d modulation. They will be of great interest not y to entomologists and to geneticists, but also to biologists who are interested in the controlling chanisms which determine the characteristics of imals.

J. F. DANIELLI

# PLANT GROWTH REGULATORS IN AMERICAN AGRICULTURE

ant Regulators in Agriculture

dited by H. B. Tukey. Pp. x+269. (New York: hn Wiley and Sons, Inc.; London: Chapman and all, Ltd., 1954.) 44*s*. net.

THIS book is in effect a symposium, written by a panel of experts, "for the many who have been zzled . . . at their seeming inability to grasp the nificance of plant growth regulators, what they e, how they operate and where they belong in riculture". Only the last-named point has been tisfactorily and consistently covered by this book that is, their place in agriculture. Thus the very ide range of practical application of those synthetic rganic chemicals, now unfortunately come to be nown almost universally as plant growth 'regulators', as been thoroughly surveyed and our knowledge rought up to date. Comprehensive as this review ay be for the American farmer and fruit-grower, its ppeal outside the American Continent will be more mited, since little attention is paid to problems om other parts of the world. Thus only one page ut of the 224 of text is devoted to weed control in mall-grain cereals—a major interest of European rmers. Its value for the non-American is further ffset by the exclusive use, in some chapters, of the ommon American name for crop plants. Thus snap bean" would mean so much more to a European its botanical name were appended.

An exposition of the biological significance and ode of action of plant 'regulators' is only spas- odically attempted, despite three somewhat 'bitty' ntroductory chapters which set out elementary facts nd general principles. The consequent confusion the mind of the layman will not be helped by the fact that the whole polyglot collection of physiologically active compounds are only too frequently considered purely in relation to the general growth symptoms they cause in the plant, and with little regard to the wide diversity of their fundamental actions in the cell. After all, both influenza and a brick on the head will cause a headache.

The main deficiency of this book is therefore the absence of a unifying theme, and this arises from the symposium technique of writing a book. However well meaning an editor may be, it will be difficult for him, short of rewriting whole sections of text, to mould difficult subject-matter such as this into a connected story and to eliminate the overlaps arising between articles of writers with competing interests. It is to be regretted that many of these overlaps were not avoided by allowing the whole of a given field of application to be covered by one author instead of sharing it out between a number of narrow specialists. Some of the contributors have produced excellent articles fulfilling completely the aims set out for the book as a whole. Chapters of this kind are those on parthenocarpy and fruit development in relation to plant regulators; abscission and plant regulators; and plant regulators for weed control in the tropics. Fewer contributions of this quality, each covering one major aspect of plant growth control, would have yielded a much better book.

A final chapter, dealing exclusively with apparatus for the application of chemical growth regulators, will be of considerable interest, although its direct value to the user outside America will depend on the type of equipment available in his country. The book is well produced, and there are many excellent photographic and line illustrations and tables giving details of plant responses to specific regulator treatments in America.

L. J. AUDUS

# AMERICAN EPHEMERIS AND NAUTICAL ALMANAC

The American Ephemeris and Nautical Almanac for the Year 1956

Pp. xvii+644. (Washington, D.C.: Government Printing Office, 1954.) 4 dollars.

THIS issue for 1956 of the "American Ephemeris and Nautical Almanac" follows its usual method of arrangement and is in many respects identical with that of the "Nautical Almanac" published in Great Britain. But in other ways it differs from its British counterpart in contents and also arrangement. A few of the points of difference may be noted here.

The American work gives the heliocentric longitude and latitude for all the planets, whereas the British one gives those for Mercury only; the former is a decided advantage, especially for those who have not got a copy of "Planetary Coordinates". The Besselian elements of the eclipses of the sun are given to the fifth significant decimal in the "Nautical Almanac", which is regarded as sufficiently accurate for computational purposes, but the "American Ephemeris" has seven significant figures; the last two figures can have little or no meaning, but this number has appeared for a long time. The same thing applies in other cases; for example, in mean places of stars, both in right ascension and declension, two extra figures are given by the "American Ephemeris" in the seconds. Under sunrise, sunset and twilight, it supplies the times for each five days, the latitudes corresponding with those of the 'Nautical Almanac', but the latter supplies the times for each day, which is a considerable advantage. In addition, for the southern hemisphere, the "American Ephemeris" gives a table with corrections to apply for the corresponding latitude in the northern hemisphere for a date about six months earlier or later. There is a certain amount of inconvenience in turning back the pages for references and, on the whole, the British scheme, while occupying more space, has the advantage of simplicity. Under phenomena, opposition, conjunctions, etc., of planets, the "American Ephemeris" gives the information in a very convenient form by using the symbols for the planets and also for oppositions, conjunction, etc.; but this system does not readily lend itself to showing in tabular form the conjunctions of planets with bright stars, which occupies about half a page in the 'Nautical Almanac".

The list of active observatories, which was discontinued in the "Nautical Almanac" after 1941, has been resumed in the 1955 issue, and includes 225 active observatories, but in general is restricted to those observatories the accurate positions of which are required for reduction of observations. The American list contains 223 active and 90 inactive observatories, but includes also the names of many observatories which do not appear in the "Nautical Almanac"—likewise the latter has the names of many observatories which do not appear in the "American Ephemeris". For this reason, each publication may be regarded as complementary to the other with regard to names of the observatories throughout the world.

# LAURENTIAN HORMONE CONFERENCE, 1953

## Recent Progress in Hormone Research

The Proceedings of the Laurentian Hormone Conference. Edited by Gregory Pincus. Volume 10. Pp. viii+511. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 9.80 dollars.

THE Laurentian Hormone Conference, inaugurated in 1943, continues to provide a forum for the discussion of current endocrinological research. Vol. 10 of its proceedings gives an account of the meeting that took place in September 1953, and deals with six main subjects: the interaction of neural and hormonal mechanisms; thyroid hormone; comparative endocrinology; protein hormone (in particular, insulin and corticotrophin); the influence of hormones on blood formation; and clinical endocrinology. This is a very wide field for one conference, and the fourteen reports which were prepared as opening papers will not appeal equally to all research workers.

Invertebrate endocrinology was the only topic completely new to the Conference. Here Dr. D. Bodenstein presented a useful review of endocrine mechanisms in insects, and the discussion it stimulated led directly into a paper by Ernst and Berta Scharrer on the hormones produced by neurosecretory cells. This subject is one of the growing-points of comparative endocrinology. By neurosecretion is meant the release by nerve cells of substances in aggregates large enough to be visible in supravital preparations at moderate magnifications. Much evidence, part histological, part experimental, now indicates t the neurons of the hypothalamic nuclei supraopti and paraventricularis secrete the hormones that to now have been regarded as the product of posterior lobe of the pituitary gland. The Schar regard the latter as a storage organ, and they a note that the fibres which transmit the neu secretory material from the hypothalamus to posterior lobe come into contact with the prim capillary loops of the vessels through which anterior pituitary receives its blood supply. Acco ingly, they suggest that the neurosecretory substan which is the visible counterpart of the active princi of the posterior lobe, might also be responsible the chemical control of the secretion of the anter lobe.

This paper stimulated an interesting discussi Dr. M. Vogt suggested that, while the hypothalam nuclei may be responsible for elaborating the poster lobe hormone vasopressin, oxytocin is produced the posterior lobe itself. Prof. G. Harris did n agree that the Gomori-stainable material seen in t axons which pass through the median eminence their way from the hypothalamus to the posteri lobe could be responsible for the activation of t anterior lobe, his reason being that there is evidence that electrical stimulation of the supr optico-hypophysial tract will liberate any anteri pituitary hormone. On the other hand, Dr. R. Porter, who earlier in the Conference had present a paper dealing with the part played by centr neural mechanisms in the so-called stress respons had reached the apparently contrary view that th median eminence, of which probably the major com ponent is the supraoptico-hypophysial tract, essential for the transmission of hypothalam influences to the anterior pituitary. Another questi that was raised was whether the same neurones whic are involved in neurosecretion also have resting an action membrane potentials, and whether they a capable of being excited by electrical stimuli, or conducting impulses. To this, as to many oth questions, there were no answers.

As one reads through the papers and the record discussions, one is inclined to feel that far too man points are raised, and far too few answered. O wonders, for example, why the possibility was n suggested that anterior pituitary hypofunction aft lesions in the median eminence, like that after stal section, is due to nothing more specific than th interruption of the gland's main blood supply, whic cannot fail to be interrupted either completely c partly when the median eminence is damaged. On wonders, too, why, in the discussion of H. A. Lard and G. F. Maley's paper on the metabolic effects c thyroid hormone *in vitro*, critical questions about th main hypothesis under discussion should be raise not once, but twice—and still left unanswered. Bu thoughts like these are perhaps as ungracious, as i is invidious, to direct them to a few out of so man excellent papers. The Laurentian Conference is a intimate affair, almost a club. It meets once a yea and clearly those who attend would not repeat thei visits if the free discussion and speculation th Conference allows did not provide a stimulus to thei further work. But some may wonder every now an then whether the progress of endocrinology woul not be better assured if some of the kites flown a the meeting were occasionally better fashioned, an their strings under more critical control.

S. ZUCKERMAN

## ence and Freedom

e Proceedings of a Conference convened by the
ngress for Cultural Freedom, and held in Hamburg
July 23rd–26th, 1953. Pp. 295. (London: Martin
ker and Warburg, Ltd., 1955. Published for the
ngress for Cultural Freedom.) 21s. net.

I this volume are collected, somewhat condensed
and translated, where necessary, the papers pre-
ted at the Congress on Science and Freedom held
Hamburg in July 1953, a brief account of which
s already been given in *Nature* (172, 445; 1953).
ere are some omissions as, for example, a con-
bution by Salvador de Madariaga, which is for-
nately preserved elsewhere, however, in his "Essays
h a Purpose". A preface by Prof. M. Polanyi
empts to give some unity to the proceedings.
mogeneity is most marked in the papers presented
the first two sessions, in which the Congress con-
ered the political and economic framework required
the cultivation of independent scientific research
a free society, and the book is to be welcomed for
oing on record in convenient and attractive form
e valuable contributions to a topic of current
erest from Prof. Polanyi himself, Dr. J. R.
ker, Dr. S. K. Allison, Dr. J. D. Millett, Prof.
an Thibaud and others and the discussions which
lowed.

The practical problems of organization and the
endant dangers are clearly displayed and in a way
at more than balances any shortcomings that are
nifest where the Conference touched on the
ilosophical implications and in which diversity of
inion and not unity is apparent. Even here, how-
er, the record has its value as a pointer to the
rd thinking which is still required from the man of
ence about the nature and limits of the scientific
thod, his duties and responsibilities as a citizen
d the interpretation and dissemination to the world
the results and implications of his work and
ought.

R. B.

## troleum Microbiology

n Introduction to Microbiological Petroleum Engin-
ring. By Prof. Ernest Beerstecher, Jr. Pp. xv + 375.
Iouston and New York: Elsevier Press, Inc.;
ndon: Cleaver-Hume Press, Ltd., 1954.) 55s. net.

THIS is a courageous but not altogether successful
attempt to link microbiology with petroleum
oduction engineering: it covers much border-
ne knowledge between bacteriology and petroleum
ology; but it is weakly linked with engineering,
ordinarily understood in the industry, since,
spite the author's obvious sincerity of purpose, it
difficult to see how the "marriage of petroleum
gineering and bacteriology" can be realistically
ccessful. When he says that "*microbiological
gineering* . . . is a little-known branch of engineer-
g . . . best visualized as that branch of chemical
gineering which employs naturally occurring
talysts as contrasted to inorganic and synthetic
talysts", he is still addressing himself primarily to
etroleum chemistry (with which is allied geology
n so far as geology is required at the outset) rather
han oil engineering.

The author lists the following as fundamentals in
his new 'discipline': role of micro-organisms in
eology and petroleum genesis; microbial utilization
f petroleum hydrocarbons; micro-organisms in oil
xplorations, drilling muds, oil-bearing rocks and
orrosion problems; effects of hydrocarbons on micro-organisms and their influence in manufacturing petroleum products; infectious micro-organisms derived from petroleum and products. Much of this is surely tangential to petroleum engineering. That bacterial forces operate in many and diverse spheres in petroleum science, realized in its more academic pursuits, in abundantly true. But does the petroleum engineer worry about this? If he has not up to now, will his future training perforce embrace this hybridism, and if so, to what practical end? Granted that vista, however, then this book appears at best as guide to a potentially unstable alliance.

H. B. Milner

## Fishes of the Western North Atlantic

Part 2: Sawfishes, Guitarfishes, Skates and Rays. By Henry B. Bigelow and William C. Schroeder. Chimaeroids. By Henry B. Bigelow and William C. Schroeder. (Sears Foundation for Marine Research—Memoir No. 1.) Pp. xv + 588. (New Haven, Conn.: Sears Foundation for Marine Research, Yale University, 1953.) 15 dollars.

IN connexion with the establishment of the Sears Foundation for Marine Research at Yale University in 1939, generous funds were provided for publication on an ambitious scale, and excellent use is now being made of the facilities thus made available. Memoir No. 1 of the Foundation is a monographic account of the "Fishes of the Western North Atlantic", and is being published as a series of magnificent volumes written by specialists in their respective fields. Part 1 of this Memoir was published in 1948 and was reviewed in *Nature* (164, 766; 1949). Part 2 has now appeared and deals with the sawfishes, guitarfishes, skates and rays. The geographical range of the species described remains essentially the same as in Part 1—that is, the western half of the North Atlantic, including the adjoining gulfs and seas from Hudson Bay south to the Amazon River. All that need be added to what has already been said in the previous review is that the present volume maintains in every way the very high standard set by the earlier part.

G. A. Steven

## Genetica Medica

1um Symposium Internationale Geneticae Medicae, 6–7 Septembris, MCMLIII. A cura di Luigi Gedda. Pp. xxiii + 468. (Roma: Edizioni dell' Istituto Gregorio Mendel, 1954.) 5,000 lire.

TWELVE addresses and eighteen papers of the symposium during September 6–7, 1953, occasioned by the opening of the Mendel Institute for Medical Genetics and Twin Studies in Rome, are presented here together with a discourse by His Holiness Pope Pius XII (in four languages) and an address by the then Prime Minister, Signor G. Pella. Well informed on the facts of genetics, but not so well on those of evolution, the Pontifical discourse constitutes the most valuable feature of this volume. It should be carefully read by all those interested in the social implications of biology.

Among the short papers, a few are of considerable interest. Most of the longer addresses are not. None of the leading human geneticists from Scandinavia, Britain and the United States appears among the contributors. The editorial standards are low. The high price of this volume is probably the consequence of the vast photographic documentation, including also a view of the Institute and two of the opening sessions of the symposium.

# BRITISH INSTRUMENT INDUSTRIES EXHIBITION, 1955

THE third British Instrument Industries Exhibition was held at Earls Court, London, between June 28 and July 9. The Exhibition provided a more impressive display of instruments for general use than has previously appeared in Great Britain. Such an exhibition, in fact, does even more than provide a display of instruments, for it gives a measure of the extent to which the use of scientific knowledge has penetrated into industrial and every other major human activity. The main purpose of the Physical Society's Annual Exhibition is to indicate the use made of scientific principles, both old and new, in the design of instruments. The main purpose of the British Instrument Industries Exhibition is to indicate the use which can be made of instruments so designed in the application of scientific principles to utilitarian purposes. Recently a conference was held at Margate, under the ægis of the Institution of Production Engineers, on the automatic factory (see also p. 183), and the recent Exhibition at Earls Court provides abundant evidence that the use of instruments and instrumentation in controlling a very wide range of industrial processes has long passed from the possible to the actual.

One of the first impressions given by any substantial instrument exhibition is the extreme diversity of the various classes of instruments. The 164 firms exhibiting at Earls Court covered almost every type of instrument used in applied science, and in any short account of the Exhibition only general observations can be made. It is apparent that, to a greater and greater extent in the field of industrial control by instrumentation, use is being made of the ability to convert any physical effect into a proportionate electrical quantity, and of amplifying the electrical quantity in a manner which preserves the original characteristics. It is an easy matter to convey an electrical effect from one point to another, and there, by the conversion of the electrical into, say, a pneumatic effect, to arrange that some variation in the original physical quantity measured shall operate, through this double conversion, some mechanical controlling device at some relatively remote position. The intermediate electrical stage comes within the field of electronics, and to the ubiquity of this newest of technologies there appears to be no limit.

One interesting development in the field of automatic control is the appearance of an apparatus for carrying out, completely automatically, the routine chemical analysis and the determinations of quantities, such as pH values, of samples of a particular liquid, which might be an integral part in a chemical engineering process, requiring continual control to achieve constancy of composition. The apparatus shown at the Exhibition was designed for a particular purpose; but, nevertheless, it would appear that a significant start has been made towards the possibility of carrying out 24-hour-a-day sample analyses without any of the drudgery to the human worker which may well accompany such activity.

Much has been said and written in recent times of the gap between discovery in science and application, but there was much at the Exhibition at Earls Cou to support the view that the tempo of application much greater than it once was. It was rather su prising to find that the energy of ultrasonic vibratio is being used very effectively for such operations drilling, grinding and polishing, and that vario varieties of ultrasonic machine tools are in existen In another direction it is apparent that the develo ment of the instrumental means for making use the properties of artificial radioactive isotopes b been exceedingly rapid and, in fact, it is hard to s that any sensible gap has existed.

One cannot but reflect, in going around an exhib tion of this type, that the scientific curiosities of t comparatively recent past provide the commonpla ingredients of scientific instruments to-day. Ultr sonics have already been mentioned; but also pho phorescence and fluorescence, paramagnetism certain gases, piezo-electricity, and many others, appear as active operating principles in moder instruments. It is apparent that the instrumen maker is far more adventurous than he us to be.

The interest in this exhibition of instruments wa however, by no means confined to the application new techniques or the further adaptation of o techniques. The engineering measuring instrumen on show not only provided an object lesson in them selves of precision engineering, but also indicate most surely that the usefulness of applied optics h by no means been exhausted. Some years ago muc criticism was levelled at the appearance and th convenience, as regards use, of British instrument The range of instruments referred to above and, fact, the whole exhibition of instruments, indicate how far the instrument industries have travelle since the time when such criticism had an validity.

It was possibly a pity that it was not more widel realized that such an exhibition of instruments the one so recently concluded has very considerabl educational value. On one hand, the changin character of industry, with a trend towards greate and greater automatic and instrumental control, obviously a matter of great importance, and to large extent the present state of affairs was epitomize in the Exhibition; no quicker way can be imagine of obtaining an impression of the extent of th application of science through instrument channel than that provided by a tour of it. On the othe hand, there can be no doubt that more and mor technicians in industry must be concerned with th use of instruments and, from the educational poin of view, it would have been well worth while fo industrial concerns to have arranged visits o a considerable scale by their technical personne to the Exhibition. It was apparent that muc greater advantage could have been taken of thi possibility, and it is to be hoped that the nex British Instrument Industries Exhibition, arrange by the five participating manufacturing association will attract a very much greater number of suc visitors.

# DUCATION AND TRAINING OF GRADUATE STAFF FOR INDUSTRIAL RESEARCH

THE education and training of graduate staff for industrial research was the subject of the fourth onference of Industrial Research Directors and anagers, which was organized by the Industrial esearch Committee of the Federation of British ndustries under the chairmanship of Mr. A. H. ilson, and held at Ashorne Hill, Leamington Spa, uring April 29–May 1. The Conference was attended y more than a hundred industrialists and some forty presentatives of science or technology from the niversities. Sir Graham Hayman, president of the ederation, acted as chairman, and Mr. George ithers, secretary of the Industrial Research Committee, acted as secretary of the Conference.

In the opening session, Sir Edward Bullard National Physical Laboratory, Teddington) spoke n staffing and managing a research department. e reminded the Conference that in a little more an thirty years research has grown from the pursuit f the individual scientist into an organized business. ut training in science still develops an individual pproach, and in consequence there can be psychogical difficulties when the young scientist becomes member of a large research department. This, and any other points in Sir Edward's address, were ken up in later sessions.

First-degree courses in science and technology, hich was the subject of the second session, may not ow offer much scope for original thought; but Prof. . G. Cox (Leeds) and Prof. J. A. Pope (Nottingham), e two introductory speakers, were not expected to o more than suggest lines of approach which the onference might consider in discussion groups. In e event, it proved that the discussion groups had terpreted the subject liberally. Clear thinking, a od grasp of fundamentals, and the ability to write raightforward reports are the usual virtues expected f good first-degree students, while the avoidance of ndue specialization and the continual pruning of verloaded curricula are characteristics of good first-egree courses. There was no disagreement.

But, inevitably, the well-known personal qualities hich industry, and indeed every employer of raduates, is looking for were reviewed, and there as an uneasy feeling that industry, in its anxiety find graduates who can readily accommodate emselves to team-work, is placing too much mphasis on a pleasant personality and is in danger f excluding graduates with original minds. After me misunderstanding about the employment of e graduate of modest abilities on development ork rather than on research, it was agreed that rst-class men are needed for both, but that more en of modest abilities can be employed on developent work, once it has been planned, than on search. An interesting point, which unfortunately as not considered in any detail, is the tendency of niversity courses to develop analytical, rather than onstructive, thinking, and it was suggested that he tendency is stronger in pure science than in ngineering.

On the whole, there was singularly little criticism f first-degree courses. The Conference was in symathy with the professor who said that it was not fficient to allow, as had been suggested, new knowledge to be concentrated by some natural process into simple principles, so lightening the courses. He favoured 'disarmament conferences' for reducing the content of the curricula, at least in engineering. The extension of first-degree courses from three to four years was briefly discussed, but received little support, mainly because the advantages it offers are outweighed by the fact that it will make the shortage of scientists and engineers even more acute.

The Conference found that it was quite impossible to discuss first-degree courses without quickly running up against the problem of the shortage of scientific and technical man-power; indeed, this became the background to all discussions. It is appropriate, as one research director put it, that the Conference should be thinking of ways of improving first-degree courses and the training given to graduates in the universities and in industry; but the most important question at the moment is how to find more boys of the present quality to read science and engineering. The Ministry of Education's report, "Early Leaving", suggests that the possibility of diverting boys from arts to science is not very great. The main hope lies in preventing early leaving. There may be as many as five thousand boys in Great Britain who leave the grammar schools at sixteen, but who would have been capable of studying at least two science subjects up to the Advanced level of the General Certificate of Education. One of the discussion groups directed attention to the great attraction that the Oxford and Cambridge classical scholarships have for the ablest boys, many of whom would have done equally well on the science side; but it was pointed out in the open discussion by a professor of chemistry that industry has it in its power to redress the balance between the number of arts and science scholarships at the universities, if this is thought to be unsatisfactory.

Mr. C. Paine (Imperial Chemical Industries, Ltd.) and Mr. C. W. Humphreys (General Electric Co., Ltd.) were the opening speakers in the third session, the subject being the selection and training of graduate research staff in industry. Mr. Humphreys deprecated what he termed the university scramble, in which firms, including his own, participate by sending representatives to the universities to recruit science and engineering graduates, and it was natural that this should be the starting point for the discussion groups. Everyone thought that the university scramble is unedifying and tending to get out of hand; but scarcely any really practical suggestions for removing the worst excesses were put forward. It was pointed out that a certain proportion of students go up to the universities having already decided on the career they intend to follow. If this proportion could be increased by making industry better known in the schools, selection would be easier. The university appointments boards through careers libraries help the student to make up his mind about careers, and their efforts are, or could be, reinforced by vacation courses, works visits and lectures by industrialists to faculty societies. There are apparently a few research directors who do not join the university scramble, and they experience no greater recruitment difficulties than those who do. The majority, however, look upon the scramble as a necessity, if only of self-defence. After remarking that it is the student that selects the firm, and not the firm the student, the chairman of the session, Sir Norman Kipping, accepted the suggestion of one of the discussion groups that the Federation of British Industries should examine the problem.

The training of graduate research staff in industry proved to be a somewhat intangible subject. Mr. Paine himself pointed out that, as compared with such matters as human relations in industry, it has not yet received much attention. It is further complicated by the fact that the training varies according to whether the graduate is a scientist or an engineer, and whether he is employed in a large or a small firm. The two-year apprenticeship for engineering graduates who are later to be engaged on research and development was held by some members of the Conference to be stultifying. As for the size of firms, this may be such that no training can be offered, in which case it is necessary to recruit men who have been in other firms. There appears to be nothing comparable for scientists, whose training is organized scarcely at all. Apparently, in certain firms the young graduate is given a range of problems and is permitted to select one for himself; in others, he is given a particular problem in applied research and told that a solution is wanted within a certain time.

The final session was a discussion on postgraduate training at the university, which was opened by Prof. H. W. Melville (Birmingham) and Prof. A. J. S. Pippard (Imperial College of Science and Technology, London), who dealt with the subject from the science and engineering points of view, respectively. The difference in their two points of view was so striking as almost to suggest that there were two quite separate subjects to be considered. Beginning with postgraduate training in science, the first question to be discussed was whether it is necessary for the young graduate to spend three years at the university on postgraduate training. Industry, it was said, can train him in a shorter period, and indeed the postgraduate course formerly lasted only two years. Apparently the length of postgraduate training depends on the particular science in which the graduate is doing research; that it has extended from two to three years is due to the complexity of modern research apparatus and the need for the student to master new techniques. It might be possible to shorten the postgraduate course if the universities could employ technical assistants on the scale on which they are employed in industry.

On the other hand, if it is true that the working life of the industrial scientist in the purely scientific field is about twenty years, even two years of postgraduate training represents 10 per cent of this period, and a longer course has therefore to be justified. It is also reasonable to ask whether the universities are themselves retaining too many young scientists. This question is not a simple one. Figures for the numbers of young science graduates remaining at the universities for further study and research are quite misleading, as these students leave the universities two or three years later and many of them enter industry. The number permanently retained by the universities is very small indeed, probably less than 2 per cent of the output. Further, although the proportion of newly qualified graduates remaining at the universities for postgraduate work may be as high as one in three, this does not mean that invariably all the ablest graduates decide to do postgraduate research. In fact, some of them prefer to go straight into industry.

The discussion on postgraduate training in engineering centred mainly on the need for a small number of young engineers in industry to return to the universities for advanced courses or research. Th need is recognized by industry; but the prese shortage of scientific and technical man-power mak it very difficult for firms to release staff for lo periods. Although industry is hopeful that th position may be easier in the not-too-distant futur at present it favours short courses. Immediate pos graduate training for engineers found little suppo at the meeting. It was even suggested that th practice of university engineering departments requiring postgraduate students to have had indu trial experience might be followed in other facultie at least as far as some of their staff are concerne Nevertheless, there was a plea for an additional yea either as part of the degree course or immediate postgraduate, for the potential research engineer wh needs an introduction to modern physics in ord that he should understand and be able to use th latest research tools.

The discussion closed with further references industry's shortage of scientific and technical ma power. First, it was felt that this is being made mo acute by the strong attractions of government esta lishments and of those firms engaged on governmen sponsored work. In consequence, the best you scientific brains are being concentrated in limite sections of the national effort to the detriment of th country as a whole. Second, and even more di turbing, it was said that the shortage of scientif man-power will last at least twenty-five years. A employers of scientists—industry and the universiti alike—will have to adjust their affairs accordingly.

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# THE BUBBLE CHAMBER

By Dr. C. DODD

Physics Department, University College, London

UNTIL recently, two methods were available f the analysis of collision events produced b high-energy particles: the photographic emulsio reveals the tracks in the form of sensitized soli grains, and the cloud chamber produces tracks i the form of tiny liquid drops in a gas. The third a most recent method of detection, the bubble chambe exhibits the tracks in the form of strings of tin bubbles in a superheated liquid, and thereby com bines the high stopping power of the photograph emulsion with the easy scanning of the cloud chamb photographs. Moreover, the chamber possesse certain characteristics, such as rapid recycling an freedom from distortion and unwanted backgroun which are particularly desirable.

Dr. D. A. Glaser[1], of the University of Michiga discovered in 1952 that a liquid could remain strongl superheated in a clean chamber for several second in the absence of radiation, before the onset boiling; but that boiling was immediate in th presence of a radioactive source provided the degre of superheat exceeded a certain value. The radiatio ionizes the liquid, producing microscopic bubble carrying like charges, the effect of the charge repulsio being to tend to cause each bubble to increase in siz in opposition to the surface tension effect whic tends to make the bubble collapse. For a certai degree of superheat and for a certain degree ionization, all bubbles, no matter how small initially grow continuously to a finite size. The degree superheat is conveniently expressed as the differenc between the saturation vapour pressure at the tem

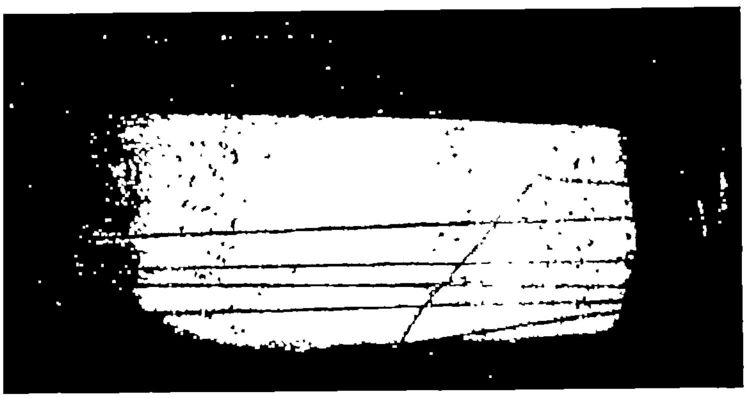

Fig. 1. π-Meson tracks in liquid hydrogen

rature of the liquid and the external pressure on e liquid after it has been expanded into the super-eated condition.

In use, the liquid in a smooth vessel is maintained equilibrium at a temperature much above its ormal boiling point by the application of sufficient ressure to the liquid, applied either directly via a iston-or through an elastic diaphragm subjected on e other side to gas pressure. On reducing this ressure to, say, atmospheric pressure, the liquid ecomes superheated and on the average would main quiescent for several seconds before violent oiling began. If, during this waiting period, an nizing particle passes through the liquid, it leaves ehind along its track a series of charged bubbles hich grow in a few microseconds to a size suitable r photography. Since the bubbles continue to grow ery rapidly, it is necessary to use a flash of only a w microseconds duration for the photographic lumination. This rapid growth-rate means that otion of the liquid medium around the tracks can ause only the minimum amount of distortion to the racks. Moreover, experiments seem to indicate that he charges induced on a bubble persist only for a w microseconds, so that events occurring before and uring the expansion do not produce unwanted ackground tracks. Another important consequence f the short life-time of the charge is that no clearing ield is necessary between expansions.

The chamber is reset by re-applying pressure to he liquid, so the complete cycle of events is: (1) xpand; (2) particle in; (3) flash; (4) recompress. ppropriate delays are inserted between stages. The ime-period of this cycle can be very short; so far, eriods as low as half a second have been used and frequency of 50 per second is contemplated and eems perfectly feasible.

Since the life-time of the charge is so short, the hamber must be in the sensitive condition when the onizing particle passes through it, so that counter-ontrolled expansions for use with cosmic rays are mpossible. It is hoped, however, to use the chamber or cosmic ray work by passing the liquid con-inuously through a cycle in which the time during which the liquid is in a sensitive condition represents n appreciable fraction of the total time of the cycle.

The density of the bubbles is a measure of the specific ionization of the particle producing them, and a hundred bubbles per centimetre can be achieved for minimum ionizing particles, so that precise determinations of ranges are possible. The density may be varied by altering the operating temperature, but the rather strong dependence of bubble density on temperature may present a serious obstacle to any attempt to relate this density to the specific ionization of the particle.

The initial experiments using small, cylindrical, all-glass chambers have shown qualitatively the immense possibilities of the bubble chamber. An example of the type of track obtainable is shown in Fig. 1, taken by Hildebrand and Nagle[4] at the University of Chicago. The chamber contained about 15 $cm.^3$ of liquid hydrogen at 26° K., at a pre-expansion pressure of 4 atmospheres, and was operated in a π-meson beam.

Such chambers have been designated 'clean' and are characterized by a relatively long waiting time in the absence of radiation. They suffer from the fact that the photographed track has suffered distortion by the curved optical media between the track and the camera; but if a plane window is inserted in the chamber wall in order to get over this difficulty, it is found that boiling always occurs immediately the chamber is expanded into the superheated condition. Fortunately, it is easy to confine this premature boiling to the gaskets used to fix the window to the body of the chamber; and it is then found that if the expansion is made sufficiently rapidly the pressure in the liquid away from the gaskets remains for a few milliseconds at a constant lower value, which is low enough to allow the growth of charged bubbles, provided the temperature of the liquid is somewhat higher than that required for operation of the corresponding clean chamber. The ionizing particles are pulsed to traverse the liquid during this sensitive time, that is, a few milliseconds after the beginning of the expansion. Such chambers are designated 'dirty', and probably because of the higher temperature and pressure at which they operate, the bubbles formed in them grow much more slowly than in a clean chamber, but still fast enough to make track distortion negligible.

Both types of chamber may be biased against recording tracks of weakly ionizing particles simply by reducing the operating temperature slightly, so that only strongly ionized bubbles are capable of continuous growth.

Many liquids have been successfully employed in bubble chambers, including methyl alcohol, diethyl ether, carbon tetrachloride, sulphur dioxide, benzene, pentane, propane, nitrogen and hydrogen. The choice has been governed by the magnitude of the pressure required to keep the liquid from boiling when at the operating temperature, though it is important to avoid the use of liquids of 'modern' origin which may contain radiocarbon atoms. Provided the liquid contains only atoms of low atomic number, the Coulomb scattering is minimized and momentum measurements from the curved tracks obtained in the presence of magnetic fields should be possible. Pentane satisfies these requirements, and Glaser and Rahm[5] have successfully operated a 'dirty' pentane chamber of more than half a litre capacity in the 2-BeV. proton beam from the Brookhaven cosmotron. In Fig. 2, the horizontal tracks mark the proton beam, and other events producing tracks of various bubble densities are visible. The operating temperature was 155° C. and the flash occurred

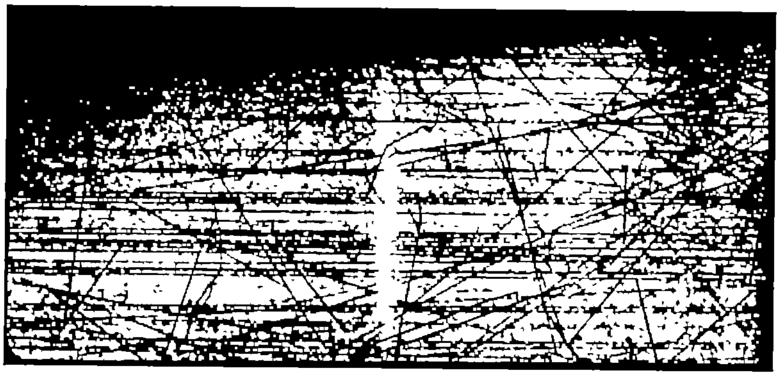

Fig. 2. Tracks produced in pentane by a 2-BeV. proton beam. From Glaser, D. A., and Rahm, D. C., *Phys. Rev.*, 97, 474 (1955)

90 microseconds after the transmission of the proton pulse. Bubbles produced by premature boiling around the top of the observation window have not interfered with the quality of the tracks in the middle of the chamber.

Prof. Luis Alvarez and his group at the University of California have concentrated on the development of the liquid-hydrogen bubble chambers, since this liquid presents a pure proton target. Already, using a 4-in. diameter chamber with a cycling time of only 4 sec., *V* events and $\pi$-$\mu$-electron decays have been photographed, and chambers containing several gallons of liquid hydrogen and operating in a magnetic field are projected for use with the Berkeley bevatron.

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[1] Glaser, D. A., *Phys. Rev.*, 87, 665 (1952).

[2] Hildebrand, R. H., and Nagle, D. E., *Phys. Rev.*, 92, 517 (1953).

[3] Glaser, D. A., and Rahm, D. C., *Phys. Rev.*, 97, 474 (1955).

# OBITUARIES

## Mr. J. S. Wilson

A FAMOUS controversy on the design of masonry dams is recalled by the death on May 20, at the age of seventy-nine, of Mr. John Sigismund Wilson. Doubts cast by Prof. Karl Pearson and one of his research students, L. W. Atcherley, on the validity of existing methods of designing such dams led to a decision by the Egyptian Government to postpone the proposed heightening of the Aswan Dam, after Sir Benjamin Baker, their consultant, had demonstrated the behaviour of models, made of stiff jelly. This decision caused widespread discussion and criticism, especially of the use of jelly to simulate masonry, and Wilson, who was then on Baker's staff, made further experiments, in conjunction with William Gore, using models of rubber, loaded to give the effect, to scale, of the density of masonry. By this means he was able to show that the method to which Pearson and Atcherley had taken exception was, in fact, in order; and, as is well known, the Aswan Dam was duly heightened.

The ingenuity displayed in the design of his model, the result of no mere guesswork but of logically pursued reasoning, was typical of Wilson's approach to the kind of problem in which, as a consulting engineer, he specialized—the sort which lies in the common ground between civil engineering and architecture. Born in Cairo on October 13, 1875, he was educated at St. Paul's School, London, and entered the City and Guilds (Engineering) College (then the Central Technical Colleg in 1893 to take the course in civ and mechanical engineering. E qualified in 1896 and, after a sho period in the office of a civ engineer, Burness Greig, entere that of Sir John Fowler and S Benjamin Baker, the designers the Forth Bridge and the Aswa Dam. Fowler died two years late but Wilson remained with the firn which had become Baker an Hurtzig, until shortly before tl First World War, in the course which he was associated with th design of directors for anti-aircra guns. After the War he went int partnership with H. C. Booth (th inventor of the vacuum cleaner) and C. W. Pettit, be ing concerned mainly with the design of bridges. Sinc 1932 he had been in practice on his own accoun latterly in association with Mr. John Mason.

Wilson took an active part in the endeavours t prevent the demolition of the old Waterloo Bridg across the Thames and was honorary secretary o the conference which, in 1926, sought to preserve it for which, and other work in the preservation o ancient buildings, the Royal Institute of Britis Architects elected him an honorary associate. H was a member of the Institution of Civil Engineers of the Royal Institution and of the Newcome Society, and was serving on the Council of the last named Society at the time of his death. He was als an active supporter of the British Association, bein secretary of Section G (Engineering) in 1923, recorde during 1929–34 and president of the Section at th Norwich meeting in 1935. He was president of th Old Centralians, the association of former student of the Central Technical College, in 1933, and ha received the distinction of Fellow of the College i 1929.

J. Foster Petree

## The Hon. Camilla Wedgwood

THE HON. CAMILLA HILDEGARDE WEDGWOOD, third daughter of the first Baron Wedgwood, died on May 17 in Australia. She was born on March 25, 1901. She received her university education at Bedford College, London, and at Newnham, specializing finally in anthropology, which she studied particularly under Dr. A. C. Haddon, to whom she always remained greatly attached. During 1926–27 she became an assistant lecturer in the Department of Social Studies at Bedford College. Then she went out to Australia, in and around which most of her future work lay. For Australia she formed a very great liking and performed much public service there. During 1928–29, as lecturer in anthropology in the Department of Anthropology at the University of Sydney, and since 1936 as honorary lecturer, she taught students with sound scholarship and flashes of brilliant exposition. For some years after 1935 her great capacity and interest in students served her as principal of the Women's College at the University of Sydney—a post to which she brought freshness and originality, having great influence on the students under her charge.

Miss Wedgwood had always wished to undertake anthropological field research. During 1932–34 she held a fellowship from the Australian National Research Council, and worked on Manam, an island the northern New Guinea coast. In this relatively lated community she made a social study with cial reference to the life of women and children and the effects upon the local culture of contact with culture of white people. She found this research ractive and published interesting material from it. e undertook a further shorter period of research in uru in 1935, at the invitation of the Administrator, ain primarily to study culture change. When war me she volunteered her services and became a utenant-colonel in the Army Women's Services, tached to the Army Directorate of Research. ter she undertook work in Army education, and after the close of the War specialized particularly in the training of education officers for the New Guinea Service, in a post which she held at the Australian School of Pacific Administration. Shortly before she died, her services to the cause of native education in New Guinea were recognized by the Government of the Commonwealth in naming a New Guinea girls' school after her.

Camilla Wedgwood was a cultured woman of striking appearance and many interests, vividly concerned with human problems. She had many friends, who will mourn her early death.

RAYMOND FIRTH

# NEWS and VIEWS

## of. S. J. Davies

PROF. S. J. DAVIES has retired from the chair of echanical engineering in King's College, London, d has been succeeded by Prof. L. J. Kastner, the University College of Swansea (see *Nature*, 1, 1004; 1948). Prof. Davies was appointed the chair at King's College in 1937. He was e of the distinguished band of engineers who me originally from H.M. Dockyard, Portsouth, where he gained a Whitworth Exhibition. uring the First World War he was engaged on the spection of aircraft engines and later was deputy orks manager of the Clyde Engineering Co., Ltd. uring 1920–26, he was lecturer in mechanical gineering in Armstrong (now King's) College, ewcastle upon Tyne. He then went to King's llege, London, as reader, and in 1937 was appointed professor in succession to Prof. Gilbert Cook; d now, after eighteen years as professor, he has ken up his new appointment as dean of the Royal ilitary College of Science at Shrivenham (*Nature*, 4, 727; 1954). Prof. Davies is widely known for s researches on oil engines. He has twice been warded the Herbert Akroyd Stuart Prize of the stitution of Mechanical Engineers, and has also ceived prizes from the Institution of Automobile ngineers and the Institute of Marine Engineers. In 51 he was elected a Fellow of King's College, ondon.

## rasitology at Imperial College, London: Prof. B. G. Peters

DR. B. G. PETERS, head of the Nematology Department of Rothamsted Experimental Station, has been pointed the first professor of parasitology at the nperial College of Science and Technology, London. rom Bristol Grammar School he went to the niversity, where he graduated with first-class nours in zoology in 1925, and received his M.Sc. in 27. During 1925–28 he was on the staff of the stitute of Agricultural Parasitology, St. Albans, st as a scholar of the Ministry of Agriculture and ter as Grocers' Company research scholar. He tained his Ph.D. of the University of London in 28. When the Imperial Bureau of Agricultural arasitology was started in 1929, he was its first puty director and remained so until 1932. From en until 1936 he was demonstrator, later lecturer, helminthology at the London School of Hygiene d Tropical Medicine, and became a recognized acher of the University in 1935. He returned to e Institute of Agricultural Parasitology in 1936 and, except for two years in Bomber Command Operational Research (1943–45), remained in that Department until, in 1947, it became the Nematology Department of Rothamsted. He succeeded Dr. T. Goodey as head of this Department in 1952. His early research dealt with the taxonomy and bionomics of the vinegar eelworm. Later he turned to the use of statistical methods in helminthological research, and his contributions in this subject have been fundamental in placing experimental helminthology on a sound basis. Since 1948 he has been studying the potato-root eelworm, *Heterodera rostochiensis*, and developing methods for laboratory assays and field-trials of nematicides.

## Haskins Laboratories, Inc.: Dr. F. S. Cooper

DR. FRANKLIN S. COOPER has been elected president and director of research of Haskins Laboratories, Inc., of New York, to succeed Dr. Caryl P. Haskins, who has been appointed president of the Carnegie Institution of Washington as from January 1, 1956 (*Nature*, 174, 1172; 1954). Dr. Cooper was born in Robinson, Illinois, in 1908 and graduated from the University of Illinois. He received his Ph.D. degree in 1936 from the Massachusetts Institute of Technology. He was with the Research Laboratory of the General Electric Company until he joined Haskins Laboratories in 1939, where he has been associate director of research. He was senior liaison officer of the Office of Scientific Research and Development during the Second World War, in charge of the exchange of scientific information with the Allies. He has served as consultant to the Secretary of Defense and to the Atomic Energy Commission of the United Nations. He is a member of various scientific and professional societies and of advisory committees of the Massachusetts Institute of Technology and New York University, and is adjunct professor of acoustic phonetics at Columbia University. Haskins Laboratories is a non-profit scientific and educational foundation. Its effort has been in scientific research and research training in selected borderline fields.

## Conference on the Effects of Nuclear Weapons

A CONFERENCE of scientists is to be held during August 3–5, under the auspices of the World Association of Parliamentarians for World Government, to discuss the nature and extent of the danger to mankind involved in experiments with nuclear weapons and their possible use in warfare. The meeting will take place in the County Hall, London.

The British Committee for the Conference is: Lord Boyd Orr (*chairman*), the Right Hon. Walter Elliot, Earl Russell, Gilbert McAllister, G. V. Morris, Prof. J. Rotblat and Henry Usborne. The conference fee for delegates (members of Parliament and scientists with a recognized qualification) is £3 and for observers £2. Particulars can be obtained from the Secretary-General of the World Association of Parliamentarians for World Government, 21 Hampstead Lane, Highgate Village, London, N.6.

## Colonial Development Corporation: Report for 1954

In the annual report and statement of accounts of the Colonial Development Corporation for the year ended December 31, 1954 (pp. 50. London: H.M.S.O., 1955; 2*s.* net), staccato presentation and condensation have been carried to a point which make it difficult to gain a clear picture of the work of the Corporation and its relation to Colonial development generally. Financial results indicate that the Corporation's net loss on the year has been reduced to £222,353; but, in spite of the abandonment of unsound projects, the Corporation at the end of 1953 still had a cumulative deficit of £9·7 million, of which £6 million represented losses on projects and activities begun before December 31, 1950, and afterwards abandoned; until satisfactory relief is given the legacy of the past will remain a factor in policy. Seven new projects were commenced during the year, and one—the experimental Yundum farm, on land originally cleared for the Gambia poultry farm—was abandoned, leaving the Corporation with fifty-six continuing projects and investigations. At the end of the year the Corporation was managing directly, or through controlled companies, sixteen trading projects with an aggregate turnover of more than £6 million a year, selling such diverse commodities as beef and hides, rice, bananas, rubber, hemp, timber, cement, electric current, housing finance and hotel accommodation. Heavy expenditure is still carried on many projects which are sterile until communications are provided, and other projects have to bear heavy public utility expenditures which by other capitalization can outweigh the marginal risk in which the Corporation deals. The report emphasizes that, although the staff is still a nucleus and requires strengthening, it is competent and reliable within that limitation, and acknowledgment is also made of the services of the scientific panel. Little indication is given of any scientific work under the Corporation; but the report notes that trials with ramie, citrus and cocoa in British Honduras have yet to disclose the best way to stimulate the economy of the territory.

## Diploma Awards in Technology

It was announced in the House of Commons on July 14 by the Minister of Education, Sir David Eccles, that a National Council of Diplomas in Technology in Technical Colleges is to be established, and that Lord Hives, chairman and managing director of Rolls-Royce, Ltd., has been appointed chairman of the Council. Awards will be available to students in technical colleges in Britain who successfully complete technological courses approved by the Council. It is intended that the diploma award shall be comparable in standard with a first degree of a university. The question of a post-graduate award is to be considered later.

## Higher Technological Education in South-ea England

The sixth annual report of the London and Hor
Counties Regional Advisory Council for High
Technological Education, covering the year end
August 31, 1954 (pp. 40; from the Council, Londo
1955), apart from a brief account of the sixth annu
meeting on July 15, 1954, is concerned chiefly wi
activities related to particular industries. In gener
policy the Council decided to support the Nation
Advisory Council's scheme for creating and admin
tering awards in technology, but made the provi
that reconsideration of the title of the award a
further consideration of a title for a higher awa
should be made, and that the relationship of the tv
boards of studies (one for engineering and the oth
for technologies other than engineering) and of t
details of their respective constitutions should
clarified. The Council has also commented on t
'sandwich' principle in general but, while general
approving the principle of combined college a
works training in about equal periods over three
four years, regards it as likely to be only of limit
application in the London and Home Counties regi
except in electrical, mechanical and productic
engineering. All but one of ten such courses
operation during 1954–55 are in engineering. Of t
Council's activities to assist technical training f
particular industries, it can only be said here th
the very variety of trades to which the wo
'technology' is, at least by implication, applie
makes it understandable that there should be su
slow progress in the expansion of technologic
education. There is little or no indication in th
report of any clear distinction between a techniqu
and a technology, and, while that confusion persist
progress is bound to be impeded.

## The Botanical Society of the British Isles

Membership of the Botanical Society of the Britis
Isles has reached a total of a thousand. This mea
that membership has doubled since January 1, 195
when it stood at 498, and during this period t
scientific standard of the Society's periodica
(*Watsonia* and the *Proceedings*) and of the meetin
(especially the conferences and the annual exhibitio
meetings) has been raised to a high level. T
Society is descended from "The Botanical Society
London", founded in 1836. It is evident from th
long history that there has never before been a tim
when interest in British field botany would hav
supported a membership approaching the prese
size at the scientific level at which the Society aim
Moreover, some recent developments, such as th
Distribution Maps Scheme and junior meetings f
students, are being supported by many people wh
are not at present members of the Society.

## Kilogram Standard Weight for South Africa

An international standard 1-kilogram weight ha
recently been made for the South African Governmen
by the firm of L. Oertling, Ltd. (St. Mary Cray
Orpington, Kent), the same company that made las
year a primary standard 10-tola weight for th
Government of Pakistan (*Nature*, **174**, 296 and 1094
1954). The weight is made from an alloy containin
90 per cent platinum and 10 per cent iridium, sup
plied by Johnson Matthey and Co., Ltd. (Hatto
Garden, London), and is in the form of a cylinder o
equal diameter and depth with a slightly concav

se so that the weight rests on an annular ring. e tolerance specified was ± 0·15 mgm. on the ished mass, and the weight has been certified by e International Bureau of Weights and Measures Sèvres, near Paris, as being well within the permitted tolerance, thus making it one of the World's ternational Kilograms. A weighing accuracy of o parts in $10^8$ was necessary. The manufacture of e weight involved a protracted series of accurate eighings coupled with the removal of successively aller and smaller amounts of material from the eight, so that the correct nominal mass and the timum surface finish were achieved simultaneously.

### andard X-Ray Diffraction Powder Patterns

The fourth in the series of "Standard X-ray iffraction Powder Patterns", prepared by the ational Bureau of Standards, Washington, D.C., s recently been published (N.B.S. Circular No. 539; . 75. Washington, D.C.: Government Printing ffice, 1955; 45 cents); in it are presented data for e elements, thirty-five organic compounds and two termetallic compounds. The patterns are recommended to replace ninety-five cards in the card file the American Society for Testing Materials and, addition, seven compounds (gallium oxide, neomium oxide, strontium chloride, thallium iodide, lver oxynitrate, aluminium antimony and indium ntimony) which are not represented in the file are cluded. The card file serves as a system for the entification of unknown crystalline materials based the three strongest reflexions of each material. In e new publication a comparison is made between l powder diffraction data available for each of the bstances reported. The samples used by the Bureau make the patterns were special preparations of ceptionally high purity obtained or prepared only in nall quantities, and the purity of each sample was etermined by spectroscopic or chemical analysis. A eiger-counter X-ray diffractometer was used, and e *d*-spacings were assigned Miller indices by comarison with calculated patterns. The densities and ttice constants also were calculated, and the fractive indices were measured wherever possible. etailed references are given.

### ystematic Anatomy of the Monocotyledons

The project of preparing a comprehensive book on e systematic anatomy of the Monocotyledons, arallel to that already available for the Dicotyledons, nd recent investigations towards that end, have been scussed by C. R. Metcalfe (*Kew Bull. Misc. Inf.*, o. 4, 523; 1954). Such a work of reference is badly eeded and is now one of the main undertakings in e Jodrell Laboratory of the Royal Botanic Gardens, ew. The numerous scattered contributions on onocotyledon anatomy have already been indexed preparation for the new work. It is realized that e proposed survey must necessarily be of a somehat general character, based on the existing terature, supplemented by the new investigations f different families now being undertaken at Kew nd elsewhere. The main objects of the book will be serve as a dictionary in which the reader can uickly ascertain what is known about any paricular plant, and, by reference to the literature, ollow up any particular aspect of plant structure; serve as an aid in identifying economic materials f monocotyledon origin; and to advance taxonomic tudies of the Monocotyledons and to throw light on heir phylogeny. An account is given of recent progress in the relevant anatomical investigations at Kew, reference being made to the Gramineae, Alismataceae, Xanthorrhoeaceae, Zingiberaceae, and to such topics as the nature of the tracheal elements in different groups. It has been recognized that anatomical studies of this kind have revealed characters which are important in the broad taxonomy of the group; but the author rejects the view that our knowledge is already so complete that it is scarcely worth while pursuing the subject further. On the contrary, he considers it probable that fuller comparative anatomical studies will ultimately contribute to an improved classification, and will help to make possible a much more comprehensive understanding of the physiology and form of the flowering plants than we yet possess.

### Soils of the Glastonbury District of Somerset

The soils of the Glastonbury district of Somerset are the subject of a recent Memoir of the Soil Survey of Great Britain, by B. W. Avery (pp. 131+4 plates. London: H.M.S.O., 1955; 15*s.* net). The area mapped comprises Sheet 296 of the Ordnance Survey and is of interest because it includes some of the 'teart' pastures of Somerset, where cattle are liable to suffer from a distinctive form of scouring, an ailment now known to be due to excessive amounts of molybdenum in the herbage. These pastures are confined to calcareous soils developed from the Lower Lias clays. The area of 216 square miles described in the memoir lies in the centre of Somerset and is predominantly rural in character. Calcareous soils form the largest group (36 per cent), while the brown earth and gley groups together account for a further 49 per cent of the soils of the area. The remaining soils are chiefly organic (13 per cent) developed over peat and are practically confined to the Sedgemoors. The concluding chapter on the agriculture and land use of the area is concise and well written and will be of more general interest. Descriptions of typical profiles and analytical data are provided in an appendix. There is also a glossary of technical terms which makes the report more palatable to the non-specialist.

### Rugby School Natural History Society

The report of the Rugby School Natural History Society for 1954—its eighty-eighth issue—again shows the valuable work done by school natural history societies in building up and sustaining interest in living things. Some years ago the Society decided to produce a complete natural history of the Rugby District, and 1954 saw the completion of the first instalment—the "Flora". The value of the work has been recognized by the Royal Society with a grant of £50 towards the cost of publications. Among other activities were a series of experiments to determine the feeding habits of certain freshwater animals in a local pond; an investigation into the importance of the cow-parsnip (*Heracleum sphondylium*) in the economy of various insect species; and an account of the archæological section's digging at the site of Brownsover in order to elucidate the date and purpose of the earthworks that are scattered around the village.

### Polish Academy of Sciences: *Quarterly Review of Publications*

The first issue of the *Quarterly Review of Publications*, published by the Polish Academy of Sciences, Warsaw, covers the period April–June 1954 and includes abstracts from a total of 112 monographs and periodicals published by the Academy and other associated bodies in Poland. Titles are given in the original version, followed by an English translation. Bibliographical data are grouped under the various subjects, which number thirty-six in all and include, besides the conventional scientific and technical ones, such subjects as economics, history, law, linguistics, literature, oriental studies and philosophy. Under agriculture, four journals are listed, two of them being new—*Postępy Nauki Rolniczej* and *Roczniki Gleboznawcze*—while under archæology various publications are given of the Warsaw Society of Science and Letters, the Polish Archæological Society and the Institute of the History of Material Culture. Papers which have appeared in *Urania* and in *Postępy Astronomii* are included in the astronomy section, and under biology close on one hundred papers published in the *Bulletin de l'Académie Polonaise des Sciences*, *Ekologia Polska*, *Folia Biologica*, *Kosmos*, *Wszechswiat* (The Universe) and *Przegląd Antropologiczny*. The chemistry section contains mostly papers published in *Roczniki Chemii* and *Wiadomosci Chemiczne*. Two new books on Poland of the Renaissance period and numerous papers published in *Kwartalnik Historyczny* and *Przegląd Historyczny* are listed under history, and under linguistics is mentioned a new "Dictionary of Old Polish", which is an account of words and their forms as preserved in manuscripts from the earliest times up to 1500. In the literature section there are several new essays on Prus, Zeromski and some contemporary writers. Under mathematics is a new journal, *Annales Polonici Mathematici*; under medicine a number of new monographs and a new journal, *Postępy Wiedzy Medycznej*; and under oriental studies another new journal, *Przegląd Orientalistyczny*. In the section headed philosophy is listed a new joint publication by several authors on the "Problem of Humanism", and in that on physics are a large number of original papers which appeared in the *Acta Physica Polonica*, *Bulletin de l'Académie Polonaise des Sciences*, *Classe troisième*, and *Postępy Fizyki*. The physiology and biochemistry section lists the contents of the relevant issues of two journals (see *Nature*, April 16, p. 667), and in the zoology section there are several new monographs including one on Caryophyllaeidae in Poland.

## *Progresso Terapeutico*: a New Italian Medical Review

A new Italian quarterly medical review, *Progresso Terapeutico*, has recently been started, edited by Ottavio Carlotto under the direction of a scientific committee. The first issue (January–March 1955; from Via Ascoli Piceno 19, Rome; price not stated) consists of forty-eight pages, the first twenty-four of which are devoted to articles by G. Luciani, on recently discovered vitamins; by V. Romeo, on an unusual hæmatological reaction (reduction of the number of granulocytes) occurring in the course of tonsillitis; by C. Pagliuca, on erythromycin derived from *Streptomyces eritrens*; and a report on the conference held by Prof. R. Lattes in the medical clinic of the University of Milan on smoking and cancer of the lung. The rest of the review gives accounts of the second congress of the Italian Society of Chemotherapy and of the eleventh national reunion of the Italian Metapsychic Society; scientific notes; short abstracts from Italian and other medical journals; a note on chronic bronchitis, bronchiectasis and *cor pulmonale*; short reviews of books and papers; various notices; and a page, by L. Vitale, c epigrams against medical men.

## Transvaal Museum, Pretoria: *Bulletin*

For many years the results of the researches c the staff of the Transvaal Museum, Pretoria, hav been published in their own *Annals and Memoir* Now a *Bulletin* (No. 1, March 1955; pp. 8) has bee issued to cover the more popular activities of th Museum. The first number contains a useful note o trapping butterflies, descriptions of expeditions t Mocamedes and Northern Bechuanaland and detail of recent acquisitions in the Museum.

## Electrical Standards and Metering: Exhibition i the Science Museum, London

A special exhibition on electrical standards an metering has been opened at the Science Museum London, to coincide with the current meeting of th International Electrotechnical Commission and wi remain open, admission free, until October 31. Th exhibition is intended to show the general public th care which is devoted to the accurate calibration c electricity meters, though there are, in addition, mor specialized exhibits which will appeal to thos directly concerned with the problems of meterin bulk supplies of electrical energy to large industria and commercial undertakings. In the section dealin with the origin and derivation of the various electrical units, an exhibit of particular interest is th complete set of the original units of resistance whic were made in 1864 for the British Association an constitute the oldest set of accurate electrica standards now in existence. These 'B.A. units' hav been stored for many years at the National Physica Laboratory, Teddington, and the Science Museum hopes to acquire them and incorporate them in it national collection of historic scientific apparatus.

## Mineral Resources Policy in Great Britain: Symposium in London

The Institution of Mining and Metallurgy i arranging a symposium on mineral resources polic in Great Britain, to be held in the hall of the Roya Society of Arts, John Adam Street, Adelphi, Strand London, W.C.2, on September 22. The object of th symposium is to allow fuller discussion of the proposals contained in a paper on "Mineral Resource Strategy", originally read by Mr. D. A. Oliver (directo of the Group Research Centre of the Birmingham Small Arms Co., Ltd.) at a conference on researc and industrial productivity held in London i November last year. The theme of Mr. Oliver' paper is that minerals productivity will be increase if greater co-ordination of the right kind can b established between all the interested parties— geologists, mineral dressing and mining specialists mining and finance houses, mining engineers, loca authorities, fabricators and users, and finally th Government. An Office of Materials Mobilizatio has been established in the United States wit similar objects, and proposals for setting up a comparable organization have been put forward in Grea Britain from time to time. Five other papers hav been submitted to the symposium, dealing respectively with mineral development and research in th United States and Canada; the mineral industry i East Africa; Canadian aids to its mineral industry some economic considerations in a British minera resources policy; and a proposal for a central ore dressing laboratory. These papers and that of Mr ver will be circulated in advance and will form basis on which the discussions can proceed. The eting will be open to non-members of the Institu- n. Further information can be obtained from the retary of the Institution, Salisbury House, sbury Circus, London, E.C.2.

## amin E: Congress in Venice

THE third International Vitamin E Congress will held in Venice during September 5–8, in the mises of the Cini Foundation on the Island of San rgio Maggiore. Each day will be devoted to a rticular topic, namely, the relation of vitamin E the following: metabolic processes; other amins, hormones and enzyme systems; cardio- scular system; and nervous and muscular system. the mornings, reports will be given on experi- ntal studies, and in the afternoons, papers on nical investigations will be read and discussed. e official languages of the congress will be English, ench, German, Italian and Spanish. Further ormation can be obtained from the secretary, of. Emilio Raverdino, Via Pietro Verri 4, Milano.

## rrelation between Calculated and Observed Stresses and Displacements in Structures

A CONFERENCE on the "Correlation between Cal- lated and Observed Stresses and Displacements in ructures" will be held by the Institution of Civil gineers in its premises at Great George Street, estminster, during September 21–22. Twenty pers will be presented and discussed in the fol- wing four separate sessions: philosophy and tech- ques of testing; steel structures; concrete struc- res; and earth pressures and movements. The pers to be presented will be printed in a preliminary lume available in August, and a final volume ntaining the discussions at the conference will be inted towards the end of this year. The regis- ation fee of £2 will include a copy of the preliminary d final volumes of the proceedings, and extra pies will be obtainable at 30s. a set. Application ms, to be returned by August 1, and further ormation can be obtained from the Secretary of e Institution, Great George Street, Westminster, ndon, S.W.1.

## ormation Theory: Symposium in London

THE third London Symposium on Information eory will be held in the Royal Institution, 21 bemarle Street, London, W.C.1, during September –16. Each day will be devoted to a particular pic as follows: fundamentals; coding, taxonomy, c.; language analysis and mechanical translation; eaning and the human senses; and behaviour and mechanism. Copies of the papers will be circu- ted in advance. The registration fee for the con- rence is £2 10s. Further information can be tained from Dr. Colin Cherry, Department of ectrical Engineering, City and Guilds College, hibition Road, South Kensington, London, S.W.7.

## ciety for Applied Bacteriology: Officers

FOLLOWING the annual meeting and summer con- rence of the Society for Applied Bacteriology, held Cambridge during July 3–6, the following were pointed officers of the Society: *President*, S. B. homas; *Secretary*, G. Sykes (Microbiology Division, oots Pure Drug Co., Ltd., Nottingham); *Treasurer*, S. Miles; *Editors of the Journal of Applied Bac- iology*, Dr. S. E. Jacobs and Dr. L. F. L. Clegg; *Publications Manager*, E. A. Whitlock; *Advertising Manager*, E. J. Mann. Dr. Ella M. Barnes, H. B. Hawley and W. H. Pierce were elected to the Committee in succession to Dr. L. A. Allen, Dr. M. Ingram and D. A. McKenzie, who retired by rotation.

## Announcements

PROF. C. VAN RIET LOWE has retired from the directorship of the Archæological Survey of the Union of South Africa, Johannesburg, and has been succeeded by Mr. B. D. Malan, of the University of the Witwatersrand. Prof. van Riet Lowe will continue to hold the chair of archæology in the University of the Witwatersrand.

IN connexion with the opening of a new Schmidt telescope at the Hamburg Observatory, a symposium will be held there during August 19–20 on the problems, methods and astronomical programmes relating to such telescopes. Further information can be obtained from the Hamburger Sternwarte, Hamburg-Bergedorf.

THE annual general meeting in the United States of the Association for Computing Machinery will be held at the Moore School of Electrical Engineering, University of Pennsylvania, during September 14–16. Further information can be obtained from Sidney Kaplan, Radio Corporation of America, Computing Systems Engineering, Building 13-2, Camden 2, N.J.

THE Society of Dyers and Colourists is holding a symposium on "Bleaching, Dyeing and Finishing To-day" during September 13–17 in the Northern Counties Hotel, Portrush, Northern Ireland. This will be the first time that the Society will have held a symposium in Northern Ireland. Further information can be obtained from the General Secretary of the Society at Dean House, 19 Piccadilly, Bradford 1, Yorks.

THE Institute of Rural Life at Home and Overseas is holding a residential course of rural studies at the Essex Institute of Agriculture, Writtle, near Chelmsford, Essex, during August 28–September 10. The course will cover a wide field of overseas problems, as well as local ones, and will be particularly useful for missionaries, social workers, Colonial students and other visitors from overseas. The fee for the course is 19 guineas. Further information can be obtained from the Secretary of the Institute at 59 Bryanston Street, London, W.1.

THE fifth congress on biological rhythm arranged by the Societas pro Studio-Rhytmi Biologici will be held in the Department of Anatomy of the Caroline Institute, Stockholm, during September 15–17. The three main themes to be discussed will be rhythmical phenomena in the nervous system, cybernetics, and rhythm and industrial medicine. Further information can be obtained from the Secretary of the Fifth Rhythm Congress, Societas pro Studio-Rhytmi Biologici, Anatomiska Institutionen, Karolinska Institutet, Solnavägen 1, Stockholm 60.

THE University of Padua is offering a Gabriella Zuccari scholarship of 300,000 lire for research of at least six months duration at the Zoological Station, Naples, during the academic year 1955–56. The scholarship is open to any person who wishes to undertake research in zoology, comparative anatomy, physiology or embryology, and it may be renewed up to a maximum of three years. Application forms, to be returned by October 31, and further information can be obtained from the Secretariat of the University of Padua.

# THE ENGINEER AND THE CONSERVATION OF NATURAL RESOURCE

IT has now become a truism that the history of man's achievement has been his constant effort to master the forces of Nature and the tremendous resources that are his inheritance. But in his endeavour to fulfil this aspiration, which has never been entirely realized, man has disturbed the delicate balance maintained by Nature in guarding her resources and has created the problem of conservation of these natural resources, the depletion of which is, in some quarters, a matter of growing concern. Such was the subject of the first Graham Clark Lecture, delivered to the Institution of Civil Engineers on May 4 by Sir Harold Hartley. The Lecture is given in honour of the late Graham Clark, who for many years was secretary of the Institution and who strove to promote co-operation between engineering societies both in Britain and abroad; after paying a brief tribute to him, Sir Harold turned to the main topic of his address, a subject which, while it has been dwelt upon previously in one way or another, he approached from a novel direction in stressing the importance of the engineer in contributing to the conservation of the great bounty of Nature.

The greatest resources upon which our civilization depends are soil and water, and Nature has always jealously guarded these and maintained her equilibrium therein; but man, when he appeared on the scene, upset this by the clearing of land for cultivation and dwellings, creating, as a result, problems of conserving these two most valuable resources. Irrigation and storage schemes have constituted one attempt to meet these problems, from the great systems of the ancient empires to the tremendous multi-purpose projects of to-day, embodying the storage of water for irrigation, hydroelectric power, flood control and transportation, such as the Tennessee Valley Authority Plan. Such facilities as improvements in dam and canal construction, the use of hydraulic models, geophysics and soil mechanics have aided the solution of many problems; but the inexorable forces of Nature are always at work, and man is reminded of this by the appearance of new difficulties such as the silting up of reservoirs or increasing salinity in irrigation systems by lack of sufficient water. In some areas shortage of water is a grave problem, and the future of water supplies is dependent on the wider acceptance of such techniques as the re-use of water by the treatment of sewage and effluents, or the distillation of sea water, added to which is needed a more thorough knowledge of the behaviour of ground water. Again, where land is valuable, coastal and inland erosion are being curtailed and land is being reclaimed from sea and marsh as in Holland and in the Fens in Britain. In all these efforts, the main problem is to maintain cultivation without loss of fertility in the soil, and in this regard we are gradually learning how to make use of Nature's gifts.

Sir Harold went on to remark that, next to soil and water, energy forms the greatest need of mankind; the consumption of energy per capita determines the standard of living of a country. Here the engineer's role is to increase the efficiency of combustion devices and so effect a saving of such sources of energy as coal and petroleum products, since these provide mankind with a tremendo amount of energy; but with the advent of nucle power man will be able to utilize these more for the chemical potentialities than before.

The conservation of raw materials and the economical use form one of the engineer's mo notable contributions to-day. New methods treating raw materials, such as the economic recove of low-grade ores, have advanced greatly during t past two decades. In the field of structural engi eering, a saving of steel has been effected by t increasing use of concrete and by new concepts structural analysis, such as the plastic method design, developed in the Engineering Department Cambridge, with the advance of new structural ste forms. Improvements in the working of metals a developments in lubricants and anti-corrosives ha resulted in further economies. Finally, there is t greatest economy of all, that of human labour the use of automatic control and the possibilities the automatic factory; here Sir Harold direct attention to the fact that, while control engineeri is making great advances abroad, more recogniti needs to be shown in Britain in this field.

In his closing remarks, Sir Harold drew thr important conclusions: first, progress needs speci ization, coupled with a wide outlook and a knowled of other fields of endeavour, for too much speciali tion is dangerous. Secondly, we must work mo closely with Nature in a new partnership ma possible only with the great forces that she encon passes. Finally, there is in each generation a lim to what is possible, and it is imposed by the resour and skills which are available to man and whic with their uneven distribution, must be used to the best advantage with careful planning, for o convenience.

One may feel inclined to think of this Lecture as catalogue of attainments, but it was, in fact, mo than that; it was a timely warning. While man h a creditable record of achievement to look ba upon, he still has to come to work more with Natur for he cannot control her. Only then will he be ab to use and enjoy the great endowment of her resour which has come to be his heritage.

E. T. HOLMGREN

# TOWNS AND THEIR HINTERLANDS

SINCE its inception in 1941, the Research Ma Office of the Ministry of Town and Count Planning, now part of the Ministry of Housing a Local Government, has carried through a remarkab programme of work. In particular, it has prepar with the joint sponsorship of the Department Health for Scotland the now extensive series National Planning maps on the uniform scale 1 : 625,000, or approximately ten miles to the inc each in two sheets covering England, Wales a Scotland. Civil servants work in anonymity; b it is not difficult to detect the skill and care of t guiding hand of Dr. E. C. Willatts, who has been charge of the work for most of the past fourte ars. Many of the maps have marked new departures cartography, and this is certainly true of the latest dition to the series depicting towns and their nterlands*. It is obvious that every market town ercises a considerable influence on the surrounding untryside, but this 'hinterland' is difficult to define d to delimit. It has little or no connexion with ministrative units, and yet is obviously of great portance in planning the social services to be proded by the urban centre as well as of no little terest in the organization of retail trade and rvices.

The criterion here adopted owes much to the oneer studies of F. H. W. Green, and is that of us services. A town or village is defined as a centre it has operating from it at least one bus service hich serves no place larger than itself. The centres th populations over three thousand (using the 1951 nsus) are represented by an orange circle proporonal to the population, surrounded by a green circle oportional to the population of the hinterland. rm lines mark—perhaps with a firmness their adowy nature does not warrant—the boundaries the hinterlands. In general terms, the people ving within a given hinterland normally visit the ntre shown for shopping, entertainment, cultural d professional services.

So much of the extensive programme of town and untry planning to which Britain is committed is necessity based upon very slight factual knowledge, d such attempts as are illustrated by this map to troduce a scientific objectivity are entirely praiseorthy. Though the centres are smaller and the nterlands are larger in the sparsely populated parts the country, what strikes one is the relatively ven spacing of the centres. In days of old when eople walked to market (or the richer rode on horseack), the effective hinterland of a market town had radius of about four miles. It still seems to be ly about six miles. Over much of England the ntres tend thus to be ten to twelve miles apart. is more in Wales and Scotland.

L. Dudley Stamp

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* Local Accessibility: the Hinterlands of Towns and Other Centres determined by an Analysis of Bus Services. Sheet 1: Scotland d N. England Sheet 2: the Remainder of England and Wales. mpiled by the Ministry of Housing and Local Government from formation supplied by the Bus Operators and the Ministry of Transrt and Civil Aviation. (Chessington, Surrey: Director General of e Ordnance Survey, 1955.) 5s. per sheet.

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# LIBRARIES OF THE DYESTUFFS IVISION OF IMPERIAL CHEMICAL INDUSTRIES, LTD.

## NEW BUILDING AT BLACKLEY

THE new library building of the Dyestuffs Division, Imperial Chemical Industries, Ltd., as opened at Blackley, Manchester 9, on June 27 by r. Clifford Paine, development director of Imperial hemical Industries, Ltd., and until recently chairan of the Division. Mr. Paine said that a first-class cientific library is the core of a research organization nd expressed the hope that the new building will rovide the conditions which will stimulate creative ork in the minds of those who are expected to make he discoveries of to-morrow. Although the value of ibrary and related services has long been recogized in the Dyestuffs Division, it is only with its removal in May 1955 to the present building that the Main Library of the Division has been housed in premises worthy of its holdings and the services provided. The Divisional libraries hold a total of nearly forty thousand bound volumes (of which about half are periodicals), together with about twenty thousand pamphlets and miscellaneous publications, some fifteen hundred bound volumes of patent specifications and several hundred unbound specifications. About half the total collection is housed at Hexagon House, Blackley, where the collection in organic chemistry and related subjects is probably one of the finest in Great Britain. More than a thousand current periodicals are taken, and about half of these are bound.

The present library collection goes back to the days before the formation of Imperial Chemical Industries, Ltd., the nucleus being provided by the libraries maintained by Levinstein, Ltd., of Blackley, and British Dyes, Ltd., of Huddersfield; the bulk of the latter forms the nucleus of the branch library now maintained at Huddersfield, just as that of Scottish Dyes, Ltd., later formed the nucleus of the Works Library at Grangemouth, Stirlingshire. In 1925 the Levinstein collection was moved into the block of buildings which now houses the administrative offices of the Dyestuffs Division, being transferred in 1932 to a new wing specially designed to be permanent quarters. This was evacuated on the outbreak of war in 1939 and, after two years in makeshift premises in a local school, the Library was moved into a temporary single-story building adjacent to the Research Department of the Division. The library organization includes a Records and Reports Section which is responsible for the care of most of the Dyestuffs Division's permanent technical and commercial records and reports, of which about a hundred and fifty thousand different documents are at present filed; a Technical Section, which collects and indexes technical data of various kinds; and a Commercial Library, not housed in the new block, but situated adjacent to the Sales Departments in Hexagon House, which also collects commercial data.

The new library building, which connects two existing research blocks, has four main floors and a top floor that is occupied by a lecture theatre seating 156, most of the seats being provided with writing flaps. Of the total floor area of 17,000 sq. ft., 2,500 sq. ft. is occupied by the lecture theatre and ancillary rooms, 3,000 sq. ft. by the ventilating plant, corridors, lift, etc., and 2,000 sq. ft. by the basement store. The Main, Technical and Patents Libraries and library offices occupy 5,500 sq. ft., the Records and Reports Section 1,600 sq. ft., and general administration and workshop 1,200 sq. ft. All are characterized by light and spaciousness; the Main Library, on the first floor, measuring 75 ft. by 45 ft., has good north and south lighting and seating accommodation for forty. Shelving and reading space are arranged in the form of alcoves, and shelving and furniture are in walnut, many of the individual tables provided having built-in table easels.

The Technical Library on the ground floor has about one-third the area of the Main Library, and seating accommodation for twelve. It is equipped with cream-coloured steel adjustable shelving, and tables and chairs in natural oak. Adjacent to it is a workshop equipped for repair work on books and pamphlets, cover and case making, report binding and parcelling, and a small dark room off the workshop is equipped with photocopying apparatus. Off the Main Library, on the first floor, there is a small room for storing and reading microfilms. On the second floor there are the main files of the Records and Reports Section, the index room and the collection of British and foreign patent specifications.

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# ENERGY VALUE OF FOOD

To determine the number of calories that a known weight of food will give when it is burned in a bomb calorimeter is relatively simple; but to assess accurately the number of calories that the animal body can derive from that food presents several problems which have not yet been satisfactorily solved. The subject was discussed at a symposium arranged by the Scottish Group of the Nutrition Society and held at the Hannah Dairy Research Institute, Kirkhill, Ayr, on April 30. The morning session was devoted to methods of assessing the energy of feeding-stuffs for animals, and the afternoon session to the problem as it concerns food for man. At intervals during the day some of the work in progress at the Hannah Institute on the production and emission of heat by farm animals was demonstrated.

In introducing the subject the chairman, Prof. R. C. Garry (University of Glasgow), stressed the danger of regarding food simply as though it were fuel for a machine. Food is much more than fuel, and the animal body much more than a machine. Food has to build, repair and maintain the fabric of the body as well as supply it with energy for work, and the body, unlike the machine, processes its fuel in digestion, absorption and metabolism. The content of minerals, vitamins and other substances present may all affect the energy value of the food by influencing the well-being of the animal, and in man the matter is still more complicated since social habit, beliefs and prejudices may all play a part. The chemistry of a foodstuff must be thoroughly understood: in time the biochemical processes by which energy is liberated from it will be elucidated; but it will still be essential to consider the living animal as a biological entity.

The first paper of the morning session was a joint communication by K. L. Blaxter and N. McC. Graham, who first dealt briefly with the history of methods of evaluating foods as sources of energy for livestock. They pointed out that reliable values are needed for planning livestock production both at farm and at national level, since on such values depend in large measure the animal product output of farming as a whole and estimations of the quantities of feeding-stuffs that must be imported. The second point they made was that measures of the energy value of foods are biological measures and cannot be expected to have the precision usually associated with the physical term 'calories' in which they are presented. Their statement that the efficiency of an animal in utilizing its food necessarily influences the nutritive value of the food it consumes emphasized this point, and was a theme that recurred time and again during the subsequent discussions.

Referring to the different ways in which the energy value of food for cattle is expressed, Blaxter and Graham emphasized the fact that, in order to estimate the value in terms of body storage of energy or in terms of energy transference to milk or eggs or its utilization for work, it is necessary to take into account the heat production incidental to the consumption of the food. For this reason the term 'net energy' or 'starch equivalent', as it is termed Britain, which takes this heat production in account, is superior to expressions of energy value terms of 'digested energy' or 'metabolizable energ Methods of determining net energy were th considered, and slides were shown illustrating t various types of respiration calorimeter in use different parts of the world. The difficulties involv in interpreting the older calorimetric observatio made with cattle and sheep, and indeed those present being made by Blaxter and Graham at t Hannah Institute, were then considered. The effe of plane of nutrition and the type of basal ration use was discussed, and the fact that very small analytic and instrumental errors become greatly magnifie by the very nature of the differential methods computing the results was emphasized. Blaxter an Graham showed that, though well-known text-boo and feeding-stuff tables quote energy values of som 250–300 foods, sixty years of work at Möcker experimental station in Germany, where almost a this work has been done, deal with but thirty-seve foods in seventy-one experiments. Most of the value in the tables are therefore computed values, an recent work has shown that the accuracy of the estimations is frequently very low. Finally, Blaxt and Graham deplored the tendency of workers in th field during the past fifty years—admittedly with few exceptions—to become involved in many point of minor importance and to spend much time on wha is nothing more than arithmetical re-expression the results obtained by Kühn, Kellner and Armsb without contributing in any way to a deeper knowledge of the subject. They regard it as imperativ that an end should be put to recalculating Kellner' results of 1900–5 and that emphasis should b placed on new experiments carried out in the ligh of modern knowledge of intermediary metabolism and with modern equipment.

The discussion was continued in a second paper b Dr. J. C. D. Hutchinson (Poultry Research Centre Edinburgh), who dealt with the reasons why there ha been so little progress in assessing the energy value o feeding-stuffs in spite of the great scientific, economi and practical importance of the subject. He referre to the great difficulties involved and the slowness o this type of work, and cited experience with th Danish calorimeter for cattle with which he is personally acquainted, where the output over a lon period averages one result per worker per year Dr. Hutchinson referred to some ways in which greater output could be obtained—by adopting mor automatic methods of measuring heat loss, by dispensing with the necessity of simultaneous estimates o carbon, nitrogen and energy retention and possibly by using methods involving carcase analysis or body-water determinations. He agreed with Blaxter an Graham that a more fundamental approach with les of the empiricism that has necessarily characterize the earlier work would prove most profitable in th future.

In the afternoon session Dr. E. M. Widdowso (University of Cambridge) mentioned that, until th Second World War, the energy values of food fo man appeared to be of interest chiefly to compilers o food composition tables; but early in the War it wa found that calorie calculations made on the two side of the Atlantic did not agree, and this led to a bette realization of the great practical importance of th subject. Dr. Widdowson discussed several tables o food composition published during the past fifty ars and stressed that, although the methods of mputation vary considerably for different tables, one of them appears to be correct. All are based on ork done half a century ago in Germany by Rubner d in the United States by Atwater, who had been pupil of Rubner. Both these early pioneers measured e intakes of protein, fat, carbohydrate and calories people on different diets and estimated the calories st in the fæces and urine. From their results they lculated the energy values of individual foods and mixed diets. In 1899 Atwater and Bryant concluded that protein and carbohydrate each give 4·0 al./gm. of total nutrients, and fat 8·9 kcal./gm.; d yet a few years later when they compiled tables food values for the composition of several thousand odstuffs, they used Rubner's earlier figures of 4·1 r protein and carbohydrate and 9·3 for fat—a range inconsistency which they did not explain nd which was the forerunner of many others by ter compilers of food tables. Indeed, throughout e years as one error was corrected another appeared creep in. Even as recently as 1947 the committee n calorie conversion factors and food composition bles of the United Nations Food and Agriculture rganization, in calculating the calories per gram of gested protein, failed to apply properly a simple orrection factor for the amount of unoxidized aterial excreted in the urine, and thus, while nproving some portions of the general computation, ntroduced a new error in another portion.

Towards the end of her paper Dr. Widdowson welt on the great need for further experiments with nixed diets more typical of those eaten to-day than vere the diets studied by Atwater. She also stressed he need for experiments to be done with larger umbers of people so that more information can be btained regarding the sort of variation that normally xists between individuals in the number of calories hey obtain from their food. She referred briefly to he need for evolving methods by which the physiological energy value of food in infancy and during rowth can be assessed. She readily admitted that nany mistakes have been made in computing the nergy values of human foods; but endeavoured to onsole herself and those present by recalling that he vho makes no mistakes rarely makes anything—ertainly not food tables.

The second paper of the afternoon session was given by Miss D. F. Hollingsworth (Ministry of Agriculture, Fisheries and Food), who carried the general problem to its next stage by discussing the lifficulties which are encountered in interpreting ables of food composition and in using them to stimate the energy value of human diets. For xample, before the energy values given in tables an be applied in practice it is essential to consider now much of the purchased food is edible, how much water it contains, how much is lost in cooking and serving, and, as Miss M. Andross pointed out later in the discussion, how much is left as waste on the plate. To take one example, the moisture content of flour in food tables is usually assumed to be 12 per cent whereas in Britain for other purposes it is more normally taken as 15 per cent; this leads to a difference of roughly 3 per cent in the calculated energy value of the flour. Again, the fat content of meat can vary over a very wide range, and this can have a marked effect on the energy value computed for it. With made-up dishes the problems become still more involved, and in estimating requirements at an international level further complications arise when figures, which have been computed for British food supplies, are used for estimating the requirements of other countries where higher proportions of the total energy of the diet may be supplied by carbohydrates.

The four papers and the subsequent discussion achieved what was no doubt one of the main objects of the symposium, namely, to bring out some of the numerous difficulties that arise when attempts are made to assess accurately the energy values of foods, and to indicate some of the numerous problems that still wait to be solved by chemist, biochemist, physiologist and dietitian, as well as by those whose difficult duty it is to consider the general subject of world food supplies, their economics and distribution.

J. A. B. SMITH

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# CHEMICAL ASPECTS OF SEMICONDUCTORS

A HALF-DAY symposium on "Chemical Aspects of Semiconductors" was held in the Chemistry Department of the University of Reading on March 26. The meeting, which attracted a gathering of some two hundred, was arranged by Dr. P. F. Holt (Reading) on behalf of the London Section of the Royal Institute of Chemistry. The chair was taken by Dr. F. S. Stone (Bristol). The aim of the symposium was to bring to the attention of chemists some of the problems of a chemical nature arising in the semiconductor field. The rapid developments in the technology of semiconducting materials which have taken place during the past ten years have only been achieved by close co-operation between the chemist and the physicist, and it is important that from time to time the current chemical problems in this predominantly physical field should be presented in a chemical forum. There is, moreover, a growing awareness among chemists of the contribution which semiconductors can make to fundamental studies on essentially chemical problems, such as adsorption and chemical bonding in solids, and this factor no doubt added to the general interest which the meeting aroused.

Since many of those present were not specialists in the semiconductor field, the main contributions were preceded by some introductory remarks on semiconductors, given by Dr. F. S. Stone. After outlining the principles underlying intrinsic and impurity semiconductivity, Dr. Stone dealt briefly with the rectifying and transistor action of germanium. In reviewing the chemical aspects, he stressed the importance of purification and standardization of materials. The significance of adsorption of active gases and vapours in creating a space charge at semiconductor surfaces was also emphasized, and attention was directed to the fact that very little fundamental work has so far appeared on adsorption at silicon and germanium surfaces.

The first of the more specialized papers was read by Mr. I. M. Ross (Services Electronics Research Laboratory, Baldock), who reviewed work on intermetallic semiconductors. Useful as silicon and germanium are for crystal-valve applications, their characteristics in respect of the combination of carrier mobility and separation between the valence and conduction bands are not entirely satisfactory. For other applications, such as photo-devices, quite different characteristics may be required. Interest has therefore turned to the closest analogues of silicon and germanium, namely, compounds between elements in Group III and Group V (for example, InSb, GaAs) crystallizing in the zinc blende structure. Like the purely covalent germanium and silicon, the bonds in these 'III/V compounds' are also mainly homopolar. Mr. Ross pointed out that the band-separation in these compounds covers a wide range of values and that electron mobilities are in general high. With InSb, for example, which has been the most widely studied of these compounds, the electron mobility is 65,000 cm.$^2$/volt-sec. at 300° K., compared with 3,600 cm.$^2$/volt-sec. for germanium. The band-separation in this case is too low for transistor action at room temperature, but the high mobility has led to a number of new applications, particularly concerned with the Hall effect, in which the available power is some three hundred times that given by germanium. Mr. Ross demonstrated this to the meeting by showing the effect of the earth's magnetic field upon the current flowing in a crystal of InSb. He also outlined some of the technical problems associated with producing crystals of III/V compounds. Zone-refining (see below) is in general difficult to apply to these compounds due to their tendency to decompose, and, with the exception of InSb, the problems of purification and growth of single crystals have not been satisfactorily solved. In GaAs, for example, reliance has had to be placed on extensive purification of the parent elements. A further problem, the study of which has only just begun, is that of obtaining stoichiometry in these compounds.

A contribution which aroused much interest was made by Mr. A. A. Smales (Atomic Energy Research Establishment, Harwell), who reviewed methods for estimating trace impurities. Besides sensitivity, specificity and accuracy, Mr. Smales classified the various methods according to their advantages in respect of freedom from contamination (either adventitious or from reagents) and their ability to deal with several elements simultaneously. Emission spectroscopy has this latter advantage and is highly specific. Freedom from contamination may be avoided if the material is examined directly, but not if impurities have been chemically concentrated before determination, to enhance the sensitivity. The most sensitive methods are undoubtedly the isotope dilution technique, employing mass-spectrometric analysis, although the contamination problem still exists there, and the radioactivation method, which involves neutron irradiation in a pile followed by radiochemical separation. For many elements these methods have sensitivities better than 1 part in $10^9$. The first technique is applicable only to those elements for which separated isotopes are available, while the second is limited to those with suitable nuclear characteristics; nevertheless, more than half the elements can be determined by one or the other method. Both require that elements be analysed individually, though the development of gamma-ray spectrometers will ultimately enable the radioactivation technique to be more versatile in this respect. Using the vacuum-spark ion source, the mass spectrometer may be applied to the determination of several elements simultaneously, but the sensitivity is greatly reduced. Mr. Smales also described the more conventional methods, such as colorimetry and polarography, pointing out that although they are fairly sensitive (0·1–1 p.p.m.), the reagent blank problem remains a major limitation.

Mr. H. J. Cluley (General Electric Co., Ltd., Wembley) described chemical processes for obtaining germanium and silicon in high purity. Germanium is extracted as the tetrachloride from coal (flue dust or from zinc blende during smelting. Purification then effected by fractional distillation and refluxin over copper or by repeated distillation. Arsenic, th main impurity, is thereby reduced in concentratio to less than 1 part in 10 million. The metal is obtaine by hydrolysis to germanium oxide and reductio with hydrogen. High-purity silicon may be prepare by fractionation of silicon tetraiodide, followed b the van Arkel technique of thermal decompositio at a hot filament. A second method is the reductio of silicon tetrachloride with zinc in the vapour phase Mr. Cluley also reviewed other methods involvin the thermal decomposition or hydrogen reduction o silicon compounds. Before germanium and silico can be used for electrical work, further purificatio by zone-refining is necessary. The details of thi technique were described by Mr. S. E. Bradsha (General Electric Co., Ltd., Wembley). In zone refining, a molten zone is slowly but repeatedly mad to pass along an ingot of the material. The effect i to concentrate the impurity at one end since, whe an impure solid is melted, the impurity concentratio in the solid ($c_s$) differs from that in the melt ($c_L$ with which it is in equilibrium. If the segregatio coefficient $K$ ($K = c_s/c_L$) is less than unity, the im purity is swept in the direction of traverse. If $K$ i greater than unity, the impurity concentrates in th regions where freezing begins. Unless $K$ happens to b close to unity (for example, boron in silicon), th method is extremely effective and impurity concentrations can readily be reduced to 1 part in $10^9$.

A paper by Mr. J. I. Carasso (Post Office Researc Station, Dollis Hill) dealt with two chemical factor affecting the performance of germanium diodes. Th first of these was the use of nickel as an additive fo the controlled shortening of carrier life-times, a requirement for high-frequency operation. It is found that the addition of nickel to the melt during the crystal-growing stage does not produce the required degree of control, the resulting concentrations o nickel in germanium being different from those expected on the basis of a simple treatment of the segregation coefficient. This anomaly is explained by a suggested diffusion of nickel atoms through the germanium lattice. Direct addition of nickel to germanium by lattice diffusion from a nickel/germanium interface may, in fact, be a more satisfactory method of controlling the incorporation, and Mr. Carasso described experiments of this type at present in progress at Dollis Hill. The second topic treated by Mr. Carasso was surface contamination. Adsorbed gas may exert an influence upon a *p–n* junction due to surface mobility of charged particles. Or again, the space charge arising at the surface may itself be sufficiently intense to form, for example, a *p*-type 'skin' on *n*-type material (channel effect). Thirdly, opportunity is provided for high rates of carrier recombination at the surface. Mr. Carasso discussed specifically the behaviour of water vapour and iodine vapour, showing that the channel effect for water is opposite to that for iodine.

The importance of employing single crystals of a high degree of perfection for semiconductor work is frequently emphasized. This aspect of the field was covered by Dr. E. Billig (Associated Electrical Industries, Ltd., Aldermaston), who gave a descriptive account of the methods of growing single crystals. Among other points, he discussed the correlation of heat dissipation with growth-rate and mentioned at the usual rates, as obtained by the standard yropoulos method, could be considerably increased y undercooling the melt. Melts can be undercooled y as much as 20–30° C. without risk of nucleation. r. Billig showed that if one (111) plane of a ger- anium crystal is maintained vertical, the crystal is le to grow without the need for nucleating new yers; no experimental evidence of growth from iral dislocations has in fact been obtained in this ork. Imperfections, however, do arise, due possibly the occlusion of impurities and to mechanical resses. Such stresses are commonly caused by neven temperature distribution or by certain ystallographic features such as the intersection of vo twin boundaries. A single twin boundary, on the her hand, apparently has no effect on the electrical roperties. Dr. Billig concluded by showing a film ustrating various features in the growth of ger- anium and silicon monocrystals. Under certain nditions, such crystals have been obtained in the rm of thin plates which display a striking degree of xternal symmetry. The film also showed the xtremely rapid growth of dendritic crystals in the rm of thin and long lamellæ, demonstrating in a nvincing manner that, even in an isotropic medium f cubic symmetry, crystal growth can take place by he deposition of individual layers orientated along he close-packed (111) planes.

F. S. STONE

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# STAR-STREAMING FROM STARS OF SPECTRAL TYPES *A* AND *B*

A PAPER by T. R. Tannahill on "Star-Streaming from the Stars of Spectral Type *B*" (*Mon. Not. Roy. Astro. Soc.*, 114, No. 4; 1954) gives the results f his analysis, on Eddington's two-drift hypothesis, f the proper motions of 1,536 stars of spectral types and *B* in the Boss "General Catalogue". The aterial for the investigation was grouped into ten egions, each region consisting of a 'square' of north alactic latitude combined with the diametrically pposite region of south galactic latitude, as shown n the first table of the paper. An examination of his table and also of the drift-curves establishes that t is impossible to represent the motions of the B-type stars by a single drift, and a large proportion f the stars has been assigned to a second drift in rder to make a satisfactory fit; in four out of the en regions in Drift ii the number of stars exceeds hat in Drift i. From an analysis of the data, the rift constants are derived with the probable errors.

In a previous paper (*Mon. Not. Roy. Astro. Soc.*, 12, No. 3; 1952), Tannahill gave the corresponding esults from the galactic zone of stars of types $A_5$–$M$, nd a comparison with the present results indicates atisfactory accordance, considering the probable rrors involved. The values of $L$, $B$ and $hW$, the alactic co-ordinates of each drift apex and the space elocities of each drift, are used to calculate the heoretical values of $hV_c$ and $\theta_c$—that is, the pro- ections of the space-velocities of the drifts on the angent-plane at the centre of the region, and the osition angles of the directions towards the drift pices—and these are listed together with the esiduals $hV_c - hV$ and $\theta_c - \theta$. Considering that only 1,536 stars were used in the investigation, the resi- duals are quite satisfactory except in Drift i, region 5, where $\theta_c - \theta_1$ exceeds 49°. The linear components of the motion of Drift i relative to Drift ii are given in a table, and also the galactic longitude and latitude of the vertex of star-streaming and the relative space-velocity of the drifts. One curious feature is the close agreement of the galactic co-ordinates of the vertex position (343·3°, −1·6°) obtained by the investigation, and that normally found (343°, −2°). It is admitted that the closeness of the agreement must be regarded as fortuitous, on account of the probable errors involved. Nevertheless, this does not vitiate the final conclusion, and the result "removes any shadow of doubt that the *B*-type stars exhibit the phenomenon of star-streaming".

The subject is continued in a further paper (*Mon. Not. Roy. Astro. Soc.*, 114, No. 5; 1954), "Star-Streaming from the Proper Motions of the *A*-Type Stars of the Boss 'General Catalogue' ", in which are given the results of the analysis of the motions of 8,676 stars of the spectral types $B_5$–$A_3$. The method of dealing with the data follows closely that described in the 1952 paper for stars of types $A_5$–$M$, and stars belonging to known clusters have been rejected; of these, twenty belong to the Pleiades group, forty-six to the Ursa Major group, and nine to the Taurid cluster. The same difficulty in analysis arose as with the $A_5$–$M$ stars, the regions around Drift i apex offering certain problems in analysis, especially in the determination of the Drift ii constants. The higher concentration of the stars in the galactic plane, the regions in the higher galactic latitudes being sparsely populated, presented further difficulties; but in spite of these, analysis was possible in all regions, and the results are given in nine tables.

One rather surprising feature may be mentioned: in the $A_5$–$M$ types there was a marked decrease of $hW$ with advancing spectral type, which was not maintained in the *A*-stars. There was a decided systematic change in the Drift ii apex, the right ascension decreasing, and the declination increasing, with advancing type. In addition, large and apparently irregular variations occurred in some of the quantities determined, and, judging by the probable errors involved, must have a statistical significance, yet they indicated no systematic trend. Some possible reasons for these discrepancies are suggested by Tannahill, and though they are only tentative, it is probable that future research will modify some of the hypotheses on which present investigations are based. The galactic co-ordinates of the vertex were found to be (365·5°, −0·5°), and the equatorial co-ordinates of the solar apex (264·8°, +31·5°); the latter is not far from the co-ordinates of the solar apex as found from the streaming of the spectral type *B* stars (260·7° + 37·3°).

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# THE INSTITUTE OF SEAWEED RESEARCH

IN the annual report for 1954 of the Institute of Seaweed Research, the interested layman's attention will be attracted by the statement that "mechanical harvesting of sublittoral Laminariaceae has now been proved to be a feasible and reasonably cheap operation". At present, six seaweed-processing factories in Scotland use more than 30,000 tons of cast weed annually, and it is estimated that one motor fishing vessel adapted to operate twin I.S.R. belt harvesters should be able to collect more than five thousand tons of *Laminaria cloustoni* a year in good areas. One of the main objectives of the Institute has therefore been attained and the advantage to the seaweed industry of planned collection of the material over cast weed is obvious.

If mechanical harvesting has been the limiting factor in the industry up to the present, its adoption may bring fresh problems. If it becomes regular practice, limited in the main by the state of the weather and sea only—it is suggested that harvesting on at least 170 days a year is a reasonable assumption—it becomes important to assess the effects of harvesting on the density of the beds of *Laminaria cloustoni* as well as on the associated fauna and flora. The same report indicates that changes in the density of these beds occur from year to year when they are subject to natural conditions only, and hence it is reasonable to ask what effect harvesting will have on them.

Processes for the manufacture of mannitol, aminarin, calcium alginate and fucosterol have been perfected at the Institute; but whatever products are to be made use of commercially, the industry is in the last resort dependent on a continuing supply of the plant. Experimental work on the effect of harvesting is therefore of prime importance.

KATHLEEN M. DREW

# WORK STUDY

IN one of the occasional papers published by the Institute of Personnel Management, a useful corrective is given to the unfortunate trend in industry which regards work study as the panacea for all industrial ills. Valuable as they are, work study and monetary incentive schemes are techniques which can have the most harmful consequences; they may increase production in the short run (not always in the long run) but at a social and psychological cost which is no less serious because it cannot be immediately perceived. It may be argued that it is unjustifiable to criticize work study together with the use of narrowly conceived incentive schemes, on the ground that there is no necessary connexion between them. There is, of course, no necessary connexion, but, in practice, there has developed a very natural connexion: the increase in repetitive work and the progressive simplification of the job have required that a substitute incentive be found for the satisfaction and skill so often destroyed. Among the many dangers and disadvantages of direct incentive schemes the following seem to be among the most important.

They are sought and used as a substitute for managerial skill in other directions, and they tend to deflect attention from matters which should have a far higher degree of priority in the development of any management policy; for example, production planning and sales/production co-ordination, education and training, method study, and systems of cost control.

The foreman's direct responsibility for output is reduced; this is said to be an advantage in that he is thus enabled to carry out more important duties. In fact, the stresses impinging on the foreman are frequently increased by the introduction of an incentive scheme and become more frustrating and harmful in character.

The impact of incentive earnings on the wages structure can be very detrimental and lead to much discontent. Supervisory differentials and other evaluated jobs are adversely affected by distorted earnings in other departments.

The installation of an individual incentive schem frequently has a disintegrating effect on the workin group which in many cases is resolved by taci agreement among workers to restrict output to a agreed level; this is strongly condemned by management, who fail to understand that in the circumstances it is indispensable for the social equilibrium of the group.

As the whole emphasis of the incentive scheme is o producing the maximum individual reward, the effec is for the incentive bonus to be won regardless o necessary co-operation with supervisors and fellow workers. The quality of production frequently suffers despite careful inspection procedures.

The scientific accuracy of time study has yet to b demonstrated, and the trade unions, aware of th difference in standards between time-study men, ar not slow to take advantage of these opportunities i negotiation; in this respect time study may b regarded as a tool for collective bargaining.

Not the least important is the insidious effect tha incentive schemes can have on the moral qualitie and sense of responsibility of the individual. It i perhaps to be expected that a system which attempt to allocate a precisely defined reward for every action of the individual in his working society should have its repercussions elsewhere.

# CONGENITAL PORPHYRIA IN SWINE AND CATTLE IN DENMARK

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AND
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CONGENITAL porphyria is a rare inborn error o metabolism in man and animals. It is occasionally seen in pigs and cattle in slaughter-houses because of the reddish-brown colour of the bones and teeth; but it has only once been studied in live cattle[1] and live pigs[2]. For further information the reader is referred to the survey by Rimington[3]. It is a puzzling coincidence that congenital porphyria has been found in both pigs and cattle in Thisted County in North Jutland. We are now studying the live animals.

In October 1951 one of us (S. K. J.) found dark bones in pigs at Thisted slaughter-house. This reduced the market value of the pork, and in consequence an investigation was started. The condition could be diagnosed with reasonable certainty on inspection of the colour of the teeth in the new-born pigs; pigs with dark teeth as a rule develop porphyria. After elimination of all pigs with dark teeth, the condition disappeared; since February 1954 no new cases have occurred at Thisted. Two sows with porphyria were transferred to the State Experiment Farm of Faurholm for breeding studies and chemical investigations under the direction of Prof. H. Clausen and a senior experiment officer, N. J. Højgaard Olsen, in collaboration with one of us (T. W.). Some material was also sent to Prof. C. Rimington in London.

The best method of characterizing the severity of porphyria in a pig is quantitative analysis of the eth or bones for porphyrin; for example, the teeth new-born pigs. The analysis is carried out as llows (to be published by T. K. W.[5,6]): The small eth are treated with 0·5 *N* hydrochloric acid, which tracts the porphyrin but not the other dark pig-ents present; the porphyrin is determined spectro-otometrically in the extract by the method of imington and collaborators[4]. Bones are pulverized ith a file, about 50 mgm. of the powder is weighed it and shaken for about a minute with 5 ml. of ·5 *N* hydrochloric acid; after standing for an hour, ntrifugation is carried out and then the determ-ation is made.

The distribution of porphyrin within the skeleton aries considerably. In the compact substance, the oncentration is often five to ten times as high as in ie spongy tissue; and even within the former, ertain zones may contain considerably more than thers—a fact readily seen on direct examination of ie bones in Wood's light. The porphyrin of the eeth is for the main part located in the dentine; the namel contains at the most only traces of porphyrin. 'eeth of new-born pigs with porphyria contain a ark non-porphyrin pigment besides porphyrin, and his is not extracted with dilute hydrochloric acid. lost often dark teeth show definite fluorescence in Vood's light; but occasionally they may fail to do o, and in such cases the extract with 0·5 *N* hydrochloric acid as a rule shows a beautiful red fluorescence. Consequently, a tooth from a new-born pig annot be regarded as porphyrin-free because it fails o fluoresce in Wood's light. Extraction with dilute ydrochloric acid and examination of the fluorescence f the extract is required.

Teeth of new-born pigs contained from a few μgm. orphyrin per gm. in slightly affected animals to 200 gm. per gm. in severe cases; in the bones of adult igs, figures of the same order were found. Lutidine hromatography[5] showed that the porphyrins of the ones and teeth were mainly uroporphyrins, with ninor amounts of coproporphyrins. The most everely affected pigs excreted 1,000–10,000 μgm. of roporphyrin in the urine per 24 hr., the more lightly affected only 100–750 μgm. Besides the roporphyrin, smaller amounts of coproporphyrin vere excreted (about 50 μgm. per 24 hr.). No porpho-ilinogen was found in the urine. Lutidine chromato-raphy[5] on the urinary porphyrins showed the resence of small amounts of porphyrins with three, ive, six and seven carboxyl groups besides the -carboxyls (uroporphyrin) and 4-carboxyls (copro-orphyrin). Dioxane chromatography[6] showed that bout 70 per cent of the uroporphyrin in urine and ones was uroporphyrin I, about 30 per cent roporphyrin III. Paper chromatography of the oproporphyrins[7] showed that the main part was oproporphyrin III.

The health of pigs showing porphyria was very ittle if at all affected, except in the most extreme ases. Photosensitivity of the skin was never bserved. A single boar died spontaneously showing ymptoms of heart failure, which may have been due o porphyria. The heredity of the condition is not uite clear; but our observations point towards a ingle dominant gene, although a more complicated nechanism cannot be excluded.

In cattle, congenital porphyria has turned up ccasionally in Thisted County for at least twenty ears in animals of the Shorthorn breed. In 1952, a armer complained of one of his young cows, that it vas not getting on at pasture but did well in the stable. It was sent to the slaughter-house and found to have dark teeth and bones. One of us (S. K. J.) examined the bones; but they have since been lost except for a tooth which on analysis showed 239 μgm. uroporphyrin per gm. In November 1954, a young bullock with discoloured teeth was found on a veterinary inspection of livestock. This bullock and its dam were sent to Svendborg for chemical study. The cow was found to be free from porphyria whereas the bullock excreted large amounts of porphyrins with urine and fæces, although it was in excellent health and development. A tooth was extracted and showed 77 μgm. uroporphyrin per gm. This tooth was sent to Prof. Rimington in London. The tip of its horn was sawn off, and the tip of the bony core removed showed bright red fluorescence in Wood's light.

The bullock excreted with its 24-hr. urine about 100 mgm. of porphyrin, consisting of about 30 per cent coproporphyrin and about 70 per cent uroporphyrin. The percentage of the total porphyrins consisting of coproporphyrin varied considerably from one portion of urine to the other, the extreme values being 5 and 60 per cent. No uroporphyrin chromogen[7] was found and only 10 per cent or less of the coproporphyrin was excreted as chromogen. Porphobilinogen was present in amounts of 25–50 mgm. per 24 hr. This was demonstrated by a positive Ehrlich reaction, the dye of which was not extracted with chloroform, and it was measured quantitatively as uroporphyrin[8] after boiling at *p*H 5–5·5[4]. This occurrence of porphobilinogen is, if confirmed, rather remarkable, because this compound has not been found in congenital porphyria before. The porphobilinogen excretion was not constant, but intermittent. We have not so far succeeded in isolating the porphobilinogen in a crystalline condition; but we obtained once a purified and concentrated solution by means of Westall's[9] procedure.

The fæces of the bull contained, per gm. of dry substance, 100–250 μgm. of coproporphyrin (extracted from ether with 0·1 *N* hydrochloric acid), 10–25 μgm. of dicarboxyl (proto) porphyrin (extracted from ether with 5 per cent hydrochloric acid), and 50–100 μgm. of the uro-type (ether-insoluble). The latter showed an absorption maximum at 402 mμ in 0·5 *N* hydrochloric acid and is therefore probably not uroporphyrin. The corresponding figures for normal cows in the same stable and on the same feed were respectively 1·0, 3–5 and nil.

Finally, it may be mentioned that a young bull with porphyria was slaughtered at Thisted in January 1955. Its bone contained 94 μgm. uroporphyrin per gm. of the compact substance of the lower jaw; the spongy substance contained only 18–32 μgm. per gm. and a tooth 21 μgm. per gm. After this, a thorough analysis of the cattle of Thisted County based on analyses of fæces and teeth from all animals in stocks where cases have occurred was planned and is now going on. Our studies on the heredity of the condition have so far supported the view of Fourie[1] that congenital porphyria in cattle is inherited as a recessive character—contrary to congenital porphyria in pigs, which is inherited as a dominant character.

In conclusion, we wish to point out that the considerable quantities of porphyrins excreted per 24 hr. by our bullock—200 mgm. coproporphyrin with the fæces, and about 35 mgm. with the urine as well as about 65 mgm. uroporphyrin with the urine—are easily extracted and purified.

Since the bullock is a young and healthy animal, it can be expected to yield large amounts of porphyrin for several years, some of which may be made available as marker substances for paper chromatography and delivered to laboratories concerned with porphyrin analysis. Investigators who may be interested in obtaining porphyrin markers are invited to communicate with us (T. W.) concerning this question.

We wish to thank Prof. C. Rimington, University College, London, for valuable advice and never-failing interest, and the Sales Association of the Danish Export Bacon Factories (Eksport-Svineslagteriernes Salgsforening) and the Co-operative Danish Cattle-breeding Associations (De Samvirkende Kvægavlsforeninger) for financial support.

[March 3

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# STEREOCHEMICAL STRUCTURE OF CYTOCHROME *c*

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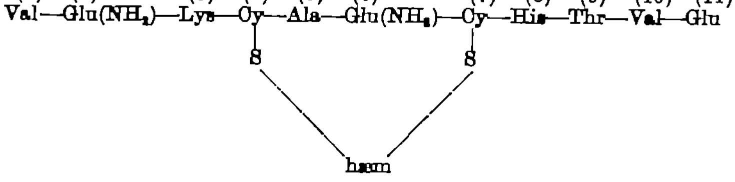
RECENTLY, a hæmopeptide obtained by peptic degradation of cytochrome *c* has been purified and its structure determined[1]:



Its physico-chemical properties in the ferric state have been examined in some detail[2] and compared with those of cytochrome *c*[3]. Magnetic measurements revealed that the bonds to the iron were essentially ionic in acid solution, but octahedral $d^2sp^3$ bonds at alkaline reaction. On acidification, the covalent bonds to the hæmochromogen-forming groups are released stepwise, with spectrophotometrically operable *pK*'s of 5·8 and 3·4 respectively; that titrated at *p*H 3·4 is presumably the imidazole residue of histidine (8), while the other one is either the α-amino group of valine (1) or the ε-amino group of lysine (3)[2].

With the aid of a set of steric bond models for building peptide chains with coplanar peptide bonds (generously given to us by Prof. L. Pauling), we have investigated different sterical possibilities for th hæmopeptide. For that purpose a hæm model in th same scale (1 A. = 1 in.) was made from a met disk, and the side chains involved were manufacture from bent metal rods and suitable joints allowin free rotation around the axis of the bonds.

It was assumed that all the amino-acids had th l-configuration. The peptide-chain model was folde to correspond to the various left- and right-hande helix-structures described[4]: α-helix with 3·7 amin acid residues per turn, π-helix with 4·4, and γ-heli with 5·1. Then attempts were made to connect th two cysteine side chains of the peptide with th α-carbon atoms of the vinyl groups in positions and 4 of the hæm disk (two possibilities) and on or two hæmochromogen-forming groups with th iron.

The γ-helix structure could immediately be ex cluded because of strong steric hindrance. With th α- or π-helices, the thioether bonds could always b formed. In these cases the ε-amino group of lysine ( could be attached to the iron; but it was neve possible with the α-amino group of valine (1).

Interest was, however, focused on the imidazol imino group of histidine (8), since there is goo evidence to show that two such groups are hæm linked in cytochrome *c*. With the π-helix this grou could reach the iron only with strain, and the angl between the helix axes and the hæm disk becam about 70°. Both the left- and right-handed α-spiral with the cysteine (4) connected to the side chain of the hæm disk gave rigid but strainless structure with the helix axes very nearly parallel to both th hæm plane and the imidazole plane. Since only th left-handed α-helix has been demonstrated in Nature we believe this structure to be the most probabl one. The α-helix of the hæmopeptide occupies jus one-quarter of the space around the hæm. In cyto chrome *c* at about neutral *p*H it is thus plausible t imagine four such helices arranged symmetricall about the hæm disk, thus shielding it from direc contact with, for example, oxygen, carbon monoxid or cyanide, but, nevertheless, in some way allowin electrons to be exchanged.

The alternatives of 'pleated sheet' configuration in cytochrome *c* looked very improb able for steric reasons.

In the hæmopeptide, two of the avail able hæmochromogen-forming group could reach the iron simultaneousl only if the structure was unfolded t a large extent.

At a low *p*H, no stable links ca be formed between the molecules and the hæmopeptide is no doub monomer. At higher *p*H, covalent bonds to the iro might be formed both intra- and inter-molecularly The fact that the hæmopeptide is precipitate between *p*H 4·4 and 7·1 may be due to a combine effect of such intermolecular bonds and the proximit of the isoelectric point (about *p*H 5). At an alkalin reaction the hæmopeptide is again soluble and hæmo chromogen formation is complete[2]. In the case o the rigid α-helix structures it is not possible for bot the iron-linked groups to be bound intramolecularly and some kind of polymerization must take place For steric reasons it would be expected that on or more types of polymers would be preferred In the case of an unfolded structure, however, polymerization would be much less favoured and irregular.

In order to study the molecular weight of the mopeptide under different conditions, we have rried out some sedimentation experiments in a inco ultracentrifuge. We obtained sedimentation nstants of 0·6 *S* at *p*H 2·3 and 1·6 *S* at *p*H 8·7. both cases the hæmopeptide appeared to be almost onodisperse. The molecular weights could be timated as 2,000 and 11,000 respectively, while the rmula of the hæmopeptide corresponds to *M* = 80. The existence of a monodisperse penta- or xa-mer at alkaline reaction thus strongly supports e existence of a rigid helix structure.

Tuppy and Bodo[5] added increasing amounts of stidine at *p*H 7 to the reduced form of hæmopeptide tained by tryptic digestion of cytochrome *c* and served absorption bands approaching the extinon coefficients of ferrocytochrome *c*. By adding 14 *M* histidine to a solution of the peptic hæmoptide at *p*H 8·7, we obtained a spectrum nearly entical with that of ferrocytochrome *c*. This sugsted that the free histidine competitively replaced e bonds causing the polymerization. To test this ssibility, an ultracentrifugal experiment was rried out under the same conditions and it showed at the sedimentation constant had in fact decreased om 1·6 *S* to 0·8 *S*. The depolymerization effected histidine was probably incomplete, since the emopeptide appeared to be slightly polydisperse.

In order to illustrate further the hæmochromogenrming capacity of the groups considered, a spectrootometric study of ferri- or ferro-protohæm plus stidine, lysine or glycyl-glycine was made at *p*H 7. ith lysine or glycyl-glycine, no reaction was served. This was not unexpected, since the *pK* of imary amino-groups is between 8·5 and 10·5. istidine, on the contrary, has a *pK* of 6·1, and two olecules of the histidine combined simultaneously ith one molecule of the protohæm ($n = 2$). The sociation constants for the histidine protohæm mpounds were found to be $K_{\rm ox} = 0·004\ M^2$ and $_{\rm red} = 0·015\ M^2$ at 20° C. Our result, $n = 2$, is in e with the findings of Cowgill and Clark[6], who udied the combination of several imidazoles with rri-mesoporphyrin. The fact that $n = 2$ also in tochrome *c*[7] cannot of itself be taken as an evidence at the iron-linked groups are identical. The present monstration of the much higher ability of histidine form a hæmochromogen at *p*H 7 as compared with her amino-acids must, however, be considered as rong support for the view that both the ironked groups of cytochrome *c* really are histidine idazoles. Furthermore, Margoliash recently found at two of the four imidazoles in horse cytochrome *c* not react with dinitrofluorobenzene[8].

It is interesting to notice that the isolation of a ptide fragment with eleven amino-acids, two or ree of which are attached to a hæm molecule in a own way, has made it possible to make predictions ncerning the sterical structure of the undegraded otein, without the aid of X-ray investigations.

A detailed report of this work will be presented in *cta Chemica Scandinavica*. [March 30

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# AGES OF PITCHBLENDES BY X-RAY DIFFRACTION

By DR. B. WASSERSTEIN

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IN a recent communication in *Nature*[1], it was shown how uraninites, essentially $UO_{2\pm x}$, could be classified into three mineralogical types, and that two of these fitted into a scheme of age determination based on progressive shrinkage of the unit cell. The third type, β-uraninite, or better known as pitchblende, was discarded as unsuitable.

Further work on pitchblendes supports this general conclusion—with certain qualifications. Relatively young pitchblendes give slightly lower cube-edges, that is, higher ages, than normal; but older pitchblendes can be accommodated within the new scheme of age determination. The explanation for such results may be found in the varying poor crystallinity of the pitchblendes. Like glass, which devitrifies with time, the older samples seem more amenable to a method relying on crystallographic measurements. Defective crystal lattices can be expected to occur in material which often appears glassy or shows signs of a colloidal origin.

Even in a scheme of age determination by X-ray diffraction, pitchblendes, although scarcely qualifying as crystalline, could not be entirely ignored. Their X-ray spectra are unsatisfactory for measurement. Heating produces a sharper spectrum, and, as uranium oxide is known to be stable in hydrogen even above 1,000° C., it is argued that ignition in hydrogen of pitchblendes would remove their characteristic excess of oxygen to give the required α-type, the parameter of which serves as the criterion of age. From the classification data previously presented[1], it was predicted that this ignition would increase the parameters of pitchblendes, and this was, in fact, observed.

| Locality | Before ignition | After ignition |
|---|---|---|
| Gilpin, Col. | 5·42 A. | 5·443 A. |
| Cornwall | 5·40 ? A. | 5·455 A. |
| Viseu, Portugal | 5·40 ? A. | 5·443 A. |
| Joachimstal, Czechoslov. (several samples) | 5·41 A. | 5·435–5·448 A. |
| Příbram, Czechoslov. | 5·41 A. | 5·448 A. |

The error in some determinations approached 0·01 A.; nevertheless, it is clear that ignition markedly increased the cube-edges; but they mostly fall short of the anticipated values around 5·46 A. (Other types of uraninites when heated *in vacuo* or in different atmospheres show a *decrease* in the cube-edge value.)

These results show that the transition from β- to α-type takes place as predicted. The value from the Cornwall sample, suggesting an age around 400 million years, may be correct within the experimental error; but the higher ages, that is, the lower cube-edge values, may be due to such crystal defects as vacant uranium atom positions, or replacements of uranium. In the Gilpin sample, such replacement by the small ions zirconium and titanium may well account for the abnormal reduction in cube-edge.

Turning to older pitchblendes—and the method primarily aims at establishing pre-Cambrian data—it became desirable to compare both an α-type and a pitchblende (that is, β-type) from the same deposit in the hope of cancelling out any major effects due to differences in age or composition. Only from one locality were both types available for investigation, namely, from the Rhokana Mine, Kitwe, Northern Rhodesia. Differences in these two types cannot entirely be ruled out, but similar results would suggest that these differences were negligible. The results obtained were:

RHOKANA MINE

| | |
|---|---|
| Untreated pitchblende (that is, $\beta$-type) | 5·417 ± 0·007 A. |
| After 1 hr. in hydrogen at 950° C. | 5·443 ± 0·004 A. |
| Untreated $\alpha$-uraninite | 5·453 ± 0·003 A. |
| After 1 hr. in hydrogen at 950° C. | 5·447 ± 0·003 A. |

The agreement after heating is highly satisfactory. It is likely that minor alteration has increased the untreated α-type—this phenomenon is commonly encountered in γ-types (paper in preparation) when oxygen enters the crystal lattice interstitially.

The slightly lower value for the heated pitchblende sample when compared with the α-type is not unexpected in view of the previously mentioned findings. The value for the untreated α-type agrees with the 'chemical age' of 520 million years reported by Davidson[2], while the parameter obtained after heating is identical with that found for the Belgian Congo α-uraninite and therefore has an age of 620 m.y. The data at this stage are not sufficient to decide the issue; but they clearly indicate this narrow range in ages.

The real significance of the Rhokana results is that they show the relationship between α- and β-types to be as presented in my classification, and thereby a procedure in obtaining ages from pitchblendes by X-ray diffraction is indicated.

With this background the method was applied to two relatively older pitchblendes the ages of which are more precisely known from isotope measurements—such material is difficult to find. Exceptionally, sufficient material was available for differential thermal analyses by Mr. E. R. Schmidt of this laboratory, and this investigation supported their classification as β-types.

## (A) Madagascar

Through the kindness of one of the authors, Dr. H. Besairie, of a recent publication on the ages of radioactive minerals of Madagascar[3], I secured a duplicate specimen of the Bemasoandra uraninite, the lead isotopes of which, determined by Nier, gave the following results:

| $^{207}$Pb/$^{206}$Pb | $^{206}$Pb/U | $^{207}$Pb/U | $^{208}$Pb/Th |
|---|---|---|---|
| 480 ± 20 | 390 | 410 ± 4 | 465 ± 2 |

The real age taken by the authors from these data is 480 ± 15 million years.

The X-ray results were as follows:

BEMASOANDRA

| | |
|---|---|
| Untreated pitchblende | 5·444 ± 0·003 A. |
| After 1 hr. in hydrogen at 950° C. | 5·459 ± 0·003 A. |
| After correcting for thoria | 5·455 ± 0·003 A. |

The parameter 5·455 A. becomes the criterion for age. As the shrinkage of the cube-edge with time is about 0·0035 A. per hundred million years, it follows that the Bemasoandra β-uraninite is just 200 million years younger than the well-authenticated age for Belgian Congo (see table), so that the X-ray results therefore give an age of 420 million years.

The experimental error is probably less than 100 million years, and the agreement with the age from isotopic data is as good as can be expected. This result is important in supporting the reasonii adopted in this investigation.

## (B) Great Bear Lake

The age of the well-known pitchblende from th Canadian locality is now accepted as close to 1,4( million years[4]. Marble[5] has shown that thoria absent and that the rare-earths are of minor si nificance; in the α-uraninite derived from th pitchblende, only radiogenic lead will therefore affe the cube-edge.

This pitchblende differs from those of its group it is the only one which showed a reduction in cub edge after ignition in hydrogen. It is suggested th weathering increased its cube-edge due to the intr duction of interstitial oxygen. The X-ray data foun were as follows:

GREAT BEAR LAKE

| | |
|---|---|
| Untreated pitchblende | 5·453 ± 0·004 A. |
| After 1 hr. in hydrogen at 950° C. | 5·421 ± 0·003 A. |

These results were duplicated under slightl differing conditions; the spectra obtained were ver satisfactory and the chemistry of the material well known—these factors suggest a high accurac in determination. The parameter 5·421 A. indicat an age just over 300 million years greater than th well-established age for Wilberforce, Ontario. Th X-ray data therefore give an age of 1,350 ± 5 million years.

The agreement with the age determined by mea of isotope data can scarcely be bettered.

Considering the kind of material that pitchblend represent, it is remarkable that one can recogni with the aid of X-rays such a degree of order i them. Their relationship to the better crystallize members of this mineral group now finds a sati factory explanation, and their study completes th picture of the uraninites and their age determinatio by means of X-rays. By inserting the two newl found values for the two pitchblendes from Mad gascar and Great Bear Lake in the previously pu lished table, perfect fits are obtained which great strengthen the chain of results—almost halving th gap between 1,000 and 2,000 million years. Th augmented table now reads:

| Samples | Types | Isotope ages | Cube-edges (corrected for thoria) |
|---|---|---|---|
| Uranium oxide—artificial | $\alpha$ | Zero | 5·470 A. |
| Connecticut, U.S.A. | $\alpha$ | 250 m.y. | 5·463 A. |
| *Madagascar* | $\beta$ | 480 ± 15 m.y. | 5·455 A. |
| Belgian Congo | $\alpha$ | 620 m.y. | 5·448 A. |
| Bisundni, India | $\alpha$ | 735 m.y. | 5·443 A. |
| Gaya, India | $\gamma$ | 955 ± 40 m.y. | 5·436 A. |
| Wilberforce, Canada | $\gamma$ | 1,035 m.y. | 5·432 A. |
| Gordonia, S. Africa (Mountain) | $\alpha$ | 1,025 m.y. | 5·428 A. |
| Gordonia, S. Africa (Holmes) | $\gamma$ | 1,025 m.y. | 5·427 A. |
| *Great Bear Lake*, Canada | $\beta$ | 1,400 m.y. | 5·421 A. |
| Witwatersrand, S. Africa | $\gamma$ | 2,000 m.y. | 5·400 A. |

An interesting fact that can be read from th table is that the exploited deposits of the Belgia Congo, Great Bear Lake and the Witwatersran yield, respectively, α-, β- and γ-uraninite. [Feb. 5

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Macromolecular Weight and Size of Deoxypentose Nucleic Acids

RECENT measurements of the weight of deoxy-ntose nucleic acid molecules extracted from calf ymus[1], pneumococcus-transforming principle[2] and . *coli*[3] have yielded values close to six million. The ssibility of a constant molecular weight with its nsequent implications has already been noted[1].

We therefore report the results of some preliminary ght-scattering studies of the molecular weight and ze of specimens of deoxyribonucleic acid from ifferent sources, which were subjected to preparative rocedures as nearly identical as possible. These ield a wide range of values, the molecular weight ncreasing markedly with the guanine content, as hown in Table 1.

able 1. MOLECULAR WEIGHT AND SIZE OF DEOXYRIBONUCLEIC ACID MOLECULES IN 0·2 *M* SODIUM CHLORIDE, *p*H 6·8

| Source | Base ratio $\frac{\text{adenine}+\text{thymine}}{\text{guanine}+\text{cytosine}}$ | Guanine content (moles/100 moles nucleotide) | Molecular weight ($\times 10^{-6}$) | Molecular radius of gyration (A.) |
|---|---|---|---|---|
| *Arbacia lixula* | 1·59[5] | 17·5 | 2·3 | 1590 |
| Calf thymus | 1·32[5] | 21·5 | 6·0 | 2240 |
| *E. coli* | 1·0[5] | 24·0 | 9·1 | 3500 |
| Avian tubercle bacillus | 0·4[5] | 37·0 | 14·4*<br>12·5† | 2300*<br>1400† |

* Specimen (1), fibres kept in solvent for three days prior to final ntrifugation.

† Specimen (2), fibres kept in solvent for eight days prior to final ntrifugation.

Calf thymus deoxyribonucleic acid was prepared by e method of Schwander and Signer[4]. Other speci-ens of deoxyribonucleic acid were obtained from *rbacia lixula* sperm, *Escherichia coli* B. and from vian tubercle bacilli, as outlined below. These were odifications of the methods used by Chargaff *et al.*[5] nd Zamenhof *et al.*[6]. The washed sperm and micro-ganisms, after the latter had been ground with umina or glass powder in a vibratory ball mill, were xtracted three times with 3 *M* and 1·7 *M* sodium loride respectively. After clarifying by centrifuga-on, the crude material was precipitated three times in 0 per cent alcohol at – 20° C. Proteins and ribo-ucleic acids were removed by Sevag's[7] procedure nd by treatment with ribonuclease and dialysis gainst 10 per cent sodium chloride. After further recipitations in alcohol, the specimens were stored 70 per cent alcohol at 4° C.

After extraction, the fibres were allowed to swell 0·2 *M* sodium chloride, *p*H 6·8, for 48 hr. before lending for 30 sec. at 10,000 r.p.m. The solution was ien shaken for 16 hr. and finally spun in a Spinco ltracentrifuge at 30,000 r.p.m. (mean centrifugal eld 60,000 *g*) for 3 hr. Particular attention was given the identity of these procedures, all of which were rried out at 4° C.

The light-scattering measurements were made at om temperature (~ 18° C.) using the wave-lengths 5461 A. and 4359 A. The results for each specimen agreed within the limits of experimental error, and those given in Table 1 are the mean values so obtained. Concentrations were determined from the phosphorus content using Allen's colorimetric method[8]. Wyatt's value of 9·4 per cent phosphorus for calf thymus deoxyribonucleic acid[10] was assumed throughout, and the values for the molecular weights are therefore subject to small corrections. The values of the refractive index increment, 0·175 at 5461 A. and 0·181 at 4359 A., were measured for calf thymus deoxyribonucleic acid and were used for all specimens. The latter figure agrees to within a few per cent with the most recent value given by Reichmann *et al.*[1]; we note also that our values for the macromolecular parameters of the calf thymus deoxyribonucleic acid are in excellent agreement with those given by these authors.

We are not aware of any previous measurements of the molecular weight of the *Arbacia lixula* or avian tubercle deoxyribonucleic acid; since these have yielded the extreme values for the molecular weight, Zimm plots for these specimens are given in Figs. 1 and 2. With the exception of the second specimen of the avian tubercle deoxyribonucleic acid, all measurements were made on solutions prepared from fibres which were placed in the solvent three days prior to the final centrifugation. For these systems the reciprocal particle-scattering factors were found to be almost linear over the angular range 25°–135°, thus indicating a system of polydisperse Gaussian coils having a weight-to-number average molecular weight ratio of 2. In order to ensure that the high molecular weight found for the avian tubercle deoxyribonucleic acid was not due to insufficient time having been allowed for the fibres to pass into solution, a second specimen was prepared using fibres which had been kept in the solvent for eight days before the final centrifugation. The molecular weight was found to be essentially the same, although the particle shape was significantly changed. A decrease in the particle radius of gyration, together with a pronounced upward curvature of the reciprocal

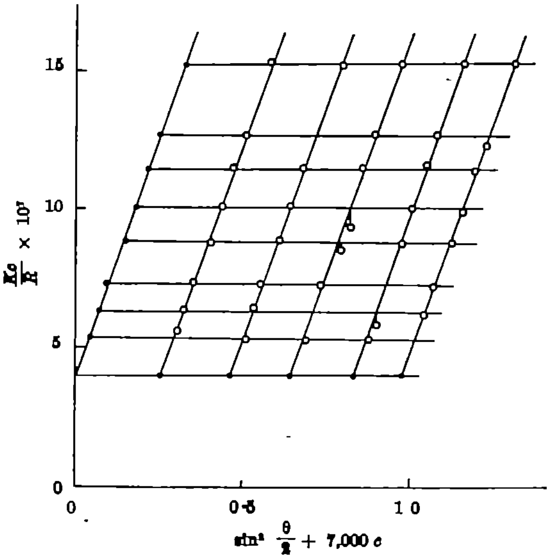

Fig. 1. Zimm plot for *Arbacia lixula* deoxyribonucleic acid in 0·2 *M* sodium chloride, *p*H 6·8. Angular range 25°–70°. Concentrations: 3·08, 6·04, 9·22, 11·9 and 14·0 × $10^{-6}$ gm./ml. $\lambda$ = 5461 A.

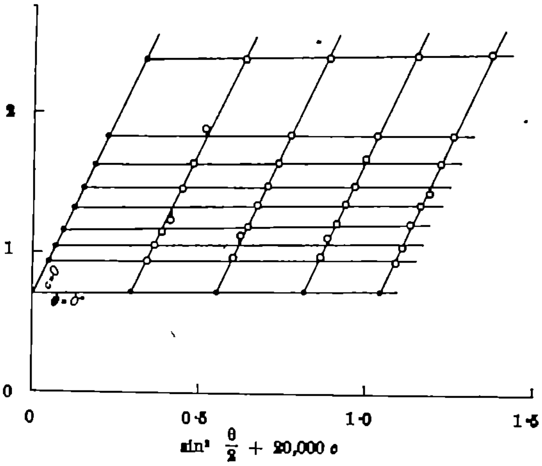

Fig. 2. Zimm plot for avian tubercle deoxyribonucleic acid in 0·2 *M* sodium chloride, pH 6·8. Angular range 25°–70°. Concentrations: 1·46, 2·75, 4·06 and 5·20 × $10^{-5}$ gm./ml. λ = 5461 A.

particle-scattering factor, indicated a more highly coiled unit.

Of the four specimens investigated, the avian tubercle deoxyribonucleic acid molecule is characterized by the fact that its increased weight is not accompanied by a corresponding increase in the radius of gyration; this suggests that the mass per unit length along the chain may be greater for this molecule. Further, its ability to take up a more coiled configuration in solution may be due to intramolecular forces between different parts of the same chain. These findings suggest that, as the guanine content increases, the chains are more strongly bonded by forces which determine both the macromolecular weight and configuration in solution. It is significant that in the twin helical, hydrogen-bonded, structure, proposed for the deoxyribonucleic acid molecule by Watson and Crick[11], the 2-amino group of the guanine base appears to be available for the binding of two chains or for the binding of different parts of the same chain.

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## Dissociation of Deoxyribonucleic Acid by Urea

WE found[1] that the molecular weight of deox
ribonucleic acid from herring sperm heads, measur
by light-scattering in dilute aqueous solution, w
reduced from 6 × $10^6$ to 3 × $10^6$ on adding a co
centrated urea solution to make the final ur
concentration 4 *M*. This halving of the molecul
weight was accompanied by a 20 per cent increa
in the radius of gyration of the coil. This behavio
is consistent with the twin spiral model of Crick a
Watson[2] if it is assumed that the urea splits t
hydrogen bonds holding the two molecules togethe
After removal of the urea by dialysis the 'spl
molecule coils up into a much more compact shape
if the dialysis is conducted from solutions co
taining less than 0·003 per cent deoxyribonucle
acid, the molecular weight remains unchanged
3 × $10^6$; in more concentrated solutions aggregati
occurs and molecular weights ranging up to 2 × 1
have been measured.

Doty and Rice[3] attempted to repeat these exper
ments with deoxyribonucleic acid from thym
glands but found that in this case urea does n
change the molecular weight. To determine wheth
this failure of thymus deoxyribonucleic acid t
dissociate was due to slight differences in techniq
or to an inherent difference between the deoxyrib
nucleic acid from herring sperm and thymus w
exchanged samples with Prof. P. Doty and confirme
his finding. Since then we have examined sever
samples of deoxyribonucleic acid prepared by Pro
J. A. V. Butler and Dr. P. F. Davison by the enzym
method described by Butler *et al.*[4] and have aga
found that material from herring sperm was split b
urea whereas that from the thymus gland was no
It seems clear, therefore, that the deoxyribonucle
acids from the two sources, although originally
similar molecular weight, show genuine differenc
in behaviour.

A further physico-chemical difference betwe
these two types of deoxyribonucleic acid was foun
in their response to heating for 15 min. in 0·05 pe
cent aqueous solution to 100° C. In agreement wit
Doty and Rice[3], we find the molecular weight
thymus deoxyribonucleic acid is unchanged, but tha
the size of the molecule is decreased. The molecula
weight of the material from herring sperm, howeve
is reduced in molecular weight to 2·5 × $10^6$ if heate
in 0·1 *M* sodium chloride.

Since Jungner[5] had reported that thymus deoxy
ribonucleic acid contained 0·1 per cent magnesium
we decided to test if chelation by metal ions migh
be responsible for the failure of urea to 'split' it
Preliminary evidence supporting this view wa
obtained; thymus deoxyribonucleic acid, after treat
ment with the sequestering agent ethylene diamin
tetracetate and its removal by dialysis, was u
changed in molecular weight but was now 'spli
by urea to give units of molecular weight of 3 × 10
The dissociation of this material required 30 mi
after the addition of the urea, whereas the splittin
of herring sperm deoxyribonucleic acid is complet
within ten to fifteen minutes.

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## Extraction of Collagen from Tissues

In the course of some estimations of deoxyribo- cleic acid by Schneider's method[1], we observed cidentally that the hot trichloroacetic acid ex- action of the tissue removed the collagen almost mpletely, judged by estimations of hydroxyproline n the hydrolysates of the solubilized and insoluble aterial.

We have now examined this method of solubilizing llagen in other tissues with the view of using it stead of the normal autoclaving procedure in con- nction with the method of Neuman and Logan[2] r estimation of collagen from the hydroxyproline ntent of an acid hydrolysate of the solubilized aterial. In order to estimate the completeness of e extractions, we estimated the hydroxyproline ontent of the extracts and of the residual insoluble aterial. On the basis of a preliminary investigation long these lines using various times of extraction, e decided on two half-hour extractions with 0·3 *M* richloroacetic acid at about 90° C. followed by two ashes with cold trichloroacetic acid. Elastin of dog's orta does not appear to be dissolved by this pro- edure, though it is rendered soluble in *N*/10 sodium ydroxide, so that the usual method of estimating ; after collagen is not applicable[4,5]. Some results ith the method are given in Table 1.

Table 1

| | Collagen (gm. per 100 gm. wet weight) | Collagen extracted (per cent) |
|---|---|---|
| Rat muscle | 0·77 | 97·4 |
| Rat skin (with hair) | 4·52 | 98·3 |
| Rat tail tendon | 15·70 | 100·1 |
| Rat mammary gland (lactating) | 1·47 | 98·0 |
| Rat liver | 0·18 | 96·4 |
| Ox liver (*a*) pulp | 0·25 | 92·8 |
| (*b*) vessels | 5·1 | 97·5 |

(*a*) Material pressed through 1 mm. diameter holes in a metal plate.
(*b*) Material retained by perforated metal plate.

The completeness of extraction tends to drop lightly as the collagen content of the material liminishes, possibly owing to increased relative mportance of adsorption of gelatin on precipitated roteins. The liver pulp, which gave the lowest xtraction, probably contains a large proportion of eticulin which is known to be difficult to solubilize, difficulty which occurs also with other methods of xtraction. This degree of extraction would in any vent be quite adequate for many purposes.

The method is quicker and simpler than the usual rocedure[3]; it also has great advantages for sampling a large bulk of tissue which is difficult to homogenize. The tissue is roughly broken up and subjected to the first period of heating with trichloroacetic acid. It can then be homogenized very easily in a blender and sampled; tissue containing bone can be dealt with easily in this way.

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## Inhibition of Histamine Release in Anaphylaxis

ALTHOUGH the effects of anaphylaxis and chemical histamine releasers are similar and mainly attributable to histamine release, the mechanism by which the release occurs in the two cases is fundamentally different. We have found that lack of oxygen and also inhibitors of oxidative and glycolytic metabolism have a powerful inhibitory action on the release of histamine in anaphylaxis but enhance its release by compound 48/80 (a condensation product of *p*-methoxyphenyl-ethyl-methylamine and formaldehyde) and octylamine.

By the use of minced guinea pig lung from animals sensitized to egg albumin, it is possible to release with the specific antigen 20–40 per cent of the total histamine contained in the tissue. Addition of 1 m*M* iodoacetate reduces this release to 5 per cent or less. Suitable concentrations of compound 48/80 (1 mgm./ml.) and octylamine (0·15 mgm./ml.) also release 20–40 per cent of the histamine content of the tissue; but in the presence of 1 m*M* iodoacetate this release is nearly doubled. Addition of the antigen in the presence of nitrogen produces similar effects, namely, an almost complete inhibition of the anaphylactic release and a potentiation of histamine release by the chemical releasers. It has previously been shown by Parrot[1] that anoxia inhibits the release of histamine in anaphylaxis. The effect of anoxia could be partially reversed by methylene blue; but that of iodoacetate was not reversed by pyruvate.

These results suggest that the release of histamine in anaphylaxis is a process which requires energy and can easily be disrupted. The action of chemical releasers, on the other hand, is enhanced by processes which interfere with normal cell metabolism. These findings may possibly explain why isolated intracellular particles containing histamine are able to release histamine when treated with chemical releasers[2], but cannot be made to release histamine in anaphylaxis[3].

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## Effect of Antibiotics on Indole Synthesis by *Escherichia coli* 7-4

It has been shown (Gibson, Jones and Teltscher[1]) that indole is formed from glucose and ammonium chloride by washed-cell suspensions of a mutant, *Escherichia coli* 7-4, blocked in the conversion of indole to tryptophan. The effect of some antibiotics on the formation of indole has now been studied.

It was found that chloramphenicol, terramycin, aureomycin and streptomycin inhibited indole formation, but penicillin had little effect (Table 1). The minimum concentrations of chloramphenicol, terramycin and aureomycin needed to inhibit indole synthesis corresponded closely to the bacteriostatic concentrations for *E. coli* 7-4 in the liquid synthetic medium described by Davis and Mingioli[2]. As an example of such inhibition, the effect of terramycin on total growth and indole synthesis is shown in Fig. 1.

Table 1. EFFECT OF ANTIBIOTICS ON INDOLE SYNTHESIS BY *E. coli* 7

| Addition to indole synthesis system* | Indole formed (mμM./mgm. dry wt. cells) |
|---|---|
| None | 260 |
| Terramycin (1 μgm./ml.) | 41 |
| Aureomycin (1 μgm./ml.) | 71 |
| Chloramphenicol (5 μgm./ml.) | 44 |
| Streptomycin (10 μgm./ml.) | 231 |
| (150 μgm./ml.) | 35 |
| Penicillin (100 units/ml.) | 274 |
| (1,000 units/ml.) | 196 |

* Indole synthesis system. Washed cells from heart infusion ag (0·8 mgm./ml. dry wt.); glucose (0·1 *M*); DL-serine (0·01 *M*) ammonium chloride (0·005 *M*); phosphate buffer (0·1 *M*, pH 7·7 Test incubated 5 hr. at 37°.

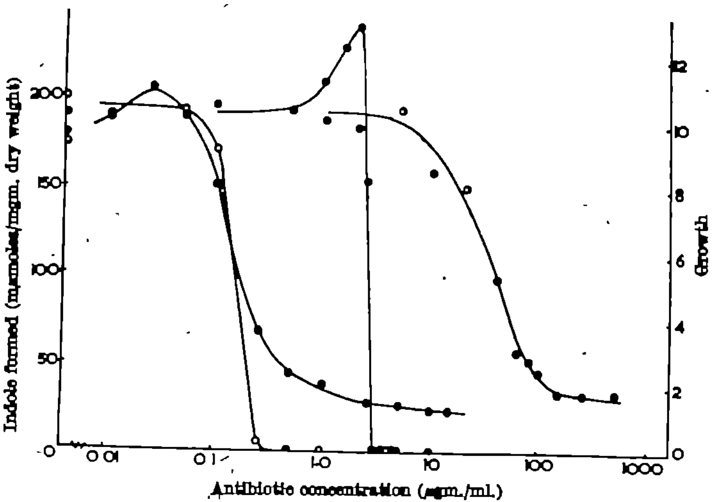

Fig. 1. Effect of terramycin and streptomycin on growth and indole synthesis by *E. coli* 7-4.
—○—○—, Terramycin, growth (expressed as turbidity with *E.E.L.* portable colorimeter); —●—●— terramycin, indole synthesis; —◒—◒—, streptomycin, growth (expressed as turbidity with *E.E.L.* portable colorimeter); —◑—◑—, streptomycin, indole synthesis.
Indole synthesis. Substrates and cells as in Table 1. Antibiotics added with substrates and test incubated 4 hr. at 37°.
Bacteriostatic tests. Davis minimal medium plus DL-tryptophan ($10^{-4}$ *M*) incubated 24 hr. at 37°

Chloramphenicol, terramycin and aureomycin have been shown to suppress the formation of adaptive enzymes in *E. coli*[3]; but their interference with indole synthesis is different since the addition of any of these drugs to adapted cells still inhibited synthesis (Fig. 2). Thus the action of these antibiotics on the formation of adaptive enzymes may be secondary to the inhibition of the synthesis of essential aromatic compounds.

Streptomycin differed from the other antibiotics tested in that it did not inhibit indole synthesis at the concentration needed to prevent growth (8 μgm./ml.), but was effective at higher concentrations (Table 1, Fig. 1). Furthermore, the addition of streptomycin (150 μgm./ml.), once indole formation was proceeding at maximum rate, did not interfere with its synthesis (Fig. 2). It appears that streptomycin inhibits some adaptive process concerned in the formation of indole.

Various workers have suggested that antibiotics may interfere with protein synthesis or with the biosynthesis of the aromatic amino-acids (see ref. 4). That chloramphenicol, terramycin and aureomycin may interfere with the same metabolic pathway is suggested by the finding that strains of *E. coli* made resistant to any one of the three drugs showed a cross-resistance to the other two[5].

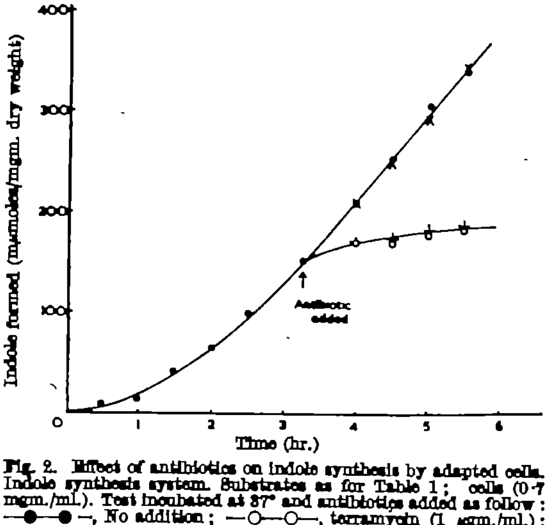

Fig. 2. Effect of antibiotics on indole synthesis by adapted cells. Indole synthesis system. Substrates as for Table 1; cells (0·7 mgm./ml.). Test incubated at 37° and antibiotics added as follow: —●—●—, No addition; —○—○—, terramycin (1 μgm./ml.); —+—+—, chloramphenicol (5 μgm./ml.); —×—×—, streptomycin (150 μgm./ml.)

The present results provide evidence that some antibiotics, at bacteriostatic concentrations, inhibit reactions associated with aromatic synthesis in *E. coli*.

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# Protective Action of Vitamin $B_{12}$ in the Hyperthyroid Rat

Since thyroxine is known to decrease the efficiency th which phosphorylation is coupled to respiration[1], e possibility suggests itself that vitamin $B_{12}$ may *action in* hyperthyroidism by restoration, in part least, of the energy-requiring functions of impaired lls. This has now been examined by a study of the llowing conjugation systems: acetylation of *p*-minobenzoic acid, benzoylation of glycine, and nthesis of glutathione.

Groups of six rats (Wistar strain), 120–140 gm. weight, were maintained on the following laboratory ook diet:

| | | | |
|---|---|---|---|
| hole wheat flour | 69 parts | Shark liver oil | 4 parts, |
| sein | 10 " | Sesame oil | 4 " |
| hole milk powder | 2 " | Calcium carbonate | 2 " |
| ded fish meal | 3 " | Sodium chloride | 2 " |
| heat bran | 4 " | | |

ith modifications as shown (Table 1). Iodinated casein Protomone': Cerophyl Laboratories, Kansas City, Io.) was at 3 per cent level and replaced an equal mount of casein in the diet. Vitamin $B_{12}$ ('Cobionne': Ierck) was administered intraperitoneally at 10 γ per at per day. The animals receiving iodinated casein group 3) in the diet lost 7–10 per cent body-weight uring two to three weeks when they were considered yperthyroid[1]. Acetylating ability was determined uring this period by the method of Bratton and Iarshall[2] after intraperitoneal administration of -aminobenzoic acid (1 mgm./300 gm. body-weight) ollowed by urine collection for the next 24 hr. A mall amount of the *p*-aminobenzoic acid was apparntly excreted as *p*-aminobenzoyl glycine, which was letermined separately in aliquots of the urine[2]. orrections were made in either case for endogenous xcretions.

Blood samples were collected from the tail veins or determinations of erythrocyte glutathione after aemolysis, plasma being nearly devoid of this netabolite.

At the end of three weeks, the animals were killed; ivers and adrenals were quickly excised and chilled or immediate determinations of glutathione[4] and for he *in vitro* synthesis of benzoyl glycine by the liver nzymes. For the latter purpose, the procedure mployed was as follows: 0·5 c.c. of 1:5 liver homogenate in 0·1 *M* phosphate buffer, *p*H 7·5, was added o a mixture of glycine (0·01 *M*), benzoic acid 0·0025 *M*), potassium dihydrogen phosphate (0·037 *M*), magnesium sulphate (0·0008 *M*), sodium citrate 0·01 *M*) and sodium fumarate (0·0015 *M*) in the oncentrations indicated in a final volume of 5 c.c., *p*H being adjusted to 7·5 with dilute potassium hydroxide. All flasks were gassed with oxygen for 10 min. prior to incubation for 3 hr. at 37° with frequent shaking. Reaction was stopped by addition of 0·2 c.c. of *N* sulphuric acid and the benzoyl glycine formed estimated[3]. Values reported in Table 1 represent increments after the incubation period over corresponding zero-time digests prepared similarly.

The results, which are averages for the six animals in each group, show that in the hyperthyroid animals there is a marked reduction in acetylating ability as well as in tissue glutathione as compared to the control group. Vitamin $B_{12}$ supplementation counteracts this condition appreciably.

An observation of interest emerging from this study is the increase in blood glutathione during thyrotoxicosis and its reversal by vitamin $B_{12}$. This inverse relationship between blood- and liver-levels of glutathione has since been confirmed in other studies now under progress, and is also suggested from the report[5] that there is an increase in erythrocyte glutathione in methionine deficiency.

Iodinated casein has been reported to interfere with vitamin $B_{12}$ absorption[6]. Since vitamin $B_{12}$ is involved in the activation of soluble and protein sulphydryl, its role in carbohydrate and lipid metabolism has been demonstrated[7]; it is also involved in the synthesis of porphyrins and respiratory pigments[8]. It seems, therefore, that the primary manifestation of thyrotoxicosis is a deficiency of vitamin $B_{12}$, and consequent interference in the generation and utilization of energy-rich bonds coupled with electron transport.

Table 1

| Group | Per cent gain in weight (during 3 weeks) | Glutathione in: Liver (mgm./gm., fresh basis) | Glutathione in: Adrenals (mgm./gm., fresh basis) | Blood (mgm./100 c.c.) | Synthesis *in vitro* of benzoyl glycine (mgm./gm. dry liver) | Per cent urinary conversion of *p*-aminobenzoic acid to: *p*-aminobenzoyl glycine | Per cent urinary conversion of *p*-aminobenzoic acid to: N-acetyl *p*-aminobenzoic acid |
|---|---|---|---|---|---|---|---|
| 1. Basal (stock diet) | 30·5±7·4* | 1·30±0·15* | 1·82±0·12* | 11·6±1·6* | 0·67±0·15* | 9·6±0·5* | 64±15* |
| 2. Basal + vitamin $B_{12}$ | 28·2±7·6 | 1·40±0·10 | 1·87±0·18 | 13·4±3·0 | 1·10±0·11 | 12·6±1·2 | 86± 8 |
| 3. Basal with iodinated casein | −8·5±2·3 | 0·82±0·02 | 0·97±0·06 | 23·1±1·4 | 0·43±0·10 | 4·8±0·3 | 32± 5 |
| 4. Basal with iodinated casein + vitamin $B_{12}$ | −1·8±3·7 | 1·11±0·04 | 1·44±0·03 | 16·9±2·8 | 0·63±0·07 | 7·9±1·5 | 48± 5 |

* Standard error.

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## Essential Relaxing Factor in Muscle other than Myokinase and Creatine Phosphokinase

EXTRACTS of rabbit skeletal muscle contain factors which play a part in the relaxation of muscle fibre models, such as glycerinated fibres[1–3]. Two of them isolated have been identified with known enzymes: myokinase by Bendall[4] and creatine phosphokinase by Lorand[5]. But these two enzymes, coupled with their co-factors, do not settle all the problems of muscular relaxation because, in the light of our experiments, they do not have any relaxing effect on glycerinated fibres which have been preserved for a long time and exhaustively washed (Fig. 2*a*).

We have shown[6] that the adenosine triphosphate-dependent relaxing factor, in fact, consists of two different components; one occurs in the fraction precipitated by ammonium sulphate at concentrations of 10–20 gm. of sulphate per 100 ml. of extracted solution from muscle, tentatively named 'fraction *A*', and the other in the fraction precipitated by concentrations of 30–40 gm. of sulphate per 100 ml. of extracted solution from muscle, 'fraction *B*'. Each has a moderate relaxing effect on relatively fresh fibres. If the fibres to be tested, however, have been preserved in 50 per cent aqueous glycerol for one month or more at – 10° C. and washed in 0·1 *M* potassium chloride solution for several hours, each fraction by itself no longer has a relaxing effect (Fig. 1, *a* and *b*). The relaxing activity is not recovered until these two fractions are used together (Fig. 1*c*).

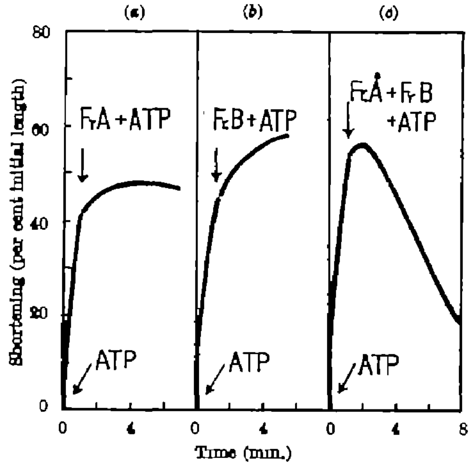

Fig. 1. Effect of fraction *A* and *B* on a muscle fibre shortened in adenosine triphosphate.

ATP = 5 m*M* adenosine triphosphate; Fr. *A* + ATP = 2·2 mgm./ml. of fraction *A* + 5 m*M* adenosine triphosphate; Fr. *B* + ATP = 17 mgm./ml. of fraction *B* + 5 m*M* adenosine triphosphate; Fr. *A* + Fr. *B* + ATP = 2·2 mgm./ml. of fraction *A* + 15 mgm./ml. of fraction *B* + 5 m*M* adenosine triphosphate. All the experiments were performed in 0·16 *M* potassium chloride containing 0·01 *M* magnesium chloride. For fractions *A* and *B*, see text

Fraction *A* is highly opalescent, suggesting that it contains a considerable amount of lipid. It has strong adenosine triphosphatase activity, which corresponds apparently to Kielley–Meyerhof's adenosine triphosphatase[7]. No method has so far been found for separating the active relaxing principle from the enzyme. These two substances are quite similar in properties in certain respects: both can be centrifuged at 18,000 *g* for 1 hr. without losing their activity; both are activated by magnesium ions, the optimum of which is about 0·004 *M*, ar inactivated specifically by a small amount of calciu ions. Their identity, however, remains to be prove and requires further study.

Fraction *B* contains myokinase and creatin phosphokinase. It is probable that myokinase pla an important part in the adenosine triphosphat dependent relaxing action of fraction *B*. Indee crude myokinase, if combined with fraction *A*, h a lengthening effect on moderately washed fibr (Fig. 2*b*). Nevertheless, the whole activity of fractio *B* cannot be ascribed to myokinase, for this fractio is far more labile to acid than myokinase, and the case of old and washed fibres, myokinase is n effective, even when combined with fraction (Fig. 2*c*). Some other factor or factors in fraction evidently participate in relaxation (Fig. 2*d*).

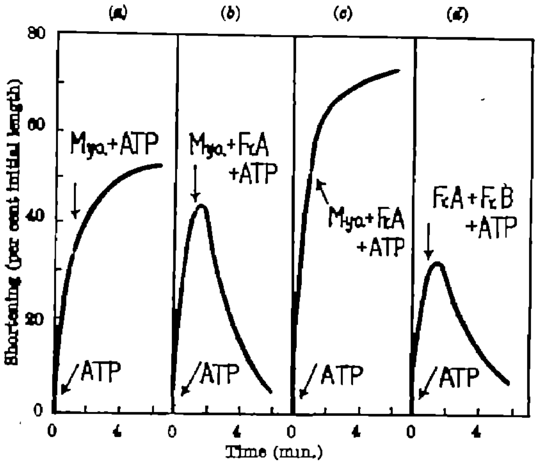

Fig. 2. Effect of crude myokinase and fraction *B* combined or uncombined with fraction *A* on a muscle fibre shortened in adenosine triphosphate.

Myo. + ATP = 0·4 mgm./ml. of crude myokinase (acidified and fractionated by ammonium sulphate) + 5 m*M* adenosine triphosphate; Myo. + Fr. *A* + ATP = 0·16 mgm./ml. of crude myokinase + 5 mgm./ml. of fraction *A* + 5 m*M* adenosine triphosphate; Fr. *A* + Fr. *B* + ATP = 5 mgm./ml. of fraction *A* + 8 mgm./ml of fraction *B* + 5 m*M* adenosine triphosphate. In (*a*) and (*b*) relatively unwashed muscle fibres were used; (*c*) and (*d*) fibres preserved and washed. Other notes as in Fig 1

Unless it is aided by fraction *A*, the creatine phos phokinase–phosphocreatine–adenosine triphosphat system[2,5] also has no effect on old and washed fibre

As described above, fraction *A* is essential for th relaxation of muscle fibre models. Experiments b other workers[1,2,4,5] have probably been conducte on fibre preparations which still contain some of th active principle of this fraction.

Details of this work will be published elsewhere.

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## Maturation Divisions of the Ova in the Pseudophyllidean Cestode, *Eubothrium crassum* (Bloch)

Much confusion still exists in generalized accounts life-histories of parasitic platyhelminthes concern-g the position of the egg at the time of its maturation visions and therefore about the exact time of rtilization. Indeed, it has been suggested[1] that ormal gametogenesis does not occur in many cestodes the Cyclophyllidea, Tetraphyllidea and Trypano-ynchs. In a number of digenetic trematodes, on e other hand, it has been carefully shown by various orkers, notably Chen[2], Rees[3], Stephenson[4] and illmott[5], that meiosis in the ovum is normal and occurs in that part of the uterus immediately beyond e central chamber of Mehlis's gland. The ova ove into the uterus at this point surrounded by olk cells and begin maturation divisions at once hile the shell is being laid down around the egg omplex, which comprises one ovum, yolk cells and ermatozoa.

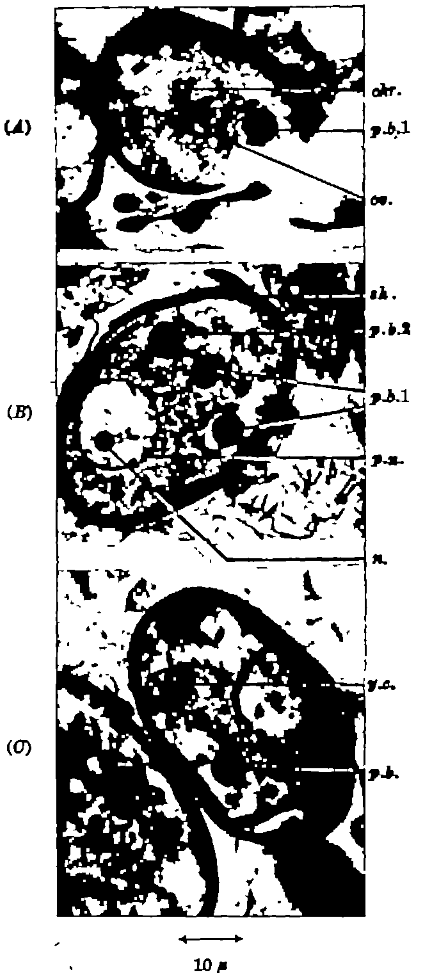

Fig. 1. Egg complex in uterine duct. Material fixed in Bouin's fluid at 70° C., sectioned at 6 µ and stained with Heidenhain's iron hæmatoxylin. *A*, first polar body and chromosomes at second maturation division metaphase; *B*, female pronucleus with well-defined nucleolus, second polar body, and first polar body divided; *C*, differentiation of yolk cells and polar body. *chr.*, Chromosomes; *n*, nucleolus; *ov.*, eccentrically placed female cell; *p.b.1*, first polar body; *p.b.2*, second polar body; *p.n.*, female pronucleus; *sh.*, shell; *y.c.*, yolk cell

Normal maturation divisions of ova have been reported in a few cestodes, both primitive and advanced, by much earlier authors, some of whom found polar bodies in association with the ovum. Young[1], however, after working on some of the more advanced cestodes mentioned above, considered that these workers had confused the polar bodies and yolk cells. The only work published since then on this aspect of cestode cytology is that of Motomura[6]. He gives convincing evidence of normal oogenesis in the monozoic cestode, *Archigetes appendiculatus*, and shows in a series of figures how the whole process of maturation, fertilization and shell formation is very similar to the condition described in the various trematodes and occurs in an analogous position, that is, immediately beyond the central chamber of Mehlis's gland. But until now there have been no photographs of the egg complex in any cestode.

I find that my results on *Eubothrium crassum*[7] agree very closely with those of Motomura, so that the same general scheme is demonstrated once again, this time in a pseudophyllidean cestode. In this and in more advanced cestodes, however, a definite uterine duct exists between the oviduct and Mehlis's gland, and it is this which is usually referred to as the 'fertilization canal' or 'befruchtungsgang'. Invariably, in my sections, this part of the uterine duct was empty and surrounded by slime gland cells, both features suggesting that this is a duct through which the contents pass quickly, while the uterine duct beyond Mehlis's gland harbours the egg complex for some time. In addition, the accompanying photographs show the chromosomes of the ovum in this position at the second maturation division with the first polar body undivided (Fig. 1,*A*), and also the pronucleus stage with its large nucleolus and second polar body (Fig. 1,*B*). At this pronucleus stage the first polar body is seen to be divided—a feature not observed by Motomura. Fig. 1,*C* shows how the polar bodies are easily distinguished from yolk cells.

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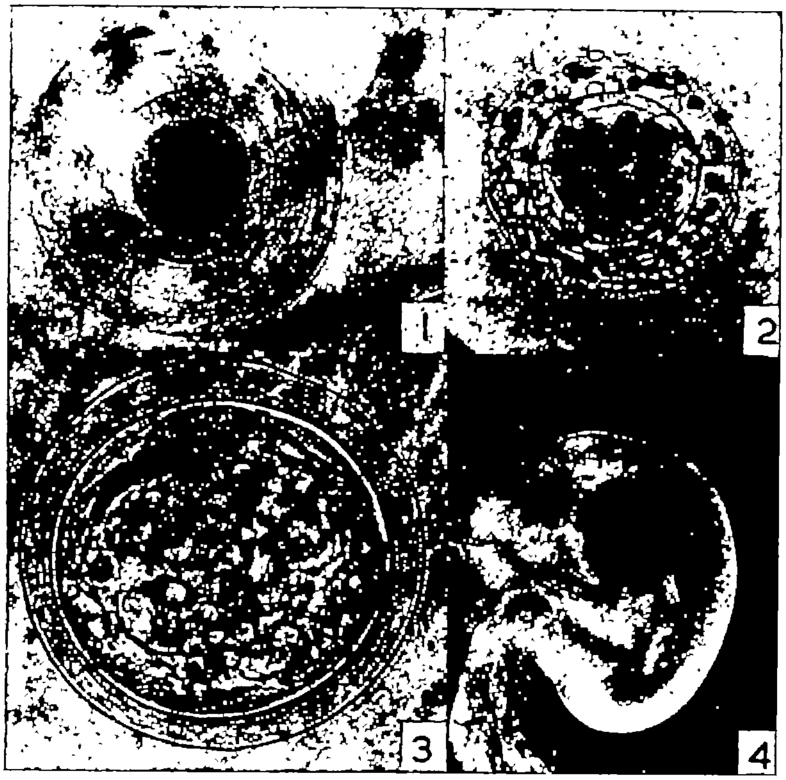
## Transfer of Mammalian Ova between Species

The intra-specific transfer of mammalian eggs has now been developed into a well-established technique[1]; but apart from two recent communications[2,3], relatively little information is available concerning either inter-generic or inter-specific transfer. The absence of any reliable method for the culture of sheep eggs *in vitro* led us to investigate whether they could develop normally following transfer to the genital tract of the rabbit. The reproductive pattern of the rabbit makes it eminently suitable for a study of this nature.

Sheep eggs were obtained from the Fallopian tubes of ewes treated with pregnant mare serum and mated



2½–3 days prior to the operation. The technique employed for the recovery of the eggs was the same as that previously described[4]; sterile sheep serum was used as the flushing and transfer medium in all experiments. Pending transfer, the eggs were stored at 10°–16° C. for 20–45 min. To date, eighteen eggs, comprising four 2-cell, four 4-cell, four 6-cell, five 8-cell and one 12-cell, have been transferred to the Fallopian tubes of seven does which had been mated with a vasectomized buck 2–114 hr. previously. Four to five days later the rabbits were killed and the eggs recovered from the uterus (four cases) or the Fallopian tubes (one case); in the remaining two does, none of the five eggs transferred was recovered. Out of the eighteen eggs transferred, nine were afterwards recovered together with a high proportion of the rabbits' own eggs. Whereas all the rabbit eggs were found uncleaved (Fig. 1), the sheep eggs had continued to cleave normally; at recovery there were six 32-cell morulae (Fig. 2), and two 6-day blastocysts and one 8-day blastocyst (Fig. 3). Although the sheep eggs had acquired the mucin layer characteristic of the rabbit egg, no difficulty was encountered in establishing their identity owing to the inherent structural differences, and the characteristic colour and density of the ooplasm.

The two 6-day blastocysts were re-transferred to a non-pregnant ewe in which ovulation had occurred six days previously. When this animal was killed sixteen days later, two normal embryos were found (Fig. 4). One morula was also re-transferred to another recipient; but no trace of it could be found at autopsy 13½ days after transfer.

It is concluded that sheep eggs can remain viable in the genital tract of the rabbit for a period of not less than five days, and are capable of developing from the 2-cell egg to at least the 8-day blastocyst stage. The deposition of the mucin layer on the transferr sheep eggs appears not to int fere with their subsequent develo ment.

Our results strongly support t view that the species differenc which exist in the rates of cleava are inherent in the eggs[3]; th also provide some evidence agai the suggestion that the success interspecific ovum transfer is lated to the ability of the spec concerned to hybridize[5].

It is hoped to develop the eg transfer technique outlined abo as a means of testing the viabili of sheep eggs in the early stag of development. Moreover, t use of the reproductive tract the rabbit as an 'incubator' m enable the successful long-distan transport of sheep eggs.

These experiments form part the investigations on ovum phys logy being carried out at t Agricultural Research Council Ur of Reproductive Physiology a Biochemistry; we are grateful Dr. T. R. R. Mann for reading a discussing the manuscript. O of us (R. L. W. A.) is in receipt a bursary from the New Zeala Wool Board.

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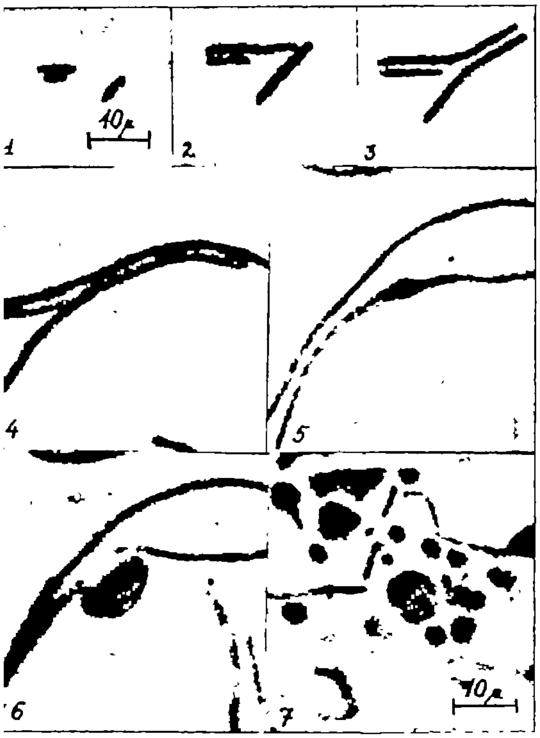
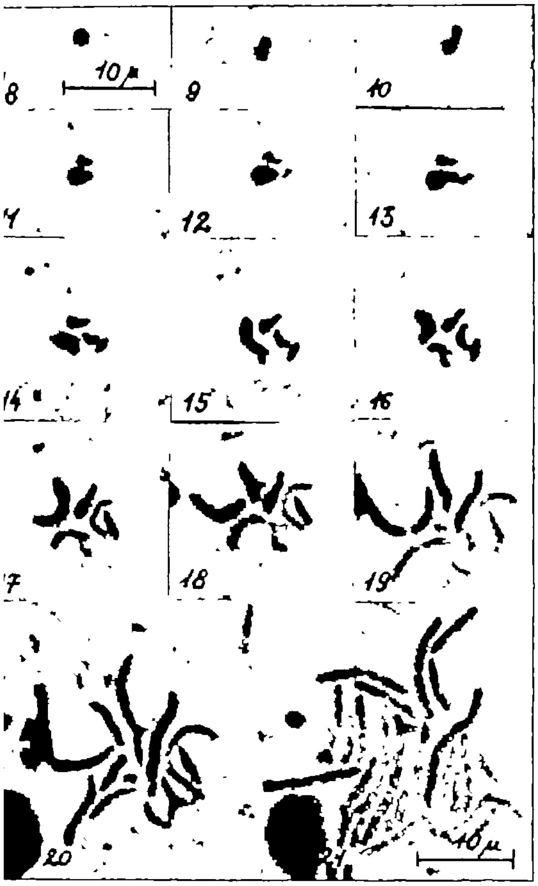
## Plasma Globules of *Salmonella enteritidis* arising under the Influence of Penicillin and their Reversion to the Original Bacillary Forms

CHANGES in the behaviour of *Salmonella enteritid* var. *danysz* have been studied by the agar bloc method and recorded microcinematographically.

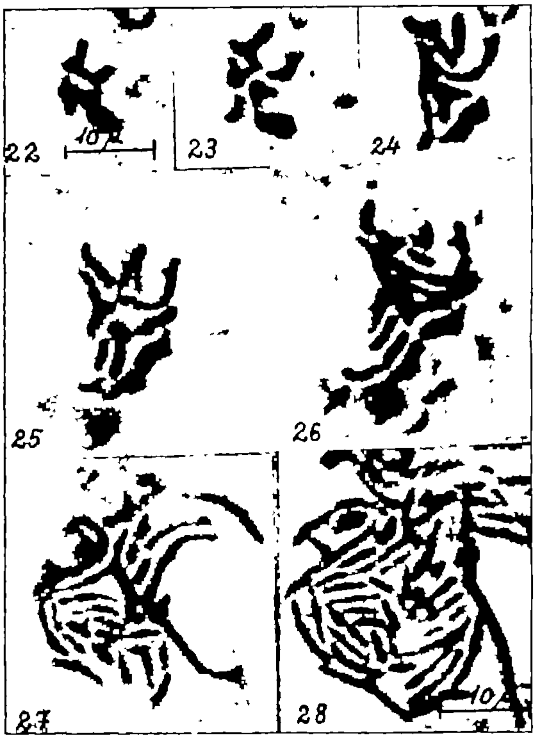
Under the influence of 30–40 I.U. of penicilli the bacteria increase in length (Figs. 1–4). Thes elongated bacteria develop a spindle-like swelling a the middle of the body (Fig. 5), which bursts afte some time, discharging its contents (Fig. 6). This followed by the disruption of the elongated fila mentous forms, some parts of which become swolle and liquid. At this time the pulsating liquid materia from burst spindles and disintegrated filaments sub divides into minor globules (Fig. 7).



igs. 1–7. Plasma globules arising on exposure to penicillin. 3-hr. process. Photomicrographs enlarged from selected single exposures from the film)



igs. 8–21. Development of bacterial microcolony from a single plasma globule in three hours (cinematographic appearance)



Figs. 22–28. Reversion through intermediate forms which arose from plasma globule in two hours (recorded cinematomicrographically)

The forms arising in the course of exposure to penicillin were gently washed with serum broth on the coverslips and transferred to penicillin-free blocks to be studied for regeneration. The following observations were made.

The remains of the rods did not regenerate, but the smaller protoplasmic globules developed, as shown in the photomicrographs 8–21 and 22–28, through an intermediate stage of irregular forms, into typical or atypical forms. The fragments thus originating from one and the same globule apparently differ in their significance.

The full report of this work is to be published in *Acta Biologica Hungarica*.

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## Origin of Man

Orowan[1] suggests that the high uric acid concentration in the blood of human beings and anthropoids, as compared with other mammals, may be a cause of their intellectual development. He holds that uric acid has the same stimulatory effect on the brain as caffeine and theobromine.

This hypothesis can be tested. Normal human plasma contains about 40 mgm./litre of uric acid. Since the methylpurines are stimulants, the effect of uric acid cannot well be maximal. The condition of hyperuricaemia, in which the plasma uric acid is raised to about 80 mgm./litre on an average, is genetically determined, and sometimes gives rise to gout. It seems to be present in nearly 1 per cent of adult Americans.

If Orowan's hypothesis is correct, two conclusions follow. Hyperuricaemics are on an average more intelligent, or at least less susceptible to some kinds of fatigue, than others; and a given dose of methylpurine has less effect on them. It is a good rule not to accept a hypothesis until such tests of its validity as can readily be made have given results confirming it. I think, therefore, that until hyperuricaemics have been studied in this way, Orowan's hypothesis should be regarded as provisional. If, on the other hand, hyperuricaemics are found to differ significantly from the rest of us in their mental processes, it will probably be accepted as an important contribution to the theory of evolution.

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## The First Australopithecine Fragment from the Makapansgat Pebble Culture Stratum

DURING October 1954, Mr. C. K. Brain[1] discovered 129 trimmed, utilized or damaged stones *in situ* in the 18-ft. red, gravel-bearing, sandy layer 25 ft. above the australopithecine-carrying grey breccia at the Makapansgat Limeworks site. Of these, seventeen were claimed by Prof. C. van Riet Lowe to be undoubted Developed Kafuan artefacts, fifteen being of deeply leached dolomite, one of vein quartz and one of dark grey quartzite.

The generous financial assistance afforded to Prof. van Riet Lowe and to me by the Wenner-Gren Foundation for our separate programmes in Makapansgat Valley has enabled us to pursue a joint programme at the Limeworks site this year. Sorting of the dump was resumed in March by Mr. Alun R. Hughes, and in the following month he was joined by Mr. Revill Mason, assistant archæologist in the Union Archæological Survey, to initiate a systematic excavation of the Limeworks Cone, an immense conical block with a basal diameter of approximately 150 ft., the collapse of which subsequent to the earlier mining operations had exposed in the cavern overhang the stratification reported by Brain (*loc. cit.*). Père E. L. Boné, of the University of Louvain, and Mlle. Suzanne Jean, of the Musée de l'Homme, Paris, also assisted in the work during April.

These field-operations have resulted in the recovery of several thousands of pebbles, the artefact content of which will doubtless form the subject of further archæological communications. The purpose of this interim communication is to announce the recovery from the pebble bed of several fossil fragmen including a single elephantine enamel plate, fo small pieces of a long bone of some large mamm such as elephant or rhinoceros and, most importar a small right australopithecine maxillary fragme found on April 30 by Mr. Alun R. Hughes. On 4 cm. × 2·5 cm. × 1·5 cm. in size, it neverthele comprises two considerably damaged (first and secon molars and the tip of the buccal second premolar ro

These teeth are so grossly damaged that, of t occlusal surface, only about two-thirds of the fi and about one-third of the second molar are preserve and the disto-buccal root of the second molar only represented by its impression: hence both pu cavities are widely exposed. The remains of t occlusal surfaces have also suffered attrition almc to their roots; so it is impossible to assess the natu of their cusp pattern even to the limited extent th could be diagnosed in the second adult palate *Australopithecus prometheus*[2] of still more advanc age previously extracted from the grey breccia itse

That *A. prometheus* specimen from the grey brecc however, displaying comparable and even mo advanced attrition, having a rather similar ro exposure and coming from the same Limeworks s though from a lower and different stratum, h afforded an indispensable means of comparing tl mutilated, but none the less identifiable, maxilla fraction (see Figs. 1 and 2).

The probable crown dimensions (*M*1, 14·0 × 14· *M*2, 14·25 × 15·0) of these mangled molars co pare reasonably well with those found for t corresponding teeth in the second (? fema promethean palate (*M*1, 13 × 14; *M*2, 14 × 15 those in the first female promethean palate[3] we somewhat smaller (*M*1, 12·5 × 12·8; *M*2, 14 × 1 Morphologically, the only gross detectable diver ences from the *A. prometheus* teeth are that t distinct grooves on their single palatal (or lingu roots are broader and shallower on both the mola

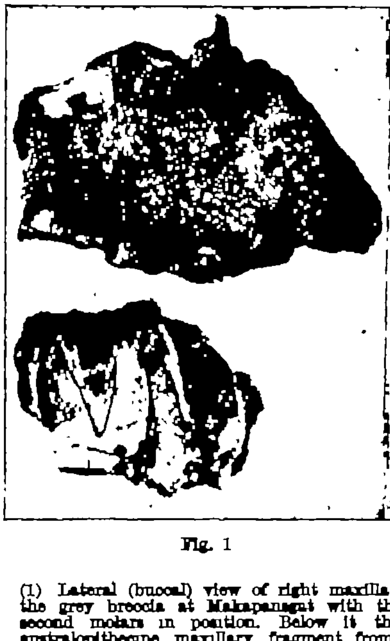

Fig. 1

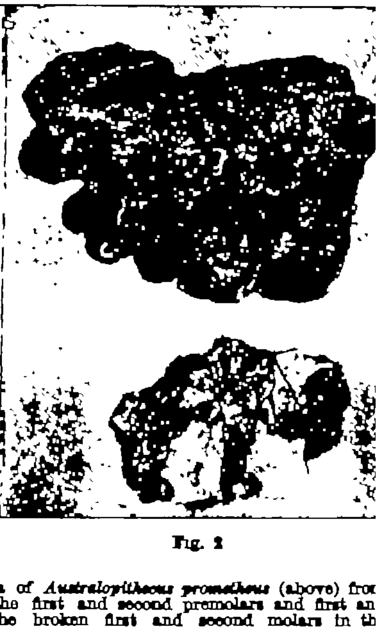

Fig. 2

(1) Lateral (buccal) view of right maxilla of *Australopithecus prometheus* (above) fro the grey breccia at Makapansgat with the first and second premolars and first an second molars in position. Below it the broken first and second molars in th australopithecine maxillary fragment from the pebble stratum in the overlying re breccia are even more distinctly visible. × 4/5

(2) The same two specimens from the medial (lingual or palatal) aspect to display th prominent grooves on the lingual roots of the first and second molars in both the australopithecine maxillæ. × 4/5

the fragment from the pebble stratum than on ose in the second specimen from the grey breccia, d that the roots of the teeth in this pebble stratum *ustralopithecus* are distinctly longer and more bust. From his extensive range of comparative stralopithecine material from Sterkfontein, Mr. T. Robinson has been able to assure me that these vergences are within the range of dental variation r *Australopithecus* (*Plesianthropus*) *transvaalensis*. outly and distinctly three-rooted molars are normal r all the Australopithecinae, as is also the presence a more or less well-defined groove on the lingual pect of the single palatal (lingual) root.

The significance of the specimen therefore rests at esent in its providing the first concrete evidence at an australopithecine type, broadly comparable ith *A. prometheus*, was contemporaneous with, and ay have been responsible for, the concomitant bble culture found in this sealed Central Transvaal vern deposit. Thereby it not only justifies the iginal nomenclature and simultaneously enhances e *hominid* status of the *Australopithecinae group*, it also demonstrates the earliest known direct sociation of such a primitive human type with that ost primitive of all known lithic cultures in southern frica.

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## Genetic Control of Sodium and Potassium Concentrations in the Red Blood Cells of Sheep

RECENTLY, it has been shown that an examination f the concentrations of sodium and potassium in the ed blood cells of sheep enables two types of animal o be recognized within a breed[1]. Sodium concentration varies inversely with potassium concentration, nd determination of the latter allows the two types o be distinguished. These two types have been alled 'high potassium' (*HK*) and 'low potassium' *LK*). A large number of repeated examinations of iany sheep have been carried out, and in no case as the electrolyte type of any sheep changed from *K* to *LK* or vice versa.

The percentages of the two types within samples f the Scottish Blackface and Cheviot[1] and other reeds (Evans, J. V., and Mounib, M. S., unpublished esults) varied considerably from breed to breed. This uggested a genetic variation which has now been ivestigated.

Scottish Blackface ewes were mated with rams of hree breeds and were typed together with all available progeny. Sodium and potassium were estimated y flame photometer. Whole blood, which had been iluted 1/500 or 1/400 with distilled water, was used. he results are shown in Table 1.

*LK* rams fall into two classes: those leaving both inds of offspring (Blackface rams (vii)–(xiii)) nd those (rams (i)–(vi), the remainder) leaving othing but *LK* offspring whatever the phenotype f the ewe. *HK* rams when mated to *LK* ewes roduced both kinds of offspring, but mated to *HK* ewes only *HK* offspring. It appears that *HK* is a recessive character, and *LK* rams may be either homozygous or heterozygous for a gene affecting the electrolyte type of red blood cell. These results do not provide much information on the segregation of the gene, the most informative matings being those of heterozygous *LK* rams with *HK* ewes. Taking only sibships with at least one *HK* member, there are 9 *LK* to 8 *HK* animals. This ratio is biased due to the exclusion of sibships which by chance contained no *HK* members, although sired by a heterozygous ram; but when corrected for this bias, does not significantly differ from the expected 1 : 1.

Table 1. RED BLOOD CELL TYPE OF PROGENY FROM MATINGS OF RAMS AND EWES OF VARIOUS PHENOTYPES

| Rams | | | Ewes | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *LK* | | *HK* | | Unknown | |
| | | | Progeny | | | | | |
| Breed | No | Red blood cell type | *LK* | *HK* | *LK* | *HK* | *LK* | *HK* |
| Southdown | (i) | *LK* | 16 | | 7 | | 5 | |
| | (ii) | *LK* | 4 | | 11 | | | |
| Suffolk | (iii) | *LK* | 4 | | 6 | | | |
| Scottish Blackface | (iv) | *LK* | | | | | 6 | |
| „ | (v) | *LK* | 1 | | 2 | | 3 | |
| „ | (vi) | *LK* | | | 2 | | 2 | |
| „ | (vii) | *LK* | 3 | 2 | | | 1 | |
| „ | (viii) | *LK* | 1 | | 2 | 2 | 1 | 2 |
| „ | (ix) | *LK* | 1 | | 2 | 1 | 2 | |
| „ | (x) | *LK* | 1 | 1 | 2 | 1 | 1 | 1 |
| „ | (xi) | *LK* | 1 | | 2 | 2 | 1 | |
| „ | (xii) | *LK* | 2 | | 1 | 2 | 1 | 1 |
| „ | (xiii) | *LK* | | | | | 4 | 4 |
| „ | (xiv) | *HK* | 3 | 3 | | 4 | | |
| „ | (xv) | *HK* | 4 | 7 | | 8 | | |

In the British breeds of sheep considered here, it appears that the balance between sodium and potassium in the red blood cells can be substantially modified by a single gene difference. It would be of interest to determine the relationship to the intermediate type found by Kerr[2].

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## 'Homing Instinct' in Sea Trout

LITTLE is known about the 'homing instinct' in sea trout. Lamond[1] gives several interesting examples of sea trout marked and recaptured in successive years in the same tributaries of rivers flowing into Loch Lomond, and Nall[2] has recorded similar results for sea trout in South Uist. There, two sea trout marked in small lochs were recaptured the following year in the lochs in which they had been marked, and another was recaptured after an absence of two years, again in the loch in which it had been marked. In each case the sea trout had turned into a minor stream instead of following the main stream.

While tagging sea trout in some of the spawning burns of the River Dee, Aberdeenshire, during November 1954, six tagged sea trout were recaptured in three of these burns. Each of these was recaptured in the same burn as that in which it had been tagged almost exactly twelve months previously. Two of these fish were recaptured on the same stretch of gravel as that on which they had been captured the previous year; both were half-spent females. All identifications are supported by scale examinations. No instance occurred of the recapture of a sea trout, tagged in 1953, in a different spawning burn the following year.

These observations suggest that sea trout return to their native stream and that they spawn at approximately the same time of year each year.

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## Transformation of the *Lewis* Groups of Human Red Cells

In general, the blood-group antigens appear to form a permanent part of the human red cell *in vivo*; they persist throughout the life of the cell not only under normal conditions, but also after transfusion into the circulation of a recipient with a different set of antigens. Moreover, antigens characteristic of the recipient do not appear upon the transfused cells. These statements have been shown to be true for the *ABO*, *MNS*, *Rh*, *Lutheran*, *Kell*, *Duffy* and *Kidd* antigens; but the *Lewis* antigens have not previously been investigated in this respect.

The *Lewis* system was discovered by Mourant[1] in 1946: the red cell antigen $Le^a$ is the only blood-group antigen yet known which is inherited as a Mendelian recessive character[2]. The antigen $Le^b$ has so far defied precise genetic analysis, and the gene controlling it may not be allelic to that for $Le^a$. The antigens may be detected on the red cell and in the serum and secretions. There are three red-cell phenotypes occurring naturally in adult blood as shown in Table 1.

Table 1

| Red cell agglutination reactions with anti-$Le^a$ | Red cell agglutination reactions with anti-$Le^b$ | *Lewis* substances present in serum $Le^a$ | *Lewis* substances present in serum $Le^b$ |
|---|---|---|---|
| + | − | + | − |
| − | + | trace | + |
| − | − | − | − |

Grubb and Morgan[3] first showed that the *Lewis* substances are present in secretions and serum, and Grubb[4] suggested that the *Lewis* antigens are primarily tissue antigens. A blood-group antigen showing somewhat similar behaviour is found in cattle—this is the *J* system: the *J* substance is present on the red cells and also in the serum. Stormont[5] has shown that *J*-negative cells acquire *J* substance from the plasma *in vivo* and *in vitro*. It is known that the $Le^a$ reactivity of the red cell diminishes after repeated washing[2], and Brendemoen[6] showed that the washings inhibited anti-$Le^a$ serum.

It was thus of interest to see whether the *Lewis* red cell antigens were changed *in vivo* after transfusion into a patient of different *Lewis* group. A transfusion from an $Le(a+b-)$ donor was given to a patient of group $Le(a-b+)$. When the two kinds of blood in a post-transfusion sample from the patient were separated (by differential *Rh* agglutination) the donor's cells were found to have becom
$Le(a+b+)$.

The transformation can be reproduced *in vit*
The results of mixing group $A_2$ red cells and plas
of different *Lewis* phenotypes are shown in Table
1 volume of packed red cells to 10 volumes
heparinized plasma (containing streptomycin a
terramycin) were continuously shaken at 35° C. T
plasma was renewed every 24 hr.

Table 2 shows that $Le(a+b-)$ cells, after 24
in $Le(a-b+)$ plasma, have become $Le(a+b+$
$Le(a-b+)$ cells in $Le(a+b-)$ plasma have a
become $Le(a+b+)$. (The results were the same wh
*O* cells and plasma were used.) It was furth
observed that after three days $Le(a+b-)$ a
$Le(a-b+)$ cells lose their antigens to $Le(a-b$
plasma, while the $Le(a-b-)$ cells can acquire eith
antigen.

Table 2. Reactions of Red Blood Cells with *Lewis* Anti
After Incubation in Plasma from Different Donors for 24

| Plasma from persons of *Lewis* phenotype | *Lewis* substances in the plasma $Le^a$ | *Lewis* substances in the plasma $Le^b$ | Red cells of *Lewis* group $Le(a+b-)$ reactions with anti-$Le^a$ | $Le(a+b-)$ anti-$Le^b$ | $Le(a-b+)$ anti-$Le^a$ | $Le(a-b+)$ anti-$Le^b$ | $Le(a-b-)$ anti-$Le^a$ | $Le(a-b-)$ anti-$Le^b$ |
|---|---|---|---|---|---|---|---|---|
| $Le(a+b-)$ | + | − | + | − | + | + | + | − |
| $Le(a-b+)$ | trace | + | + | + | − | + | − | + |
| $Le(a-b-)$ | − | − | +* | − | − | +* | − | − |

* After three days, these reactions were extremely weak, where
the other agglutination reactions were almost as strong as those giv
by fresh cells.

These findings may be correlated with the aberra
*Lewis* reactions given by the red cells of infant
and pregnant women[7] (where perhaps the norm
level of *Lewis* substances in the plasma is disturbed
The absence of the $Le(a+b+)$ phenotype in adul
may be accounted for by the low level of $Le^a$ su
stance in the serum of $Le(a-b+)$ people.

It seems possible that red cells simply adsorb t
*Lewis* antigens *in vivo* and that the fundament
expression of the system is to be found in the seru
antigens.

We wish to thank Dr. W. M. Davidson, of King
College Hospital, for sending blood from patien
who had been transfused.

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## Colour Anomaly, the Rayleigh Equation and Selective Adaptation

So long ago as 1878, von Kries[1] reported th
adapting lights fail to upset colour matches. Th
observation was modified in 1934 by Prof. W.
Wright, who showed that lights of very high intensit
above about 15,000 photons, do upset colour matche
Wright considers the breakdown at glare intensiti
to be due to radical photochemical changes. G.

indley has recently reported a detailed investiga- n of this breakdown at high intensities[3]. It might be ggested that the original findings of von Kries— at matches do not break down after adaptation th intensities within the normal range—has import- t implications for theories of colour vision, and particular for the explanation of the Rayleigh uation.

I have confirmed the finding for thirty normal and ır anomalous observers, using a Nagel spectro- aphic anomaloscope, and Ilford 'spectral red' and ectral green' filters for the adapting lights. After aptation to red light, both the monochromatic llow field and the red + green mixture field of e anomaloscope appeared green, the match remain- g true. After adaptation to green light, both fields peared red, the match again remaining true. In e case of two protanomalous and two deuter- omalous subjects, it was found that their matches o held after selective adaptation, though their d + green mixtures were, of course, different from e normal observers' mixture, as was found to be e case by Lord Rayleigh, in 1891.

Now since matches hold after adaptation, although bjects with defective colour vision require abnormal xture intensities to make their match, it appears at the mechanism of colour anomaly must be differ- t from that of selective colour adaptation. But this fference is not generally made evident in discussions colour vision.

On a trichromatic theory in which no special yellow ceptor system is postulated—yellow perception ing attributed to combined activity of red and een systems—we should expect the match to hold ter adaptation, since the perception of yellow is pposed to be the result of red + green mixture hatever the spectral composition of the stimulus ht. Not only is the finding that matches do hold ter selective adaptation compatible with a tri- romatic theory, but also it may be regarded as idence against the supposition that there is a special llow receptor system functional in the foveal region the retina. A special yellow receptor would be imulated by the monochromatic yellow field, but ould be comparatively unaffected by the adapting ht, if this is red or green. If it were affected, it uld scarcely be supposed to produce a shift towards d or green, but only a reduced sensitivity to yellow ht, which again would not allow the match to ld after adaptation.

The stability of colour matches with selective aptation up to high intensities thus provides at st *prima facie* evidence against a foveal yellow ceptor system. This is strengthened by Brindley's ding (*op. cit.*) that when the match does break wn with very high adapting intensities, increase red light is always required to restore the match, matter what the colour of the adapting light. If lective adaptation be supposed to depress the nsitivity of the stimulated systems (for which there a great deal of evidence[4]) whereas anomaly is tributed to abnormal spectral *positions* of the sponse systems, then there is no longer any paradox the fact that colour adaptation does not produce change in colour matches while the anomalous eye quires abnormal mixture intensities to make the atch.

We may tentatively conclude that these facts ) provide evidence against a foveal yellow receptor stem, and (*b*) suggest that colour anomaly is due abnormal spectral positions of the fundamental response curves, rather than to abnormal sensitivities, or to neural leakage[5] across receptor systems.

I thank Prof. W. D. Wright, of the Imperial College of Science and Technology, London, for valuable discussions.

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## Semiconductivity of a Type IIb Diamond

IT is a common opinion that diamond is an insulator at room temperature. Diamonds are known to occur in two types[1], classified as I and II. In 1952 it was suggested[2] that type II be further subdivided into II*a* and II*b* ; type II*a* is an insulator with a resistivity of about $10^{14}$ ohm-cm., whereas type II*b* is a semi-conductor[3]. Although this semiconductivity would point to impurities, I am inclined to the view that some type of crystal imperfection may be the primary cause.

In this communication it will be shown that in a temperature-range slightly above room temperature, type II*b* diamonds exhibit conductivity which depends on temperature, the relation taking the form $\exp(-W/2kT)$. The energy gap between the imperfection level and the conduction band (or the valence band, as the case may be) of the diamond examined in our laboratory was found to be 0·70 eV., which is about the same as the energy gap of germanium in the intrinsic range. This value is appreciably smaller than the energy gap of diamonds in the intrinsic region, which amounts to about 6 eV.

The size of the diamond, which came from the Premier Mine, South Africa, was 6·5 mm. × 2·0 mm. × 1·9 mm.[3]. A thin layer of silver was deposited on two opposite faces (size of each face, 6·5 mm. × 2·0 mm.) and the stone was then clamped between two silver electrodes. A constant voltage of 25 V. was applied over the electrodes. The diamond was held in a holder which was placed in a furnace. Table 1 shows the temperature $T°$ abs. at which the electrical current through the diamond was measured, the electrical current $i$ in milliamp., the resistance $R$ in ohms as calculated by applying Ohm's law, log $R$ and the value of $1/T$ abs. From a graph of log $R$ against $1/T$ abs. and the formula $\rho = A \exp W/2kT$, the energy gap $W$ was calculated. In this formula, $\rho$ is the resistivity, $A$ a constant and $k$ the Boltzmann constant. At $T = 293{\cdot}3°$ abs., $\rho = 7{\cdot}1 \times 10^{8}$ ohm-cm. The observations were complicated by the fact that, on applying the voltage, the current rose to an initial value followed by a slight drop which was of the order of a few per cent. The final value was measured after a few seconds, and this value was used for drawing the graph. This drop in current, relatively higher at higher currents, was in all probability due to polarization or a space-charge effect.

The figures of Table 1 were obtained by starting at 18·7° C. and gradually increasing the temperature. Going the reverse way, that is from higher to lower temperatures, a type of hysteresis was encountered,

Table 1

| $T$ (° abs.) | $i$ (m.amp.) | $R \times 10^{-5}$ (ohms) | log $R$ | $\frac{1}{T} \times 10^3$ |
|---|---|---|---|---|
| 291·9 | 0·236 | 1·059 | 5·025 | 3·426 |
| 293·3 | 0·252 | 0·992 | 4·997 | 3·410 |
| 297·1 | 0·290 | 0·862 | 4·936 | 3·366 |
| 299·5 | 0·325 | 0·769 | 4·886 | 3·339 |
| 301·2 | 0·346 | 0·723 | 4·859 | 3·320 |
| 303·3 | 0·390 | 0·641 | 4·807 | 3·297 |
| 304·7 | 0·418 | 0·598 | 4·777 | 3·282 |
| 307·1 | 0·472 | 0·530 | 4·724 | 3·256 |
| 308·7 | 0·502 | 0·498 | 4·697 | 3·239 |
| 310·1 | 0·523 | 0·478 | 4·679 | 3·225 |
| 312·3 | 0·584 | 0·428 | 4·631 | 3·202 |
| 314·5 | 0·632 | 0·396 | 4·597 | 3·180 |
| 317·5 | 0·727 | 0·344 | 4·537 | 3·150 |
| 319·9 | 0·776 | 0·322 | 4·508 | 3·126 |
| 321·7 | 0·828 | 0·302 | 4·480 | 3·109 |
| 323·1 | 0·868 | 0·288 | 4·459 | 3·095 |

the ($i,T$) graph being shifted in the direction of the $i$-axis. This shift amounted to 21 per cent at 30° C. under the experimental conditions of cooling the furnace in contact with the air of the room. The hysteresis would mean that the electrons are subject to a delay factor on falling back into the lower energy-level. The original state of the diamond is, however, fully restored in the course of time when left at room temperature, which shows that the conductivity is purely electronic.

The diamond can be used as a crystal rectifier, as was verified by measuring forward and reverse current after the stone had been provided with a silver layer on the one side and a point contact on the other side. At a temperature of 200° C. and 5 V., the forward current was 100 microamp., the reverse current practically nil; currents of the order of a few milliamperes were observed at 125 V. The extraordinary aspect of the semiconductivity of type II*b* diamonds is obvious from the fact that some of these may carry currents of the order of 10 amp. at 125 V. There is an indication that at such high currents permanent changes are produced.

We have also verified that all blue diamonds are of type II*b*. There are, however, type II*b* diamonds which do not show a blue coloration. The example discussed in this communication was slightly brownish. Two blue diamonds have been analysed spectrochemically, the only impurity element found being silicon. As the valency of this element is four, it could scarcely act either as a donor or an acceptor atom.

Blackwell and Sutherland expressed the opinion[4] that the type II diamond is a normal pure diamond, whereas all type I diamonds have some impurity or imperfection in their structure which would account for the anomalies of this type. In a later publication[5], Sutherland, Blackwell and Simeral gave further evidence of the perfection of type II, based on spectrographic measurements. Our semi-conducting diamond, in view of its transparency in the ultraviolet, would be of type II*S* according to Sutherland's nomenclature; but it is not a perfect crystal, nor is it a chemically pure diamond.

Lark-Horovitz and co-workers have shown that lattice disorder may produce $p$-type conductivity, the lattice defects acting as acceptors[6]. James L. Brophy, who examined the Hall effect of a blue semiconducting diamond, has informed me (private communication) that the sample was $p$-type over the entire temperature range − 40° to 60° C. He established an activation energy of 0·35 eV., as was also found for the diamond examined by Leivo and Smoluchowski[7].

I thank Industrial Distributors (1946), Ltd., f
making the diamond available, and in particular M
E. T. S. Brown, whose stimulating interest in resea
on diamonds is gladly acknowledged. I am a
grateful for information given by Mr. J. J. Broph
of the Armour Research Foundation, of the Illin
Institute of Technology, Chicago.

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## Radar and Phosphorescence at Sea

THE idea of ship-borne radar stimulating phosphc
escence in the sea was first put forward by Capta
F. G. Baker of M.V. *British Premier* in the *Mari
Observer* (October 1952). The next case was t
S.S. *Strathmore*, Captain J. M. Plaice, in the san
journal (January 1954). This ship saw patches
light which flashed about once a second, thou
there was none of the usual small specks of pho
phorescence in the ship's wake or bow wave. Wh
the radar was switched off, the patches near the sh
faded out, though some distant ones were still faint
visible. On switching the radar on again, the patch
reappeared near the ship, but less brightly, and so
disappeared altogether. These reports were referr
to authorities in England, including the Nav
Weather Service and the Institute of Navigatio
Their opinion was that it was most unlikely th
radar could stimulate any phosphorescence in t
sea, but invited more reports.

At 2 a.m. local time on September 5, 1954, t
M.V. *Malaita* was steering a course of 210° tru
passing Hardman Islands off the eastern extremi
of New Guinea. The second officer saw a loom
light on the horizon to the south-west, extendi
over an arc of about 15°. There were submerg
reefs in that direction, and as the ship passed the
the illumination remained apparently in coinciden
with the reefs, about two miles off.

We were steering for Bright Island Light, and ne
saw another loom of light extending from ahead
two points on the port bow. This again coincid
with the direction of submerged reefs, but prov
to be much closer than the reefs. The light fi
showed as a brilliant line along the horizon, like
breaking reef, or a line squall. As we got closer,
was found to be showing on the radar screen like
rain squall; but there was only very light ra
falling at the time from low clouds, and the visibili
was clear enough to see some islands beyond t
phosphorescence, about three miles away. Both
the screen and to the naked eye, the illuminati
appeared to cover an area about two miles squa

g in lines and patches like sandbanks in an ary.

Vhile the nearest reef in that direction was still miles away, the ship entered the first big patch phosphorescence, which appeared to be lit from epth of 30 ft., as the ship passed over it. The e was 2.20 a.m. and the ship then had to alter rse to the westward, to pass through China Strait. break of the ship's bow wave showed dark against light from the phosphorescence below. There was noticeable increase in rainfall as the ship reached area of illumination. The wind was light (south- t, force two), the air temperature was 78° F., and sea was about the same.

t was necessary here to keep the radar working the time, and there was no opportunity to switch ff to see whether it was stimulating the phos- rescence, which was particularly brilliant, in fact te disturbing in the circumstances. My report he Meteorological Office was sent to some experts England, who received it with understandable redulity, especially the picture on the radar een.

he next sighting from the M.V. *Malaita* occurred months later in the Solomon Islands. At 3 a.m. l time on March 4, 1955, when the wind was th-west, force 3, the air temperature 76° F., and sea 84° F., the sky was clouded with strato- nulus and there was some rain in the distance. e ship was three miles off the coast of Guadalcanal, water about 400 fathoms deep, and making about knots. The first patch of phosphorescence appeared the starboard bow, about a mile distant, and king like a breaking reef. The radar was working the time. Two minutes later a large number of hes appeared over a radius of about two miles, il the illumination was so bright that visibility the horizon and land was affected. The patches ight were oval, about fifty feet in length, and looked hough their light source was a few fathoms below surface. They were flashing regularly, but not phase with each other. On attempting to time m, I found that they were flashing in exact e with the beat of the ship's engines, 94 per .

ome of the patches were only 100 ft. from the p, and we even passed over some which lay in our h. Twenty minutes after the first sighting, the ches started to lose their strength, and we tried tching off the radar. The patches then faded , but reappeared when the radar was switched on in. Finally, all the patches had been passed, and min. after the first sighting they had all gone. The ches appeared to have no movement of their , nor did they show any trace on the radar een.

he problems involved in the apparent connexion ween radar and phosphorescence in the sea call some co-ordination between the meteorologists, anographers, biologists and radio-physicists. While is easy to believe that phosphorescent plankton ld pulsate with the beat of a ship's engines, there ms to be no explanation for the observed stimula- n of phosphorescence by radar. The echo shown the screen is still less understandable, and has y been reported by one ship to my knowledge.

here are some strange forms of phosphorescence sea known as 'phosphorescent wheels', which are s of light in the water radiating from a point and ating clockwise or anticlockwise over an area of miles or more. These rays of light are curved, are only a few feet wide, and apparently travel at something like one hundred knots; they suggest to me the rays which are sometimes seen around the aurora borealis or australis. Perhaps the phosphorescence in the sea is stimulated both by radar waves and by disturbances in the earth's magnetic field, such as occur on occasions of brilliant auroræ.

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## A Reagent for the Detection of Chloride and of Certain Purines and Pyrimidines on Paper Chromatograms

INORGANIC chloride is commonly present in mixtures of biological origin and, if not removed, may interfere with the identification of the organic constituents. A silver nitrate reagent has been developed which will detect as little as 1 μgm. of chloride ion on a paper chromatogram.

The reagent is prepared by dissolving 0·2 gm. of bromophenol blue in 50 ml. of acetone and adding an equal volume of 2 per cent silver nitrate solution. It is stable for one week. Chromatograms were run in butanol/acetic acid/water (60 : 15 : 25), dried, treated with ammonia vapour (to prevent a 'fast' staining of the lower regions of the paper) and the excess ammonia removed in a current of air. The papers were dipped in the reagent and dried at room temperature. They were then rinsed in distilled water until the background was white or pale blue, and the spots were marked while the paper was still damp.

Chloride, bromide and iodide showed as rose spots ($R_F = 0·20$) which became violet as the paper dried. Purines, pyrimidines and other substances capable of giving a spot showed up blue. It is suggested that the distinctive colour obtained with these halogen ions, in conjunction with their $R_F$ values, will serve as a ready means of demonstrating their presence on a chromatogram.

After being run on paper as described above, the following amounts of various substances could be detected: adenine, guanine, xanthine and hypoxanthine 0·5 μgm.; adenylic acid 1 μgm.; potassium chloride 2 μgm.; cytosine 5 μgm. Uric acid, uracil, thymine, cytidylic acid and sodium veronal did not react.

For chloride only, the coloured spot was more obvious if 5 ml. of the above reagent was diluted with 95 ml. of 1 per cent silver nitrate in aqueous acetone; the silver chloride precipitate on the paper adsorbed the dye strongly from this dilute solution and became plainly visible as a rose-coloured spot on a pale blue background.

It would appear that compounds in the purine and pyrimidine series must contain an intact imidazole ring, or an amino substituent in the pyrimidine ring, in order to react. In a hydrolysate of nucleic acid, spots revealed by ultra-violet light may be further differentiated by this reagent.

A silver dichromate reagent has been proposed for the purines[1]; but, in my experience, the method is insensitive and difficult to apply. A bromophenol blue–mercuric chloride reagent used by Geschwind and Li[2] to reveal proteins after paper electrophoresis has been found useful in some cases, but it is not so sensitive as silver nitrate.

It is suggested that the reagent might be of general application wherever a compound forms an insoluble complex with silver. For example, carbobenzoxy-β-alanine thiophenol ester (a derivative employed in peptide synthesis) is not detectable with reagents commonly used, but forms an insoluble complex with silver nitrate and appears as a blue spot on a chromatogram. With the aid of the reagent, the progress of the coupling of this ester with an amino-acid can be followed by paper chromatography, the carbobenzoxy-β-alanine thiophenol ester spot disappearing as the coupling proceeds.

The reagent thus has three distinct fields of application: first, in the detection of halogen ions; secondly, to reveal spots due to compounds forming insoluble complexes with silver; and finally, as a sensitive reagent for certain purine and pyrimidine compounds.

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## Origin of Penicillin-resistant *Staphylococcus pyogenes*

CLASSIFICATION of strains of staphylococci by their reactions to bacteriophages has been extensively used in epidemiological studies of staphylococcal infection. Thus three main groups of these organisms can be separated, and strains belonging to different groups have been considered to be unrelated. For example, a patient who is infected with a strain of one group, when later found to be infected with a strain belonging to another group, is regarded as having suffered a second infection from a different source.

The present high prevalence of penicillin-resistant staphylococci in the community, associated with the extensive therapeutic use of this antibiotic, is believed to be due largely to their selective spread associated with suppression of the sensitive strains. The fact that the majority of antibiotic-resistant strains belong to phage group III and the majority of sensitive strains to groups I and II might seem to support this view[1].

The alternative view is that antibiotic-resistant strains originate by mutation from sensitive strains under the impact of the antibiotic during treatment. If this is so, one would expect the distribution of resistant strains between the various phage groups to be the same as that of the sensitive strains, that is, the majority would be of groups I and II; but this is not the case. However, Barber and Whitehead[2] found that antibiotic-sensitive strains of group III tend to become resistant to penicillin more readily than strains of other groups, and this might afford an explanation of their preponderance. Another explanation is suggested by the results of the following experiments involving the production of antibiotic resistance *in vitro*.

These experiments were carried out with cultures of penicillin-sensitive *Staphylococcus pyogenes* derived from single colonies. The cultures were exposed to penicillin by growing them on the surface of nutrient agar plates containing various concentr tions of the antibiotic. After incubation, these plat showed two variant types of colony which we resistant to penicillin. The first, and most frequer was a relatively slow-growing, unpigmented colon and cultures from it produced no penicillinase n did they show any change in phage type. Penicilli resistant variants of this type have been obtain *in vitro* by many other investigators, but do n appear to occur *in vivo*. The second, less-frequer type of variant gave colonies which were larg opaque and pigmented; they produced penicillinas and the majority belonged to phage group III, ev when their antibiotic-sensitive parent cultures b longed to groups I and II. A change in phage ty thus occurred in association with the acquisiti of antibiotic-resistance, and this may explain tl preponderance of resistant strains belonging group III.

If this change can also occur *in vivo*, the develo ment of antibiotic resistance within the individu patient during treatment must be considered as more frequent occurrence than hitherto believed.

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March 19.

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## Quercetin Glucosiduronic Acid from the French Bean

THE monoglucosiduronic acids of polyhydrox flavones, for example, chrysin, baicalein and scut larein, that have been isolated from plant materi occur chiefly in the genus *Scutellaria*[1]. These ha been shown to be β-D-glucopyranuronides with high affinity for animal tissue β-glucuronidas Recently, a conjugate of apigenin with glucuror acid has been found in the flowers of *Erigeron annuu* French beans (*Phaseolus vulgaris*) have been reporte to contain a glycoside which on acid hydroly yielded glucuronic acid and a flavone that appear to be quercetin; this has been confirmed and t compound has been found to be a substrate f β-glucuronidase.

The beans (var. Prince: other varieties yield much less product) were cultivated in Aberdeenshi and collected just prior to flowering. Extraction the leaf by the method previously described yield quercetin glucosiduronic acid, melting point 190–19 (corr.), $[\alpha]_D^{18}$ − 50° (c, 1 in 50 per cent aqueo pyridine) for the anhydrous product. After bei recrystallized from water and dried at 100° *in vac* the product lost 7·2 per cent in weight, correspondi to $C_{21}H_{18}O_{13},2H_2O$ (found for the anhydrous produc C, 52·9; H, 3·9; calc. for $C_{21}H_{18}O_{13}$: C, 52· H, 3·8 per cent). The yield was 0·25 per cent of t dry weight of leaf.

Hydrolysis with a mouse-liver β-glucuronide preparation in acetate buffer at *p*H 5·2, or wi hot aqueous sulphuric acid (10 per cent w/v), yield quercetin, melting points 300–303° and 304–30 (uncorr.) respectively, after recrystallization fro eous ethanol. In the enzymic hydrolysis, 10 mgm. ercetin glucosiduronic acid yielded 4·2 mgm. ercetin after 24 hr. incubation at 38°, correspond- to 75 per cent hydrolysis. There was no de- ssion of the melting points on admixture with an hentic specimen of quercetin, melting point –306° (uncorr.). The product of hydrolysis and hentic quercetin when treated with anhydrous ium acetate and acetic anhydride yielded identical ta-acetates, melting points 191–192° and 193–194° rr.) respectively. Examination of the ultra-violet ctral adsorption in ethanolic solution showed orption maxima at 260 and 361 mμ for quercetin cosiduronic acid, and at 256 and 373 mμ for ercetin.

Determination of reducing sugar showed that the ymic hydrolysis was strongly inhibited by a boiled cosaccharate solution (a $2\cdot5 \times 10^{-4}$ *M* solution sed 70 per cent inhibition of the hydrolysis of a $\times 10^{-3}$ *M* quercetin glucosiduronic acid solution), ving that the responsible enzyme was β-gluc- nidase and thus that the glycoside has a β-D- copyranoside structure[1]. The value of $K_m$, the sociation constant of the enzyme-substrate com- x, for quercetin glucosiduronic acid was determined irectly by its action as a competing substrate in hydrolysis of phenolphthalein glucuronide by use-liver β-glucuronidase. Mean values for $K_m$ of $\times 10^{-4}$ *M* at *p*H 4·5, and $9\cdot8 \times 10^{-4}$ *M* at *p*H 5·2 re obtained—that is, similar to the values found other plant flavone glucosiduronic acids[1].

When tested by the procedure of Levvy[2], there s no evidence of the existence in the leaf, root or t nodules of the French bean of an enzyme pable of decomposing phenolphthalein glucuronide *p*H 4·5.

Table 1

| Aglycone | Positions of nuclear hydroxyls in flavone | Source of glucosiduronic acid |
|---|---|---|
| hrysin | 5,7 | Leaf of *Scutellaria galericulata* |
| pigenin* | 5,7,4′ | Flower of *Erigeron annuus* |
| aicalein | 5,6,7 | Root of *Scutellaria baicalensis* |
| cutellarein | 5,6,7,4′ | Leaf of *Scutellaria* sp. Leaf of *Centaurea scabiosa* |
| uercetin | 3,5,7,3′,4′ | Leaf of *Phaseolus vulgaris* |

In this instance, the β-glucopyranuronide structure of the glucosid- nic acid has still to be demonstrated.

It is interesting to note that a few plants are able synthesize hetero-glucosiduronic acids akin to ose excreted by animals. The structural similarity the parent flavones is demonstrated in Table 1. the case of apigenin glucosiduronic acid, the point conjugation with glucuronic acid has been shown be at $C_7$ of the flavone nucleus[3]; it had previously en suggested[5], from indirect evidence, that this s also the position of glycosidic linkage for baicalein d scutellarein.

I thank the North of Scotland College of Agriculture cultivating the beans used in these experiments.

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## "Adult Education"

THE main thesis of the article on "Adult Education" which appeared in *Nature* of May 7 (p. 783) seems to be that the present weakness of the Workers' Educational Association is largely attributable to the activities of "a few university extra-mural departments [which] found that it was simpler to arrange classes by dispensing altogether with the services of W.E.A. branches". This is not in accordance with the facts. Every extra-mural department, except one, provides classes and courses in co-operation with W.E.A. branches, and the exception (Aberystwyth) has never done so. Some make rather less provision than they did a few years ago; but the reasons for this are not as simple as the article in *Nature* suggests. It is certainly not the case that this change has come about through the deliberate action of any extra-mural department. Although no department would now concede to the W.E.A. the exclusive right of interpreting its university to the people as a whole, departments still look to the W.E.A. to do this among working-people.

There is probably a causal connexion between the recent modest decline in university extra-mural provision through the W.E.A. and the appreciable increase in university extension; but it is very indirect. The rebirth of the latter, which is one of the outstanding features of post-war development in adult education, is due chiefly to the discovery that, for extra-mural work of a certain kind, there is a public which the W.E.A. is unable to reach. This consists of people who have had a good secondary or even a tertiary education, to whom the "education for social purpose" of the W.E.A. makes no appeal. Some members of this public wish for provision which will widen or refresh their professional education; others, whose full-time education was very highly specialized, wish to study (at a level suited to their abilities) subjects which they had to leave aside in their college or university days. It is surely not improper for extra-mural departments to try to satisfy the needs of this public. Yet it would seem to be so according to the article in *Nature*.

University extension designed for its new public is said to be provided directly by extra-mural departments—"laid on" is the term used in the article. If this statement is intended to imply that extra-mural departments normally prepare their extension programmes in the light of coolly calculated market prospects, and then proceed, by high-pressure salesmanship, to sell to the public what they have devised, it is very wide of the mark. Before any programme is drawn up, many interests are consulted—professional, scientific, religious, etc.—and in promoting classes and courses there is the closest co-operation with a great variety of bodies representing prospective students. It is wrong to suggest that provision, other than that through the W.E.A., is devoid of the voluntary principle. The recent growth of extension provision in science, to which Dr. H. D. Turner's article in *Nature* on "Science and Adult Education" (January 22, p. 142) refers, has been due almost entirely to close collaboration between the officers of extra-mural departments and voluntary bodies especially interested in science.

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June 21.

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATOR IN SOIL SCIENCE—The Registrar, Wye College, near Ashford, Kent (July 26).

ASSISTANT LECTURER IN GEOGRAPHY—The Secretary, University College, Gower Street, London, W.C.1 (July 28).

DEMONSTRATOR IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (July 28).

ASSISTANTS (2) (preferably with an honours degree in bacteriology, or equivalent qualification) IN THE DEPARTMENT OF BACTERIOLOGY, to take part in the lecturing and advisory work of the department—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (July 29).

DEMONSTRATOR (with a first- or second-class honours degree in chemistry) IN THE DEPARTMENT OF ORGANIC CHEMISTRY; and a RESEARCH ASSISTANT (with at least two or three years experience in postgraduate research work) for work on mold metabolites—The Registrar, The University, Liverpool (July 30).

LECTURER (preferably with some knowledge of statistics) IN MATHEMATICS—Secretary of University Court, The University, Glasgow (July 30).

LECTURER (with a good honours degree in botany or agricultural botany) IN BOTANY—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (July 30).

ASSISTANT LECTURERS IN PHYSICAL CHEMISTRY, and INORGANIC CHEMISTRY—Prof. R. M. Barrer, Imperial College of Science and Technology, London, S.W.7 (August 5).

LECTURERS (2) (with a good honours degree and some teaching experience) IN MATHEMATICS—The Principal, Heriot-Watt College, Edinburgh (August 5).

ANALYTICAL CHEMIST (with a degree, A.R.I.C., or equivalent qualifications) to work on plant biochemistry and, in particular, on pigments—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford (August 6).

ASSISTANT DIVISIONAL CHIEF SCIENTIST (with good academic qualifications in chemistry or physics, experience in research, a thorough knowledge of the work of a Scientific Department in the National Coal Board or similar industrial organization, and some experience of administration)—Divisional Chief Scientist, National Coal Board, Northern (N. and C. Division), The Grange, Grange Avenue, Longbenton, Newcastle-upon-Tyne (August 6).

LECTURER OR SENIOR LECTURER (with an honours degree in science or engineering and satisfactory qualifications in physics and mechanics) IN PHYSICS AND MECHANICS, at Britannia R.N. College, Dartmouth—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4491-55 (August 6).

RESEARCH ASSISTANT (male or female, with experience in practical microscopy) IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Manchester (August 8).

RESEARCH ASSISTANT IN THE PHYSICS DEPARTMENT, to help supervise a group of students working on acoustics—The Registrar, King's College, Newcastle-upon-Tyne (August 15).

UNIVERSITY STUDENTS and FELLOWS for research in Experimental or Theoretical Nuclear and Elementary Particle Physics—Professor of Natural Philosophy, The University, Glasgow (August 15).

BACTERIOLOGISTS (2) (graduates in microbiology with postgraduate experience in microbiology or bacteriology) at the ANIMAL RESEARCH STATION, New Zealand Department of Agriculture, Wallaceville, for research into the bacteriological aspects of diagnosis or control of animal disease—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref No A.3/4/37 (August 19).

LECTURER IN GEOLOGY, with special reference to petrology—Head of the Department of Geology, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (August 19).

LECTURER (with a recognized qualification in mining, mine surveying or mechanical engineering) IN THE DEPARTMENT OF MINING AND GEOLOGY—The Principal, Wigan and District Mining and Technical College, Wigan (August 19).

CHAIR OF HYDRAULIC ENGINEERING at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, August 20).

CHEMIST (Research Officer) (with a university honours or high degree in science, with chemistry as a major subject or equivalent qualifications) in the Plant Fibre Section of the Commonwealth Scientific and Industrial Research Organization, Highett, Victoria, Australia, to undertake research on the chemistry of fodder conservation with special reference to the protein content—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 400/61 (August 20).

LECTURER (with special qualifications in physical chemistry) IN CHEMISTRY—The Secretary, The University, Aberdeen (August 20).

RESEARCH CHEMIST (with a university honours degree in chemistry and research experience in the field of surface chemistry or coal chemistry) in the Coal Research Section of the Commonwealth Scientific and Industrial Research Organization, North Ryde, Sydney, N.S.W., Australia, for investigations of the surface and electrical properties of Australian coals and cokes made therefrom, as part of a general programme of research into coal carbonization—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/170 (August 20).

DEMONSTRATOR IN THE DEPARTMENT OF INORGANIC CHEMISTRY—The Registrar, King's College, Newcastle upon Tyne (August 31).

LECTURER IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—Joint Clerk to the University Court, Queen's College Dundee (September 15).

CHAIR OF ANATOMY at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, September 17).

ASSISTANT, Grade A (with a good honours degree) FOR MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham.

ASSISTANT LECTURER (with a degree or equivalent qualification) teach Chemistry to the level of B.Sc. general degree and high national certificate—The Registrar, Medway College of Technolog Maidstone Road, Chatham.

ENGINEERS and PHYSICISTS, Experimental Officer and Assista Experimental Officer grades, in Royal Naval Scientific Service Expe mental Establishments in the London, Portsmouth and Weymou areas, Gloucestershire and Scotland—The Ministry of Labour a National Service, Technical and Scientific Register (K), 26 Ki Street, London, S.W.1, quoting A214/5A.

MASTER TO TEACH PHYSICS and some CHEMISTRY—The Director Studies, The Nautical College, Pangbourne.

PHYSICAL CHEMISTS (graduates, with research experience a preferably of Ph.D. standing) for research on (a) thermodynamics absorption (Ref. P.C.1); and (b) the mechanism of precipitation high polymers from solution (Ref. P.C.2)—The Appointments Offic British Rayon Research Association, Heald Green Laboratori Wythenshawe, Manchester 22, quoting appropriate Ref. No.

RESEARCH ASSISTANTS (2) IN PHYSICAL CHEMISTRY, to work problems connected with the combination of amino-acids with sug —The Clerk to the Governors, South-West Essex Technical Colle and School of Art, Forest Road, Walthamstow, London, E.17.

SCIENTIFIC OFFICERS (with a first- or second-class honours degr in physics or mechanical engineering, and preferably with resear experience in the field of mechanics) to assist in a group studying t effect of vibration and impulse stresses on weapon assemblies—Seni Recruitment Officer, Atomic Weapons Research Establishme Aldermaston, Berks, quoting 703/WGH/34.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honou degree in physics and some experience in the theory, design a application of electric measurement or gauging instruments), develop instruments for measuring thermal and mechanical distorti in weapon assemblies—Senior Recruitment Officer, Atomic Weapo Research Establishment, Aldermaston, Berks, quoting 702/WGH/

# REPORTS and other PUBLICATION

*(not included in the monthly Books Supplement)*

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Publications de l'Institut National pour l'Étude Agronomique Congo Belge. Carte des Sols et de la Vegetation du Congo Belge et Ruanda-Urundi. 3: Vallée de la Ruzizi, A et B. Notice explicative la Carte des Sols et de la Vegetation. Par R. Germain, J. Croegaert C. Sys, avec la collaboration de H. Maldague et G. Kevers. Pp. 48+ cartes. (Bruxelles: Institut National pour l'Étude Agronomique Congo Belge, 1955.) 100 francs. [2

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# TRANSPORT POLICY IN GREAT BRITAIN

T is now more than two years since the Minister of Transport, then Mr. A. Lennox-Boyd, stated in e House of Commons that to delay an extended ogramme of major road improvements in Great itain would cause serious damage to the economy the country. At that time the total Exchequer penditure on the schemes to be authorized in the xt three financial years was not to exceed £50 illion, and no major reconstruction schemes to restall serious damage to our economy were conmplated. Within two years, however, the Governent was forced, almost simultaneously with its ans for reconstructing railways, to formulate plans r expending £147 million, spread over four years, a roads, together with an average of about £117 illion per annum.

The plans announced by Mr. J. A. Boyd-Carpenter a February 2 provided for new motor-ways from ondon to Yorkshire and from Preston to Birmingam, but at a date still unspecified. A start was to e made with a crossing of the Firth of Forth, though e decision between a concrete tube moored to its ed, estimated to cost £5·5 million, and a bridge sting £15 million had still to be made. A new high-vel bridge over the Manchester Ship Canal was to e built as part of the Manchester outer ring road, nd there were a number of subsidiary and very seful improvements to be made to existing roads; ut there were some notable omissions, such as the evern scheme and the Tamar bridge. It was also nnounced that the Government was prepared to onsider charging tolls where appropriate.

There was no indication in Mr. Lennox-Boyd's atement that the Government is ready to tackle ad reconstruction with the urgency that, on its own howing, is required, and the merits of the individual hemes *do not suggest that reconstruction* is being lanned as a whole; rather it seems to be a series f piecemeal improvements. The plans made on aper give no sign of comprehensive policy, or that he old tradition that roads are a local responsibility being combated. The Minister of Transport is till directly responsible for little more than eight housand miles of road out of more than 180,000 on hich public money is spent, and to more than half he total mileage of roads in Britain the central overnment contributes nothing. Road construction nd efficiency thus depend largely on the enterprise nd vision or indifference—and on the reluctance or illingness to spend local rates primarily to benefit hrough traffic—of nearly 1,300 local authorities.

Schemes for 340 miles of new motor roads which Ir. Lennox-Boyd's successor as Minister of Transport, Ir. Boyd-Carpenter, announced on July 5 as a rst instalment of the Government's plans the day fter the Road Traffic Bill had received its second eading in the House of Commons show, therefore, a elcome advance. Nevertheless, they scarcely easure up to the urgent need during the next wo decades to spend more of the national income pon roads and such facilities as bridges, fly-overs, etc., designed to increase the efficiency of roads and their adequacy to the traffic they carry. Although it is expected that all the new motor roads will be completed within ten years, and that a start will be made on all within four, it will still be nearly ten before the major projects are complete. Inclusive of land purchase, they are expected to cost on average about £250,000 a mile. Including seven by-passes totalling 84 miles and costing some £20 million, the total cost is estimated at £85 million, and by 1959 annual expenditure on roads will run at about £50 million a year.

The two motor-ways specifically described by Mr. Boyd-Carpenter are a first section of fifty-three miles of the London–Yorkshire motor way between St. Albans and Dunchurch, near Birmingham, and one of 94 miles between a point north of Birmingham and the Preston by-pass. The by-pass roads will be built to motor-way specifications, and the Ministry has endeavoured to incorporate the lessons of Continental and American experience. The London–Yorkshire motor-way will have six fly-over junctions, at four of which it will be joined by slip-roads to a roundabout built above or under the motor-way on the level of the existing road, and there will be no access to the motor-way except at these points. Parking will be prohibited except in lay-bys, and although it is expected that the acquisition of land and other preparatory work may take up to two years, thereafter the work should go ahead quickly. It is anticipated that the lines of the new roadways will be indicated precisely in September.

Mr. Boyd-Carpenter's statement indicates that the Government is drawing on the full range of technical experience of other countries as well as on the knowledge placed at its disposal by the work of the Building Research Station (Department of Scientific and Industrial Research). The timing of the programme, however, scarcely suggests that the Government is alive to the urgency of the task of matching what is largely an eighteenth-century road system to the needs of mid-twentieth century traffic, or to the speed of construction made possible by the recent great advances in the mechanization of road construction. The civil engineering industry has stated categorically that materials and skilled man-power for doubling the size of the present programme are available. Admittedly these resources cannot be deployed until the surveys involved and acquisition of the land required have been completed; but that is a further reason for planning on a larger scale, so that the full technical resources available can be put into operation immediately the more time-consuming operations of survey have been completed and legal problems settled.

That makes it the more imperative that the Government should now detail its plans for road construction and improvement as part of a national policy for roads, which itself forms part of an even larger policy for transport, taking full account not only of rail transport but also of the contribution which other forms of transport such as canals and aviation, including helicopter services, could bring to the alleviation of congestion and use of the roads. The recent railway strike showed that there is still a good deal of traffic that could go by road rather than by rail, and that the fullest use was not yet being made of available road services, disregarding the congestion which retards their efficiency. It is no less true, however, that much heavy traffic goes by road which does not contribute in proportion to the damage it does to road surfaces, or the congestion it causes, and which from the national point of view should go by rail. Further, as was remarked in the House of Commons, the high cost of transport is already encouraging private transport instead of the use of public transport to an extent that increases congestion and makes the public service vehicles still less remunerative.

It is for such reasons that the plans announced by Mr. Boyd-Carpenter are disappointing, though they might have been more acceptable had they been presented as part of a comprehensive plan and accompanied by unmistakable evidence of a sense of urgency and of determination to grapple with the issues with imagination and energy. Much of the criticism of the Road Traffic Bill arises from a similar cause. As Mr. Boyd-Carpenter quite rightly said in concluding the debate on the second reading of the Bill on July 4, it is only intended to embody that part of a policy which requires a change of the law; but he gave little indication that the Government has thought out the comprehensive policy implied by his remarks.

The Road Traffic Bill embodies some good features which did not receive due recognition in the debate, notably in giving the Government power to start experiments in traffic control and in dealing with congestion. Essentially it is a measure designed to increase road safety and to reduce congestion, and in introducing the Bill, the Joint Parliamentary Secretary to the Ministry of Transport and Civil Aviation, Mr. Hugh Molson, claimed that it rested on the three determinants of road safety stressed by the Departmental Committee—the application of technical or engineering skill, education and enforcement. It embodies indeed, as the Minister himself claimed, the major part of the Government's policy in respect of congestion and of road safety, and he made the important admission that the major road programme assumed that there would continue to be a very great expansion in the number of vehicles on the roads of Britain. By 1980 there will probably be four times the number of private motor-cars on the road than there were in 1939, and twice the present number.

Accordingly, it is the more important that bad, dangerous and incompetent driving should be penalized severely, because in the future dangerous driving will become an even grosser social evil than at present; it is from this point of view that the penal provisions of the Bill are a subsidiary part of a major road programme. As such, however, they appear to be open to two criticisms. The root difficulty with driving offences is the present uneven administration of the law. To remedy this may well be essentially a matter of public education; but t debate on July 4 indicated that the Governme would receive plenty of support if withdrawal of driving licence were made an automatic consequen in any conviction for dangerous driving. The seco criticism relates to the renewal of provisional drivi licences. Apart from the question of the number competent examiners, some attempt should be ma to check the repeated issue of provisional licences holders who have not attempted to take the te The sensible suggestion has been made that a seco or third provisional licence should be made incre ingly expensive for those who have not attempted take the test when opportunity has been offered.

There are two other main points of criticism the Road Traffic Bill which were freely expressed the debate and to which no adequate answer w given by the Government. The first of these is relation to parking. The use of parking meters m well be worth trying; but provision of adequa parking space off the streets is a matter of urgen which cannot be shelved, even if it involves a co comitant problem of bringing more traffic into th large towns. Mr. Ernest Davies commented in th connexion on the freer flow of traffic throug London during the railway strike, which he attribute to three factors: the increased restriction on parki in Central London; manual direction of traffic b the police; and the acceptance by drivers of t necessity for these further regulations and the consequent co-operation with the police.

These matters obviously involve problems public education and understanding, both of whic are important factors in the second and more seriou criticism made of the Bill. The Government h decided for the time being not to make the testin of vehicles compulsory in Great Britain. The pr posals to that end embodied in the Bill introduced i the previous session admittedly had serious practic difficulties; but in a matter involving public safet to this extent, Mr. Molson's reason for dropping th proposal was inept. After establishing a convincin argument for compulsory tests he added tha although the Government believed inspection vehicles would reduce the number of road accident if public opinion was not prepared to put up wit the additional interference and inconvenience, it wa unwise to try to legislate ahead of public opinion.

That is an abdication of public responsibility whic ought not to be tolerated, and apart from the risk to life and limb involved, it deprives the public the benefit which expert knowledge could contribut to road safety. It may well be that a system inspection of all vehicles is at present impracticable but a start could be made with the inspection of a vehicles of more than a specified age. In addition the Government, on the evidence before it, should b undertaking a campaign of public education designe to secure full support for a more drastic policy at a early date, and it should also be seeking the mean by which to implement that policy through th provision of appropriate inspectors.

Road policy has two main aspects, and these ar not opposed as is sometimes implied. There is th

ect of road safety, and there is the economic or
ductive aspect. Both are social, and neglect of
her has anti-social as well as economic consequences.
e country can ill afford the continued toll of life
ich defective vehicles and dangerous driving take
ek by week, and the Federation of British Indus-
es and the Trades Union Congress agree that
proved roads would be the biggest single contri-
tion to higher productivity.

Road policy is, however, interlocked with transport
licy generally, and with the larger question of the
of land and of urban as well as rural development,
d there are implications for local government.
at is why a series of piecemeal improvements or
ojects is regarded with distrust unless it is
esented with clear evidence that the wider im-
cations have been considered. As Mr. Strauss
narked, much traffic at present on the roads could
, and in the national interest should go, on the
lways, and he also suggested that expenditure of
million upon canals might be more advantageous
an a like or greater expenditure upon new roads.
Mr. Strauss was undoubtedly right in urging that
possibility of making greater use of canals in
ure should be an essential part of any study for a
mprehensive traffic policy, and the Government
arly must make up its mind what action to
ke on the report of Lord Rusholme's Board of
rvey of Canals and Inland Waterways. Some
licy for canals is essential and any such policy will
volve expenditure; to neglect this on the excuse
at we have already to face a plan for modernization
the railways will involve waste rather than saving
our resources.

Inland transport in Britain, it cannot be too
ongly emphasized, must be considered as a whole
d in relation to the implications not only of
entific advances in road construction, in electric
nsport, the diesel engine and the utilization of
l, but also in relation to the rising costs of solid
l, labour and the potentialities of nuclear energy.
is a problem to which the contribution of the
entist and technologist is indispensable; but it is
o a problem with which the scientist and tech-
logist are concerned as citizens as well as pro-
sionally. For that very reason they are the better
uipped to participate in the task of public education
ich will be required as part of any comprehensive
licy if success is to be achieved; and they should
o be qualified to help to keep the discussion of the
ge issues involved objective and free from political
ejudice. The Government's plans for road con-
uction and for the modernization of railways
d the Road Traffic Bill raise issues which concern
ny scientists professionally. But they also chal-
ge all scientists to take part in the task of public
ucation which the framing and execution of a
nsport policy embodying the full advantages of
ientific advance demand; the administrative
anges alone required for any adequate and effective
stem of supervision as well as planning of the road
stem of Britain as a whole are immense, and will
t be acceptable unless they are understood and
eive full support.

# THE PROTEINS ENCOMPASSED

**The Proteins**

Chemistry, Biological Activity, and Methods. Edited by Hans Neurath and Kenneth Bailey. Vol. 2, Part B. Pp. ix+663–1418. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 16.50 dollars.

THE final volume of this four-volume work has now appeared, so that it is possible to consider balance and completeness of the whole. Different editors would probably have divided up the subject somewhat differently, and different types of protein might sometimes have been used as examples. But there are no glaring omissions. There may, however, be some inconsistencies; thus, nucleoproteins have a chapter to themselves, while mucoproteins and lipoproteins are dealt with incidentally and so have to be searched for in the index. A general survey of those proteins which are firmly attached to 5 per cent or more of material other than amino-acids would have been valuable, particularly if it had discussed the nature of the links between the peptide moiety and the prosthetic group.

There are six articles in the volume, each ninety or more pages long, and some of them would have made excellent monographs. The doubts about the usefulness of binding monographs together, already raised when reviewing the third volume (*Nature*, 174, 762; 1954), may be repeated. Some articles will get out of date much sooner than others, and separate publication of sections would make revision easy.

W. L. Hughes discusses the various functions that a circulating plasma might be expected to play and then considers, for each plasma fraction in turn, the evidence that it fills a specific role—for example, that it is a hormone or protection against an infective agent, or that it has a general nutritive or solvent function. Protection is considered in more detail in the chapter by W. C. Boyd on immune reactions. He gives a clear account of the diffuse fields of antigenic specificity and of the nature of the union between antigen and antibody. The final picture is as valid and comprehensive as could have been drawn in the space, though it contains a few irrelevant surprises: What, for example, is the evidence that "most plant proteins seem to be good antigens" or that protein synthesis goes on in viruses? Many would argue the contrary.

There are two articles on structure proteins: J. C. Kendrew on silk, keratin and collagen, and K. Bailey on muscle. In many other articles in these volumes the assumption is made, sometimes explicitly, that proteins with defined functions have unique structures and that heterogeneity in the preparations is a consequence of damage to the protein or of admixture with other proteins. It is pleasant, therefore, to find Kendrew emphasizing that homogeneity is a term with no relevance to insoluble proteins. Bailey starts his survey with Moses and Aristotle. The conclusions of more recent authorities on the interrelation of the actions of the various muscle enzymes are described lucidly, and stress is laid on the difficulties introduced into attempts at muscular micro-anatomy by the tendency myosin has to adsorb enzymes with which it may not have been associated *in vivo*. Both chapters make good use of the X-ray and electron microscope evidence that has been brought to bear recently on the problem.

N. M. Green and H. Neurath discuss proteolytic enzymes. They assemble a vast amount of evidence about the kinetics of action of different enzymes on substrates of known structure. It is puzzling that out of this no positive suggestion has yet come about the nature of the active spot on a protease. There may already be abundant hieroglyphs on this Rosetta Stone but neither a Young nor a Champollion to read them! Two points now seem to be clear: there is only one active site on some enzymes, and the proteolytic site is also used when the enzyme catalyses transpeptidization.

The final article is the most ambitious. H. Tarver, discussing peptide and protein synthesis and protein turnover, arouses the reader's suspicions at the start by claiming objectivity. This presumably is what the other contributors to these volumes were aiming at, and they seem to have been no less successful in achieving it. However, the article gives a useful survey of a difficult field and comments shrewdly on the gap there often is between the interpretations that follow of necessity from a set of observations and the interpretations that are published. Tarver discusses the alternative possibilities—that proteins are in a state of flux with a regular 'turnover' or that they are stable in the environment in which they were synthesized. No positive conclusion can yet be reached; perhaps because in this respect, as in others, proteins are protean.

N. W. Pirie

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# HISTORY OF TECHNOLOGY

## A History of Technology

Edited by Charles Singer, E. J. Holmyard and A. R. Hall; assisted by E. Jaffe, R. H. G. Thomson and J. M. Donaldson. Vol. 1: From Early Times to Fall of Ancient Empires. Pp. lv+8 maps+828+36 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) £7 7s. net.

This book presents the first of five volumes of a wide-ranging history of technology for which the English-speaking nations will be envied by others. The whole work will deal with the development of technology from the Stone Age down to the end of the nineteenth century. Its publication has been made possible by the help of Imperial Chemical Industries, Ltd., an organization which has shown its interest in the history of science and technology by publishing the very attractive and useful periodical *Endeavour*.

The very great amount of material for the present work has been divided up between a large number of well-known men of science, working under a triumvirate of editors, headed by that distinguished historian of science and medicine, Dr. Charles Singer, in whose honour his colleagues published two years ago a *Festschrift*, "Science, Medicine and History" (London, 1953), in two volumes. The second and third editors are E. J. Holmyard, the historian of chemistry, who was also the editor of *Endeavour*, and A. R. Hall, the historian of the natural sciences, well known also as the author of an excellent history of ballistics in the seventeenth century (Cambridge, 1952) and of a history of the scientific revolution, 1500–1800 (London, 1954). What is perhaps missing is the name of a historian of technology among the editors, but Dr. Singer's field of research is so wide that one can also reckon him in this category; one need only think of his masterly treatise on the history of the alum industry ("The Earliest Chemical Industry", London, 1948). Apart from this, the advice a prominent British historian of technology, H. Dickinson, was sought during the planning of t five volumes, but unfortunately he died in 1952.

The work is not meant for historians of technolo only, but rather as a contribution to a reade general technical education. Its intention is to gi to students and research workers in the field technology and applied sciences the humanistic a historical background of their studies. It is design to show them that the problems of their specialis studies have had a long history and have originat in different civilizations. The work will also be use to history students in general by showing them t development of material culture.

The first volume covers the period from t palæolithic age to the downfall of the empires of t ancient East. Part 1 starts with a history of t fundamental social conditions of early humani K. P. Oakley deals with man as tool-maker, a V. Gordon Childe then discusses the early forms society, in which he gives a good definition of t term 'technology'. H. S. Harrison describes how t early inventions were made, developed and sprea A. Sommerfelt deals with the problem of languag and R. E. Leach concludes Part 1 with an artic about the primitive calendar.

Part 2 is devoted to the age of the hunter a hoarder. L. S. B. Leakey writes on the technolo of stones, bones and wood, and, in another co tribution, with palæolithic art. Daryll Forde describ the early ways of hunting and fishing. As to tra for animals (p. 177), mention might have been ma to J. E. Lips's "The Origin of Things" (New Yor 1946), in which book a very vivid description those first machines of mankind is to be found.

Part 3 is devoted to domestic activities. Gord Childe writes very instructively about rotary mov ment and the early history of the drill, the potte wheel and the carriage wheel. In his bibliograph (p. 214) he might have mentioned the instructi papers of H. T. Horwitz ("Die Entwicklung d Drehbewegung" in *Beiträge zur Geschichte der Techni* 10, 179; 1920) and of O. Mahr ("Zur Geschichte d Wagenrads" in *Technikgeschichte*, 23, 51; 193 H. S. Harrison introduces his readers to the ear ways of firemaking and of using materials for heati and lighting. The picture (p. 217) on "The Dome tication of Fire" from the Parisian edition Vitruvius (1547) is only a free reproduction of t woodcut in the famous Vitruvius edition of 152 published at Como. The pneumatic firelighter ( 227) was no doubt only introduced to Borneo b the Portuguese in the nineteenth century, and ca therefore not be said to be autochthonous. R. Forbes, who is well known through many of h papers as a historian of technology, writes about t technology of chemistry, cookery and cosmetic The last article of Part 3, by J. Bradford, describ very vividly the different forms of structures whi were made by using wood, woven reeds or turf.

Various technical activities are considered i Part 4. F. E. Zeuner deals with the domesticatio of animals and the cultivation of plants; to th bibliography, H. Nachtsheim's book, "Vom Wildti zum Haustier" (second edition, Hamburg, 1949 might usefully be added. Sir Lindsay Scott tells th early history of pottery. In an excellent pape G. M. Crowfoot deals with textiles, straw plaitin and mat-making. Two appendixes by J. Grant an K. R. Gilbert deal with the materials of ancie tiles, basketry and rope-making. Then follow pers about bricks and stone structures (S. Lloyd), e Stonehenge monument (R. H. G. Thomson), the ferentiation of non-metallic utensils (S. M. Cole) d the use of irrigation and agriculture (M. S. ower).

Part 5 deals with the use of metals. Mines and arries are dealt with by C. N. Bromhead. R. J. rbes describes how metals were won from ores, d how they were melted and alloyed. H. H. gblan deals with utensils and metal weapons, H. aryon and H. F. Plenderleith with fine metal-crafts, . D. Barnett with objects made of ebony, and C. dred with artistic woodwork.

The subject of transport is the theme of Part 6. M. Cole describes wheeled vehicles and deals with ads and bridges. Wheeled vehicles are also scribed by Gordon Childe. The part is concluded A. Digby's paper on boats and ships down to the pe of the Ægean galley.

Part 7, the last one in the volume, considers ings essential for the development of natural iences: S. H. Hooke tells the history of writing, . G. Skinner that of weights and measures, and O. eugebauer that of mathematics and astronomy in e Ancient Orient.

The book is splendidly illustrated, most impressive ing the thirty-six photographic plates. Some of e contributions have excellent bibliographies; but hers have none at all—which is a pity. Each article ould have its own bibliography; it is not enough direct the reader's attention to R. J. Forbes's Bibliographia Antiqua" (Leyden, 1940–50). It need arcely be said that a standard work like this s a detailed index. Special features are the ronological tables by F. E. Zeuner covering the eriod from the geological ages down to the birth of hrist, and the chronological tables of prehistoric d historical civilizations of the Near East. In nclusion, I should like to say that the work succeeds achieving its objects, as might be expected from e profound knowledge and truly humanistic outok of its editors and contributors. We are waiting ith impatience for the other volumes.

Friedrich Klemm

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# A POLICY FOR WAGES

## he Social Foundations of Wage Policy

Study of Contemporary British Wage and Salary ructure. By Barbara Wootton. Pp. 200. (London: eorge Allen and Unwin, Ltd., 1955.) 15s. net.

THERE is much in this book by Mrs. Barbara Wootton that is familiar to students of economics d industrial relations. The limitations of economic eory which seeks to explain the process of wage etermination on the basis of a set of highly unalistic assumptions have long been the cause of issatisfaction both to economists and to those who ok to theory as a possible source of guidance in ractical affairs. Equally, the failure of theoretical nalysis to account satisfactorily for what the author escribes as curiosities of British wage structure—xtreme inequality of rewards far beyond the range f individual differences in inborn aptitudes or in sts of training; the lack of an inverse relationship etween the monetary and non-monetary attractions different jobs, or of a positive relationship between e length of the normal working week and the standard time-rate of wages; variations in the practice of differentiating wage-rates according to sex—is a not unfamiliar theme, and much of the description and comment on methods of wage determination, on the attitudes and policies of trade unions, employers and arbitrators are inevitably part of the common stock-in-trade of all those whose professional or academic interests lie in the field of industrial relations.

Nevertheless, one of the great merits of Mrs. Wootton's work is her vivid and spirited presentation of familiar arguments, accompanied by penetrating observations based on a long academic and practical experience, to demonstrate once more that the economist's highly simplified account of the process of wage determination must be supplemented and modified by analysis of the institutional, social and ethical considerations surrounding the wage bargain. With this book, Mrs. Wootton joins the growing company of challengers, from Mr. J. W. F. Rowe in Britain to Mr. A. M. Ross in the United States, whose work may stimulate attempts to reformulate economic theory in this very significant area.

Analysis of these non-economic considerations is held to show the existence of two distinct and opposing sets of forces: ethical considerations—justice and fairness—are said to pull in the direction of equality; social considerations—status and prestige—make for conservatism and the maintenance of traditionally established differentials. In a wide survey of wage negotiation and arbitration in recent years, Mrs. Wootton concludes that, notwithstanding the tendency to phrase the arguments in ethical terms, the emphasis on the social factors of status and prestige has tended to produce an increasing degree of rigidity in the wages structure. Moreover, since conservatism justifies itself, no principles need be sought, and thus expediency or reference to custom becomes the rule.

This absence of principles of decision prevents the development of a coherent wage policy and stultifies the work of negotiators and arbitrators. So far as arbitration is concerned, the lack of principles has, of course, long been recognized as a major difficulty. Contrary to Mrs. Wootton's statement that, in the report of the 1954 court of inquiry in engineering, "the true nature of the problem here was explicitly stated at last", the difficulty was in fact recognized in the Report of the Royal Commission on Trade Unions of 1867–69, which rejected compulsory arbitration on the grounds that "there are no admitted principles of decision on which an arbitrator may proceed". For Mrs. Wootton, arbitration is a judicial process in spite of the absence of principles or of governmental statements of policy. In fact, however, it may be regarded as a legislative process, since the arbitrator is not being asked to interpret existing laws but to make a new law—a situation which led Parliament throughout the nineteenth century consistently to refuse to grant compulsory powers to arbitrators despite the widespread desire to strengthen the system of arbitration. Mrs. Wootton would not only require Parliament to legislate, in very broad terms, on wages policy, but also would expect negotiators and arbitrators to act as interpreters of this legislation. This proposal, quite apart from its merits, ignores the practical difficulties, which also beset the idea of compulsory arbitration, of enforcing the law against the very large groups of aggrieved workers which may emerge under certain conditions.

Finally, in addition to advocacy of guidance in wage policy by pronouncements of economic planning, the one principle suggested by Mrs. Wootton, that of equality, appears to spring from a particular set of social and political beliefs rather than from any practical consideration of the unquestionably urgent problems involved in the present wages situation in Great Britain.

N. S. Ross

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## PHYSICS IN ONE VOLUME

### Textbook of Physics

Edited by R. Kronig, in collaboration with J. De Boer, H. C. Burger, P. H. Van Cittert, C. J. Gorter, A. C. S. Van Heel, P. Van Der Leeden and G. J. Sizoo, with biographical notes and tables by J. Korringa. (Translated from the Third Dutch Edition published in 1951.) Pp. xv+856. (London: Pergamon Press, Ltd.; New York: Interscience Publishers, Inc., 1954.) 70*s*. net.

A DISINCLINATION to believe that he has ever known more than could be put into one book has often persuaded the reviewer to hope for a single comprehensive text-book of physics which could be safely recommended to students and which could be used as an occasional refresher for himself—now happily beyond active service in examinations.

This English translation of a very successful text-book written by a group of Dutch physicists during the Second World War is probably the most ambitious attempt yet made at providing in one volume an account of physics as a whole at a reasonably advanced level. It would be easy to make criticisms of detail or complaints about particular omissions; but a more appropriate treatment—which this book deserves—would be to attempt to explain what it does and does not succeed in doing.

First, as would be guessed from the names of the contributors, the treatment is of high quality. Its level is roughly that which an honours student might aim to reach at the end of his second year; it would not be adequate for a third year in which any specialization was permitted. It is modern in outlook on the whole; for example, in discussing elasticity it mentions interatomic forces, but does not describe all the variations possible in the measurement of surface tension. It does not deal only with theoretical principles, but gets down to such practical details as the design of optical instruments. In general—though not everywhere—the phenomenological description is placed first; there are, for example, fifty pages on vibrations and waves early in the book. Unusual features include a section on medical physics and a collection of biographies of famous physicists.

However, the final and perhaps inevitable verdict must be that too much of the matter has been over-condensed. Perhaps two volumes really are necessary. To take a few examples at random: the cyclotron is dismissed in half a page, the Linde method of liquefying gases in two lines, infra-red spectroscopy in two separated paragraphs, piezo-electricity and ultrasonics in half a page. In the first chapter, in which an account is given of the objects and methods of physics, a discussion of errors is given which occupies only half a page, and an even shorter discussion of graphical methods. To be frank, one cannot imagine a student deriving much from su abbreviated accounts unless he is also pursuing normal course of physics and has access to oth books. In other words, this book must be regard as additional reading. In this capacity it would greatly stimulating to a serious student of phys Within these limits, the book is about as good as o written by a group of authors could be, and probat better than one author could hope to write.

The diagrams are excellent, and the writing is fr from eccentricities often found in translated wo The price, though high, is probably—in terms pence per word—a good deal lower than the prese day average.

G. O. Jones

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## GLOSSARY OF COALS

### Coals and Bitumens and Related Fossil Carbo aceous Substances

Nomenclature and Classification. By Dr. S. Tomkeieff. Pp. v+122. (London: Pergamon Pre Ltd., 1954.) 17*s*. 6*d*. net.

A GLOSSARY of this wide and unsystemat subject has long been needed, and yet ha never been made; it is admirable to have it nov Dr. S. I. Tomkeieff's book contains some thirtee hundred terms, of which all but about two hundre relate to coal. The body of the book lists the alphabetically, with short definitions and reference This is followed by a series of synoptic tables an some diagrams, which give schematic order to th bewildering variety of names and substances. Th methods of these classifications are explained in short introduction.

Dr. Tomkeieff has done his work well. Where s much of the matter is traditional and local, gaps ca of course be found, and there are some oddities c usage. But the book is a remarkable collectio across a multitude of dialects and even languages— there are nearly two hundred terms in some twent foreign languages.

The interests of the author are those of the geo logist rather than, say, the coal chemist, and in thi respect the book falls short of the needs of the latte For example, such important technical terms a 'volatile content' and 'carbon ratio' are defined i ways which are no longer the best standard practice There is no classification of coals by the paramete of their ranks; and, most serious, the importan modern work on the physical and chemical structur of coals is not mentioned. Outstanding progress ha been made during the past few years in understandin the properties of different coals, by deductions mad from their examination by X-ray, infra-red, an other physical methods. These researches offer th best promise for bringing order of a fundament kind into the present empirical classifications; an the neglect of such ideas in this book is therefor regrettable.

The next edition would be greatly strengthened b including in the introduction a systematic accoun of modern physical and chemical theories of coa structure, and by adding to the synoptic tables an diagrams a classification based on them. In it present form, Dr. Tomkeieff's book is thoroughl useful; with these additions, it would become indis pensable to all students of coal and allied substance

J. Bronowski

## nalyse Spectrale Quantitative par la Flamme

-Propriétés de la Flamme : Réalisation et Util-
tion. 2—Analyse des Émissions dans la Flamme.
r Dr. R. Mavrodineanu et H. Boiteux. (Pub-
ation de l'Office de la Recherche Scientifique Outre-
r.) Pp. vi+248+11 plates. (Paris : Masson et Cie.,
54.) Broché 3,800 francs ; Cartonné 4,800 francs.

N this volume, an excellent account is given of the
theoretical and practical aspects of flame photo-
try. The book is divided into two parts, the first
aling with the general properties of flame sources
d a very comprehensive consideration of the factors
ecting the design of burners, atomizers and other
mponents in a complete flame photometer. There
chapters on photoelectric and photographic
thods, and also on instruments with dispersing
stems and with filters. A short account is given of
e interferences between different elements.

It is easy to suggest additional material which
ght have been included in any book, but perhaps
fuller account could have been given of the large
ount of work done in recent years on photoelectric
struments, and reference made to the value of
terference filters. The effect on flame temperature
the introduction of different salts also deserves
tention, as one cause of interference between one
ment and another.

The second part of the book is concerned with the
eory of the emission spectra of the flame itself and
the elements and compounds giving lines used for
alysis. Its value lies in the inclusion within a
gle volume, not only of the spectral terms and
ergy-levels of a great many elements, but also of
full account of the molecular spectra of interest
d the chemical reactions and equilibria within the
me. A list of useful spectral lines, and photographs
a number of flame spectra are included. There is
extensive bibliography of more than five hundred
ferences, and a good index. The book makes a
stinct contribution to a subject which has not
cently been presented in a form primarily intended
r the analyst.

J. R. Stansfield

## eology of Petroleum

y A. I. Levorsen. (A Series of Geology Texts.) Pp.
+703. (San Francisco : W. H. Freeman and
mpany ; London : Bailey Bros. and Swinfen,
d., 1954.) 8 dollars ; 68s.

EOLOGIES of petroleum have in the past tended
to a pattern of theory first, and practice second.
such works the principles are enunciated, explained,
agrammatically presented, and thereafter followed
ually with geographically arranged oilfield strati-
aphies and structures. Sometimes descriptive
atter is too detailed, and a monotonous record of
st developments is given ; these date quickly
less particularly exemplary. However, the author
this present book is fully aware that there is no
int in cataloguing producing pools except as they
ustrate specific principles that apply to exploration,
r our first interest is in finding new producing areas,
d this point of view is much to be commended.

Unrelieved oil geology, without full leavening of
ntacts with closely allied sister sciences, lacks
spiration and reality. Recognizing this, the author
eats his material objectively : first the reservoir
mphasis on trap rock) ; then reservoir conditions
mperature, pressure, differential fluids) ; next
peculative ideas on origin, migration and accumu-
tion" (the operative word here is 'speculative') ;
d finally, "ways of applying what has been considered in the search for new pools and provinces". There is logic in this sequence. Geological manuscripts are inevitably read in terms of economic values, and theories put to practical trial by drilling. The experienced oil geologist can interpret his findings understandably to geophysicists, reservoir and production engineers and the like ; and this applies to administrative 'laymen' as well. Reciprocally, many of these other people desire to learn from a not too technical, modern text something of the geologist's technique. This is the book for them ; its appeal should be deservedly wide.

H. B. Milner

## Entire Functions

By Ralph Philip Boas, Jr. (Pure and Applied Mathematics : a Series of Monographs and Textbooks.) Pp. xi+276. (New York : Academic Press, Inc. ; London : Academic Books, Ltd., 1954.) 6 dollars.

THIS book presents in orderly fashion a wealth of material not previously brought under one cover. It is about functions of exponential type, with emphasis on entire (integral) functions. There are chapters on entire functions of finite order, the minimum modulus and functions with real negative zeros. Then follows a chapter on general properties of functions of exponential type, and then three chapters on special properties, such as the connexion between growth and the distribution of zeros. There is a chapter on uniqueness theorems, and this is followed by a chapter on growth theorems and one on operators and their extremal properties. The last chapter, on applications, is exciting because it demonstrates the wide field within which entire functions find a place. Illustrations are given of applications to Fourier series, power series on the circle of convergence, Dirichlet series and gap theorems. There are brief sections on differential equations of infinite order and approximation. It is a pity that these are so short ; but there is an extensive bibliography for those requiring more detail.

A survey of the present book shows that the subject-matter of the theory of entire functions consists of a great number of more-or-less special results. The indications are that these are becoming overwhelming in their numbers and ramifications. One is led to ask the question whether some general theory might be developed which will compress a lot of the known results into several strong channels. It certainly looks as if some new method of classification is needed. It may be that modern algebra and topology can help here, via such tools as ultrafilters and the structure theory of complete local rings, as used recently by Henriksen and others.

L. S. Goddard

## Physics for Medical Students

By Dr. J. S. Rogers. Third edition, revised and enlarged. Pp. xiii+405. (Melbourne : Melbourne University Press ; London : Cambridge University Press, 1953.) 35s. net.

FOR some twenty years Dr. J. S. Rogers's book has done admirable service in providing a course which supplements the ordinary university physics text, with applications of special interest to medical students. In this, the third edition, developments of nuclear physics and electronics are included, together with topics such as reflecting objectives and phase-contrast microscopy. Outstanding in its own field, the book will be gladly welcomed in this new edition.

G. R. Noakes

# THE AGES AND ORIGIN OF METEORITES

By Dr. P. REASBECK*

Londonderry Laboratory for Radiochemistry, University of Durham

AND

Dr. K. I. MAYNE

Clarendon Laboratory, University of Oxford

THE geological ages of meteorites have been discussed recently by several authors[1-8]. Paneth's classical helium method based on analyses for helium, uranium and thorium, now taking into account the helium generated also by cosmic rays[4,5], is being supplemented by the argon–potassium method[6-8]. The latter is, of course, only applicable to the stony phase of meteorites, since the iron phase contains too little potassium. It is clearly of interest to compare the apparent ages derived from both experimental methods. Two questions may now be posed: First, is there agreement in the ages found by both methods applied to identical samples of meteoric stone? Secondly, do either of these ages agree with that found by the helium method applied to meteoric iron? If the answer to the first question is in the affirmative, one can have much more confidence in the derived ages than one would have by either method alone. Granted this agreement, the answer to the second question cannot then fail to be significant in a discussion of the life-history of these bodies.

Table 1

| Meteorite | Helium content (in $10^{-6}$ c.c./gm.) | $^3$He/$^4$He ratio (%) | Uranium (in $10^{-8}$ gm./gm.) | Thorium (in $10^{-8}$ gm./gm. |
|---|---|---|---|---|
| Beddgelert | | | | |
| Stone | 30 | — | 10·8 ± 2·7 | 39 ± 8 |
| Iron | 2·8 | — | 9·1 ± 1 | 8·5 ± 4·9 |
| Akaber | | | | |
| Stone | 14·2 | 6·3 | 0·84 ± 0·08 | 6·0 ± 2·1 |
| | | | (J. C. Dalton, private communication) | |
| Iron | Proportion of iron present in meteorite too small to permit determination | | | |
| Brenham Township | | | | |
| Stone | 3·44 | 1·0 | 0·60 ± 0·17 | 5·3 ± 2·4<br>(J. C. Dalton, private communication) |
| Iron | 0·018 | Helium content too low for mass-spectrometric determination | 0·06 ± 0·02 | < 0·7 |

In the case of stone meteorites, very few age determinations have been made by the helium method, since some terrestrial minerals have been shown to be not necessarily helium-tight (see, for example, ref. 9), and it was thus assumed that the diffusive loss of helium from stone meteorites would invalidate the method. Evidence is presented here which indicates that this effect may not be so serious as presumed. It has been suggested[8] that diffusive loss of argon from stony meteorites should not, however, be large, and for this reason it seems of especial interest to compare results obtained by the two methods.

We have extracted the helium from meteorite samples and measured the amount and helium-3 content by gas analytical techniques described elsewhere[10,11]. Very careful blank assays showed that the amount of helium contamination from the atmosphere could be reduced, in the case of irons, to 0·1 per cent of the meteoric helium measured, and, in the case of stones, to a negligible amount. Determinations of the uranium, thorium and potassium contents of t meteorites were carried out on aliquot portions of t same samples, from which portions were taken the helium and argon measurements.

In Table 1 are given the results of these determi tions, and in Table 2 are collected the apparent a of the two phases.

Other workers, using the argon–potassium meth for stone meteorites, have reported figures simi to those given in Table 2. Thus, Wasserbe and Hayden[7] report 4·6 × 10⁹ yr. for Forest C and 4·8 × 10⁹ yr. for Beardsley; Gerling a Pavlova[8] give 3 × 10⁹ yr. to 0·5 × 10⁹ yr. for so chondrites.

It may be noted that our figures for the heliu method may be slightly in error owing to the presen of cosmogenic helium in addition to the radioge helium. A correction has been made in the case Akaba and Brenham Township based on the measured content of helium-3. The ratio of helium to helium-3 formed by cosmic rays in stony materi is not yet known, and, in any event, this ratio w vary with depth within the meteorite. A value unity has been assumed in making the correction the observed content of helium-4. This is unlike to be far out, and even if the true ratio were as hi as 3, the ages quoted would have to be reduced less than 25 per cent.

It has always hitherto been considered that t helium method would probably not be reliable f stony meteorites, because of the risk of loss of heliu by diffusion. A consideration of the figures Table 2 indicates on the contrary that the loss helium may not be very serious. Thus the observ deviation between the two figures in the case of t Akaba meteorite is in fact within the statistical err of the experiment, although it may be that in t case of Brenham Township meteorite about half t radiogenic helium has been lost. In addition, t lowest age found for a stone by the helium metho is well within the range of ages found for sto meteorites by the argon method.

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* Now at the Physics Department, University of Birmingham.

Table 2

| Meteorite | Helium method age | Argon–potassium age (ref. 8) |
|---|---|---|
| APPARENT AGES OF STONE PHASE OF METEORITES | | |
| Akaba | 3·2 × $10^9$ yr. | 3·6 × $10^9$ yr. |
| Brenham Township | 1·4 × $10^9$ yr. | 3·3 × $10^9$ yr. |
| Beddgelert | 1·2 × $10^9$ yr. | — |
| Monze | — | 1·8 × $10^9$ yr. |
| APPARENT AGES OF IRON PHASE OF METEORITES | | |
| Beddgelert | 2 × $10^8$ yr. | — |
| Brenham Township | 4 × $10^8$ yr. | — |

It therefore does appear that the two methods are substantial agreement, and that (having regard to e tendency for the helium method to err on the de of under-estimation) the true ages of stony-phase eteorites are of the order of 2–4 × $10^9$ yr. They are us of about the same age as the Earth and certainly ot older than the revised expansion-age of the iverse.

Our earlier figures for iron meteorites[4,10] have been iticized[8] on the grounds of giving too low an age. or this type of meteorite we had suggested an age about 2 or 3 × $10^8$ yr. However, it is now obvious at, by one and the same method, the age of the one phase of the meteorites described here agrees ell with the age derived by the argon method, while e iron phase is undoubtedly younger, and has an e in good agreement with our figure mentioned ove for irons.

It has been argued by Urey[8] that on thermodynamic ounds it is unlikely for the observed uranium and orium contents of meteoric irons to be correct. He ggests instead that the uranium and thorium are fact held in small stone or sulphide inclusions ithin the iron, and that the ages are falsified by cape of helium along fissures in the iron. Such a ss of helium from the bulk iron would, however, em extremely improbable, from the following perimental observations. (*a*) There is great fficulty in abstracting the helium from meteoric on *in vacuo*, even at high temperatures[12]. (*b*) urther, no fall in helium concentration with proach to the surface is observed radially in eteorites[10], and, in fact, in the only meteorite rge enough for the purpose so far available e measured concentration gradient was in the posite sense to that which would be caused by ffusive loss of helium. (*c*) Several determinations ve been made by one of us (P. R.) on each of enty different iron meteorites; samples up to gm. in weight were dissolved in dilute sulphuric id, and in only one case (Toluca (Durham), 3·7 per nt of stone by weight) was any trace of stone served after the iron had completely dissolved. is indicated that many iron meteorites have few no stone inclusions at all, and that the uranium d thorium, and hence the helium, cannot then be stulated to come from such inclusions, since, where esent, they would have to contain a far higher ncentration of uranium and thorium than occurs the bulk stony phase. (*d*) Even with the much ore friable stone meteorites, we now have evidence at helium loss is small during what appears to be much longer life-history. (*e*) No sign of such clusions, which, as pointed out above, would have contain a high concentration of uranium and orium, have been detected by autoradiographs of eteoric iron slices. Thus, it seems that the only ssible explanation of Urey's thermodynamic argu-ent is that the true thermodynamic equilibrium, as regards the distribution of uranium and thorium between the two phases, was never achieved.

There remains always the possibility of experimental error. The uranium and thorium contents of the iron phase are about ten times smaller than those of the stone. It is therefore true that a systematic error in the measurements on the stone phase might not be noticeable, whereas the same absolute error in measurements of the iron phase would be quite important. Even so, it seems that the error in the case of the iron would not be as much as a factor of 2, whereas a factor of 10 would be required to explain the difference in ages. This consideration is quite independent of arguments based on the carrying out of duplicate analyses, blank analyses, and analyses by quite different methods, all of which have been done in the attempt to eliminate systematic errors. Further, the fact that the uranium and thorium figures for the stone phase give an age in agreement with that found by the argon method is an added indication of the validity of these figures, and hence, a confirmation of the validity of the uranium and thorium contents of the iron phase, which were measured by the same methods and under the same conditions as those of the stone phase[13].

At this stage it would be as well to correct the impression given by Urey[8] that we have suggested that all iron meteorites have lost much of their helium by being heated relatively recently in a close approach to the Sun. Such an event has indeed been postulated[8] to cover the case of three meteorites of very exceptionally low helium content; but it has never been suggested for the large majority of them.

The only other experimental approach to the ages of meteorites is that of Patterson and Hayden[14], who have investigated the isotopic composition of meteoric lead, and find evidence for an age of the order of 4·5 × $10^9$ yr. for stones.

In sum, it appears to be an inescapable conclusion that the stony phase reached an evolutionary stage, after which it has lost little radiogenic or cosmogenic gas, at a period about ten times as remote from us as the corresponding period for the iron phase. If this be accepted, the hypothesis of a planetary origin for all the meteorites seems attractive, the planet having undergone a cataclysmic break-up fairly soon after the solidification of the bulk of the iron phase[15].

This would offer an explanation for the existence of (*a*) old stone-phase meteorites; (*b*) younger iron-phase meteorites which are still old enough to have been exposed to cosmic rays for sufficient time to build up their observed cosmogenic helium, and which have cooled sufficiently slowly to form their Widmannstätten figures; (*c*) chondrites, pallasites, etc., which combine the features of (*a*) and (*b*). The suggestion of pallasite formation put forward by Lord Rayleigh (1944) may well be in agreement with the results presented here, as may also be the recent suggestions of Kuiper[16], that the melting of the metallic iron in the meteorites occurred late in the history of the solar system, the melting having been produced by radioactive heating in bodies that were highly insulated. The metallurgical investigations of Uhlig[17] also seem to present evidence for the irons having been formed in the interior of a large body.

It would now seem that the range of ages suggested for stony meteoric material, from about 4·5 × $10^9$ yr. by Wasserberg and Hayden down to about 0·5 × $10^9$ yr. for the 'youngest' meteorite examined by Gerling and Pavlova, within which the present results fall, is not in serious disagreement with the range of ages for different terrestrial materials, while the younger age of meteoric irons can well fit into a general scheme of planetary evolution.

We wish to thank Prof. F. A. Paneth for providing the samples of meteorites, and for his continued interest in the work. [May 11

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# A NEW METHOD FOR THE ABSOLUTE MEASUREMENT OF HIGH PRESSURES

By R. S. DADSON

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AS part of a programme of work in the field of high-pressure physics, the National Physical Laboratory is now working on a project for the establishment of standards for the measurement of high pressures.

In practice, most measurements of high pressures intended to be of the greatest precision are made with pressure balances, or dead-weight gauges, of the familiar type in which fluid pressure acting on a piston of known area is balanced by a load applied by means of calibrated weights. The accuracy of such balances has hitherto been limited principally by the fact that at high pressures the piston and the cylinder in which it moves are distorted to an extent which is not easily measurable. As a result of this, the 'effective area' of the assembly is subject to an uncertainty which is likely to increase as the pressure is raised.

The usual method adopted in the past for the determination of the effective areas of piston–cylinder assemblies[1] has relied on the use of high-pressure mercury columns, but the results of these investigations have not so far given any clear or consistent indication of the changes in effective area under the influence of elevated pressures. A new standard mercury column of this type capable of operating up to about 2,500 atmospheres has recently been described by Bett, Hayes and Newitt[2], who discuss in detail a number of factors affecting the accuracy likely to be achieved. So far, however, no results of measurements with this instrument on actu balances have been published. While it is clear th a well-designed high-pressure mercury column capable of the establishment of high pressures wit considerable accuracy, it nevertheless seems like to be a somewhat difficult instrument to use, mainl on account of the long and laborious series of pressu transfers which need to be made to reach the hig pressure range.

The purpose of this communication is to give preliminary description of a new method for estab lishing the calibrations of pressure balances whic has recently been developed at the National Physic Laboratory. In measuring the change of effecti area of a balance as the pressure is raised, the meth makes use of a quite simple principle of similarity applied to pressure balances of the same dimensio but constructed of different materials. If we consid two piston–cylinder assemblies of the same nomin dimensions but of materials the elastic constants which differ in a known ratio, then in certain circum stances, considered in more detail below, the di tortions, under applied pressure, of the two assembli will remain proportional to one another througho the range of pressure concerned. Under these con ditions, and neglecting small quantities of the secon order, we may represent the effective areas $A$ and of the two assemblies at a given pressure in the for

$$A = A_0\{1 + \alpha.\mathrm{f}(P)\}\,;\quad B = B_0\{1 + \beta.\mathrm{f}(P)\}.$$

In these expressions $A_0$ and $B_0$ are the (nominall equal) effective areas at zero pressure, $\alpha$ and $\beta$ a constants inversely proportional to the elastic modu of the two materials, and f($P$) is an unknown functio of the pressure, $P$. The ratio of the two effectiv areas will be given, to the same order, by th expression

$$A/B = A_0/B_0\{1 + (\alpha - \beta).\mathrm{f}(P)\}.$$

This ratio is easily determined by balancing the tw assemblies directly against one another, and th procedure determines the quantity $(\alpha - \beta).\mathrm{f}(P$ The quantity $\alpha/\beta$ may be obtained from direc measurements of the elastic constants of the tw materials. These two procedures thus enable th absolute value of the change of effective area of eac of the piston–cylinder assemblies to be determined

For the theory outlined above to be valid, number of conditions must be satisfied, both a regards the materials and the construction of th assemblies. Since two independent elastic modu will be involved in a somewhat complicated manne in the distortion of each assembly, true proportion ality can only be achieved if both moduli are in th same ratio—in other words, the values of Poisson' ratio for the two materials should be closely simila As regards construction, the forms of the interna bores of the cylinders, and of the pistons, must b closely similar in contour, since otherwise the dis tributions of pressure in the gap between piston an cylinder will not be the same in the two assemblie The similarity principle also requires that the gap widths at zero pressure should be inversely pro portional to the elastic moduli. If these condition are adequately met, and the elastic properties of th materials are uniform throughout the range of stres involved, proportionality of the distortions will b assured. This will remain valid even if the viscosit of the transmitting fluid is dependent on pressure, a will almost certainly be the case. It is, however worth noting that the effective area of a pressur

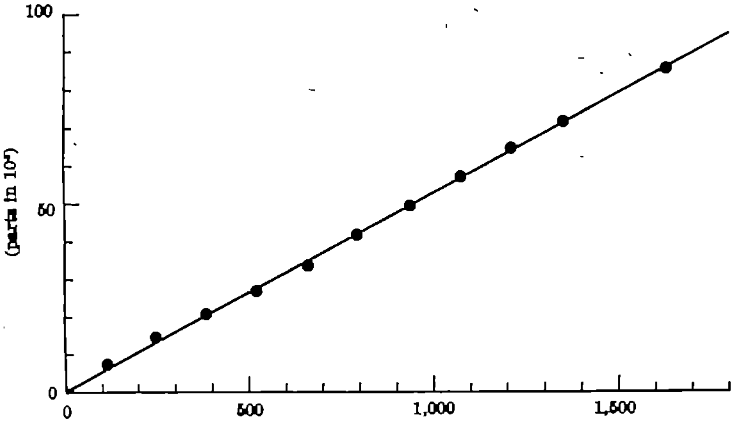

Fig. 1. Dependence of effective area on pressure for steel piston–cylinder assembly of nominal area 0·02 sq. in.

alance may depend to some extent, at high pressures, n the viscous properties of the fluid used.

The present series of experiments at the National hysical Laboratory is intended to cover the range p to 3,000 atmospheres. The two materials so far sed are a hard tool steel and a special type of bronze f high tensile strength. The strains of the materials aded in tension, compression and shear have been easured over the range of stresses imposed in the ressure experiments. Within the limits of accuracy f these measurements, the stress–strain relationships ere linear and conformed to a fixed ratio of the astic moduli of 1·44 : 1. Measurements in three irections at right angles which were made by the ltrasonic-wave velocity method, using longitudinal nd shear waves, indicated the materials to be satis- ctorily isotropic. The accuracy of construction of e assemblies is largely limited by the accuracy with hich the cylinder bore can be made and measured. wing to recent improvements which have been ade in the Metrology Division of the Laboratory the measurement of the form and diameters of ylinder bores[3], it has proved possible to construct iston–cylinder assemblies to the requisite precision, nd with the required degree of similarity.

The results of the present series of measurements ow that the method is capable of a very satisfactory egree of accuracy and consistency, and permits the easurement of the variation in effective area over wide range of pressure to within a few parts in $10^5$ f the total area. In fact, over small ranges of ressure, variations in effective area of only a few arts in $10^6$ of the total area can be determined. An ample of the results obtained is shown in Fig. 1, here it will be seen that a particular steel piston– ylinder assembly of nominal area 0·02 sq. in. may ange in effective area by an amount of the order part in 2,000 per 1,000 bars of applied pressure. In is instance the change proved to be a linear function f pressure to the order ± 1 part in $10^5$ of the total rea.

While the present series of tests is intended to over the range up to 3,000 atmospheres, plans are eing made to extend this range to higher pressures o far as may be practicable, and some further teresting possibilities of the similarity method are nder investigation. Full details of this work will be ublished in a further paper. From the nature of e method it seems that it should be applicable over irtually any range over which pressure balances can be used, and in which two materials having the necessary properties are available. The main difficulty in the method resides in the construction of the highly accurate pistons and cylinders which are required. Once these are available, the experimental work in determining the variation of effective area is simple, quick and convenient.

We have so far dealt only with the variation in effective area with pressure, but at some point of the scale the effective area must be measured in absolute terms. This link is most easily made at a low pressure where distortion is known to be negligible. The present procedure at the National Physical Laboratory is to use two independent methods to obtain this measurement: (*a*) direct measurement by balancing at a low pressure against a mercury manometer; (*b*) by computing the effective area from the measured dimensions of the piston and cylinder.

These two methods of measurement have given agreement to within 2 parts in $10^5$; but it is thought that this accuracy can be somewhat improved.

I acknowledge the helpful co-operation of the Metrology Division of the Laboratory, which undertook the measurement and construction of the special piston–cylinder assemblies required, and of the Engineering Section of the Physics Division, which determined the elastic constants of the materials.

The work described was carried out as part of the research programme of the National Physical Laboratory, and this communication is published by permission of the Director of the Laboratory.

[May 19

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# THE COMMONWEALTH MYCOLOGICAL INSTITUTE

By Dr. S. P. WILTSHIRE

Director

THE opening of the new building of the Commonwealth Mycological Institute at Kew by H.R.H. the Duke of Edinburgh on July 13 was a notable event in the history of the Institute. Founded in 1921, the Institute first occupied two houses, 17–19 Kew Green, but in 1930 moved to a building in Ferry Lane, erected with the help of the Empire Marketing Board. That building rapidly proved inadequate and plans were prepared for an extension of it to be put before the Commonwealth Mycological Conference arranged for September 1939, but which had to be abandoned owing to the outbreak of war. Since 1939 the work of the Institute has increased enormously, and the Fourth Commonwealth Mycological Conference, held in 1948, recommended the immediate erection of a new building. The freehold site on which the new building stands became available and was purchased in 1950 through the prompt action of the chairman of the Executive Council. Detailed plans were put before the Commonwealth Agricultural Bureaux Review Conference in 1950 and approved; but the cost was to be borne on a separate vote. Administrative difficulties arose and the funds for the building were not sanctioned until 1953. Building operations started in May 1954, and were just completed in time for the opening. The lack of accommodation has been most seriously felt; but the new building now erected to the plans of Messrs. Waterhouse and Ripley affords adequate and most suitable quarters.

The need for additional space may be judged from the fact that the staff of the Institute now numbers thirty-seven and includes ten mycologists covering the editorial and identification services, including the culture collection, six abstractors, five of whom are linguists covering most of the languages in the literature of the subject, a herbarium recording staff of three, an indexer-librarian and five technical assistants, besides clerical staff. In addition, there is a pool of three plant pathologists attached to the Institute by arrangement with the Colonial Office, which provides the necessary finance. These plant pathologists undertake research into the cause and control of disease in the Colonial dependencies when required and may be moved to danger spots at short notice.

In his address, the Duke of Edinburgh stressed the importance of plant disease control in increasing and maintaining agricultural production. The spear-head of the attack on plant disease is, he emphasized, research, and the fight is seldom once and for all. New diseases or new variations of old diseases are always cropping up. Plant diseases could have disastrous effects not only on the economy but also on the social pattern of a country. The Institute has the important task of making it easier for research workers to follow what is going on elsewhere and to avoid duplication of effort. Much is heard, he said, of the invisible links of the Commonwealth, but this is one of the tangible ones. He was glad to find it possible for Commonwealth countries to co-operate in this particular field, and he hoped everyone who works at the Institute would find it a rewarding occupation.

The building is in the Georgian style to fit in with the surrounding architecture. The ground floor is devoted wholly to the library, apart from a small room for the Director. The literature of plant pathology and mycology increased enormously during the Second World War, and as one of the main functions of the Institute is to abstract this information for its journal, the *Review of Applied Mycology*, adequate library accommodation is absolutely vital for its work. The opening ceremony took place in this spacious room, which in due course is to be fitted with the requisite shelving and furniture. The room is well lit by fifteen windows, and tables are to be provided for fifteen readers. For several years the purchase of journals has had to be limited from lack of space, and the need for reprints of plant-pathological and mycological articles published in past as well as recent years, especially from foreign countries, is very great. The library of the Institute should be one of the best phytopathological and mycological libraries in the world, and the co-operation of all plant pathologists is earnestly sought in supplying or making available the necessary literature. The collection of 'separates', now numbering some sixty thousand pamphlets, is to be inco porated in the library.

Besides the *Review of Applied Mycology*, th Institute publishes distribution maps of plan diseases, the "Index of Fungi", listing all new specie of fungi described throughout the world, the *Revie of Medical and Veterinary Mycology*, surveying th world's literature on this subject, *Mycological Paper* recording the results of research in systemati mycology, and the quarterly *Commonwealth Phyt pathological News*. The Institute has also issue several books, the best known being the "Diction ary of Fungi", by G. C. Ainsworth and G. F Bisby.

The first floor of the new building accommodate the herbarium of the Institute, which now contain about 65,000 collections. The identification servic maintained for the benefit of Commonwealth plan pathologists and mycologists, is the other majc activity of the Institute. From the start, th Institute has recognized that investigations into th etiology of plant diseases can only be made by plan pathologists working in the countries where th diseases occur; and on the other hand, the identi fication of the pathogens can only be carried out b trained systematists working in a herbarium witl adequate literature and specimens available. Th identification of fungi is difficult work and require special qualities and prolonged training. Mr. E. W Mason, chief mycologist, has developed a herbarium technique which is both unique and valuable an has built up an enthusiastic staff for this arduou task. For years the staff employed in the work hav been greatly hampered by overcrowded conditions In the new building, the main herbarium runs th whole length of the building, with the exception of room for the chief mycologist. Rooms are also pro vided on the south side for herbarium records, drying room where specimens can be dried for th herbarium, a culture room, and a disinfestation room where all incoming material is disinfested from beetles and other insects with methyl bromide Fluorescent lighting enables the herbarium cases t be placed in rows, with a resultant great saving o space.

The top floor comprises four rooms for visitors with eight working benches, and two large rooms fo the culture collection, one a preparation room, an the main laboratory occupying the whole of the fa end of the building. The collection now comprise upwards of two thousand cultures and is constantl being added to. Adequate storage cabinets designe for the work, incubators, cupboards, desks an benches make the laboratory a well-equipped an pleasant room for culture work. Special cabinets fo making transfers have not been found necessary an are not incorporated in the new laboratory, with corresponding saving in cost.

The basement runs the whole length of the buildin and provides accommodation for photographic dark rooms, comprising two developing rooms, one studi and one microfilm room, storage room for pub lications, the boiler with space provided for a secon boiler should the building ever be extended, a work shop, and a room for electric and gas meters. Th building is constructed of reinforced concrete witl hot-water pipes embedded in the floors, thermo static control and automatic firing of the boiler, an provision for the mechanical delivery of the fue from suitably constructed lorries. The plans provid for an extension of the building to double its presen e should this be required, and the internal walls n readily be removed without damage to the ructure if a rearrangement of the rooms should ove desirable in the years to come.

The old building is being retained to house the lministration and editorial and abstracting staffs, id one room is set apart for the pool of plant thologists when they happen to be working in reat Britain.

# OBITUARY

## Dr. Bernard J. Flurscheim

DR. BERNARD J. FLURSCHEIM, who died recently t his home in Fleet, was in his eighty-first year. So asses the last of the great pre-electronic builders of e theory of organic chemistry.

After a school education on classical lines at Baden nd Bournemouth, Flurscheim made his first scientific udies in the University of Geneva; afterwards he orked with Werner in Zurich, and with Thiele in trassburg. He took his Ph.D. degree in Heidelberg 1901. In 1905 he set up his house in Fleet, in the arden of which he built the laboratory, where he orked, until other duties claimed him in the First Vorld War. For the periods 1905–7 and 1925–28 he orked in the Royal Institution in London.

In his main scientific work, the provision of rganic chemistry with a theoretical framework, lurscheim was natural successor to both Werner nd Thiele: he started from Werner's ideas of the ivisibility of chemical affinity when discussing its istribution on molecules, and it ranks as a major nd lasting discovery that his schemes of distribution ivolve a generalization of Thiele's theory of conigation, as is to-day so readily appreciated in elecronic terms.

Flurscheim's first paper of classical importance, ublished in the *Journal für praktische Chemie* in 1902, described the first rational explanation of orientation in aromatic substitution. In 1909–10 he published in the *Journal of the Chemical Society* two papers of like importance on the strengths of acids and bases. Here he was extending the application of his theory from the kinetic to the thermodynamic field, thereby showing that his valency redistributions apply not only to activated states but also to normal molecules. To-day, with the aid of the quantum theory, we re-express this, too, in electronic terms, and call the result mesomerism or resonance.

Flurscheim published many other papers of more limited importance. He never participated in the remoulding of his theories in conformity with the electronic theory of valency and quantum mechanics. However, the largely correct form of Flurscheim's theories made this task of recasting them a particularly easy one for others.

His discovery of tetranitroaniline, perhaps the most powerful of known explosives at the time of its discovery, was an accidental result of his work in the Fleet laboratory, directed as this was to the experimental control of his theoretical ideas. It was an accident that he sometimes regretted, inasmuch as it led him into commercial work, to which he was not well suited. However, it enabled him to render notable service during the First World War, when, on the request of the late Lord Moulton, he undertook supervision of the large-scale manufacture of this explosive in the United States. During the Second World War he worked as gas identification officer for the A.R.P. authorities.

Flurscheim did not make human contacts easily or treat them lightly. He was devoted to his family, and to a few firm friends. His chief personal hobbies were travel and climbing. In 1903 he visited New Zealand, where his father, Michael Flurscheim, lived, and there made acquaintance with the New Zealand Alps. He knew the Alps of Europe very well. He leaves a widow, a daughter and a son.

C. K. INGOLD

# NEWS and VIEWS

### hemistry at University College, London: Prof. D. P. Craig

A NEW chair of chemistry at University College, ondon, has been instituted, and Prof. D. P. Craig, f the University of Sydney, is to be its first occupant. Ie will take up the duties of the chair in 1956. Prof. raig took his first degree with first-class honours in hemistry in 1940 in the University of Sydney, where e remained as Commonwealth Research Fellow until 942. During 1942–44 he served with the rank of aptain in the Australian military forces. In 1946 he vas appointed lecturer in chemistry in the University f Sydney, and during 1946–50 he was Turner and Newall Fellow in the University of London, being ppointed lecturer in chemistry at University College, ondon, in 1950; since 1952 he has been professor f physical chemistry in the University of Sydney. Prof. Craig's research career is that of an experimental physical chemist with deep knowledge of, nd interest in, the theory of chemistry. He has ublished work on co-ordination compounds with articular reference to the nature of metal-ligand onds, on aromatic character and the conditions or its appearance, on the excited states of unsaturated and aromatic molecules, on the excited states of crystals, and on the relation between molecular and crystal states. He has also contributed to the methodology of quantum mechanics by introducing configuration interaction into molecular orbital theory, and clarifying the role of polar structures in valency-bond theory. The addition of so accomplished a theoretician to the Chemistry Department of University College, where co-ordination chemistry, molecular spectroscopy and crystal chemistry are all intensively studied, seems particularly appropriate.

### Sir William Hamilton (1805–65)

ONE of the most brilliant mathematicians of modern times, William Rowan Hamilton was born in Dublin one hundred and fifty years ago, at midnight between August 3 and 4, 1805, of a Scottish family that had settled in Ireland. He was a precocious child, being able to read Hebrew at the age of seven; at twelve he had mastered Latin, Greek and the leading Continental languages, and had acquired some knowledge of Syriac, Persian, Arabic, Sanskrit, Hindustani and Malay. Quite early he showed his genius for mathematics, and in his seventeenth year detected an error of reasoning in Laplace's "Mécanique céleste". At Trinity College, Dublin, he was first in all his examinations and, while still an undergraduate, he predicted in 1833 by the aid of mathematics the internal conical refraction of light, which was verified experimentally in the same year by H. Lloyd. Hamilton was then appointed John Brinkley's successor in the chair of astronomy; he later became Astronomer Royal for Ireland. From 1843 onwards Hamilton devoted his life to the elaboration of his theory of quaternions, which was announced in "Lectures on Quaternions" (1853) and posthumously in "Elements of Quaternions" (1866). As a writer he was sometimes obscure and metaphysical, but he excelled as a fluent and ornate lecturer. He was knighted in 1835, was elected president of the Royal Irish Academy in 1837, and died on September 2, 1865, at the age of sixty, worn out physically and mentally.

## Shortage of Scientific Workers and Teachers in Great Britain

IN a debate in the House of Lords on July 5 on exemption from National Service, Lord Cherwell pressed again for the exemption of highly trained scientific workers, especially those engaged in high-grade research in the universities. Lord Cherwell suggested that there was great lack of balance in limiting deferment to fifty such scientists in a year when eight thousand agricultural workers are deferred each year; but Lord Carrington, replying for the Government as Parliamentary Secretary to the Ministry of Defence, stated that the Government has not yet received fifty applications from the universities for deferment under this scheme, and thought that it is much too early to judge how well this scheme, introduced earlier this year, is working. Lord Carrington also referred to a scheme, introduced since 1949, under which science and engineering graduates have been deferred for employment on a limited number of research and development projects mostly connected with the defence programme; and he emphasized the need of the Armed Services for technical graduates, particularly for younger workers with degrees in engineering, physics and mathematics. It has been estimated that in 1955 the Services will recruit less than half their requirements, and graduates in science are also badly needed by the education branches of all three Services for teaching in technical training colleges.

The debate was thus related to an adjournment debate in the House of Commons later in the week on the shortage of science teachers—a matter to which Lord Cherwell also referred, as did Lord Hull and Lord Glyn, whose purpose in tabling the motion was to emphasize the importance of giving technical and technological education and research a very high place in the affairs of the country. In raising this question in the Commons on July 8 and asking the Government what steps it proposes to take to meet the shortage, Dr. Horace King supported the exemption of science teachers from national service, or at least the exemption of those who had completed their initial or basic training, and Mr. E. C. Willis pointed out that the Appleton Committee had recommended the exemption of teachers with first- or second-class honours in mathematics, physics or chemistry, as being the only sure means of getting more teachers quickly. In replying for the Government, Mr. Dennis Vosper, Parliamentary Secretary to the Ministry of Education, declined to discuss th question of deferment; he pointed out that th teaching profession itself is divided on the question that deferment would make a comparatively smal contribution to the removal of the shortage, and tha it would involve a breach in the principle of universality. He did not think that too much importanc should be attached to the proposal in trying to solv the larger problem. Mr. Vosper said that the presen shortage of science teachers is less than expected recruitment having exceeded the forecast; durin the period March 1952–March 1954, the number o graduate science and mathematics teachers in maintained primary and secondary schools in Englan and Wales increased from 11,022 to 11,615. Th main difficulty is in quality, and the real gravity o the problem was in the anticipated increase of 650,00 in the number of senior pupils by 1960 compare with 1954, with the consequent demand for a furthe 3,200 graduate science teachers. Mr. Vosper referre to the possibility of making conditions of servic more attractive for teachers of science and mathematics, and said that the Minister hopes shortly t advise local education authorities as to the possibilit of paid leave to teachers to take part in research but he thought that the real solution to the shortag lies in a change in the public esteem of the teachin profession and an increasing public awareness of th needs of science.

## Personnel Research in the Royal Navy

THE record during the Second World War of th Royal Navy's concern with the safety and efficiency of its personnel can be found in the volume o medical research in the "Official Medical History o the War" (1953). In the post-war period the alliance between the Navy and the Medical Research Council in this field of research has continued vigorously and fruitfully. An up-to-date survey of naval personnel research (Admiralty Bulletin 67, pp. 12; Department of Chief of Naval Information, Admiralty, London, S.W.1; 1955) has now been written by Surgeon-Commander Crosfill, the present secretary to the Royal Naval Personnel Research Committee. The survey is a record of progress both in occupational hygiene and that branch of operational research for which the name ergonomics has been coined and which is concerned with the efficiency of the operator in his working environment. Commander Crosfill gives an informative and readable account of the important work sponsored by the various sub-committees of the main Committee. It is quite clear that the *ad hoc* work has nearly always been based on, and been a fruitful source of, much fundamental investigation. This is evident, on the psychological side, in studies of multi-channel communication, of various kinds of pressure and velocity control systems, and the effects of noise, all of which raise fundamental questions of vigilance, perception, proprioceptive 'feed-back' and skill. On the physiological side, studies of working efficiency in abnormal climates have yielded a great deal of basic data on human heat regulation, acclimatization and limits of heat tolerance and have led to improvements in the design of climatological 'indices' and the introduction of the ionization anemometer. Perhaps the most spectacular of the investigations is that sponsored by the underwater physiology sub-committee in connexion with the problem of submarine escape. This work has led to the development of the technique of escape by 'free ascent', and has made a breathing set unnecessary. Other interesting topics in the report are concerned with survival at sea, nutrition in the arctics and the tropics, anatomical problems of seating and sighting, and the use of standardized photographs for the anthropometry of naval personnel.

## Hydraulics Research Station, Wallingford : Report for 1954

THE report of the Hydraulics Research Board for 1954, with which is published the report of the Director of Hydraulics Research (pp. 52+11 plates. H.M.S.O., London, 1955; 5s. net), summarizes the work on loose-boundary hydraulics done at the Hydraulics Research Station, Wallingford, Berks. The greater part of it is concerned with ten model investigations and field studies of estuaries, river improvement schemes, and dock and harbour modifications, carried out at the request of various official bodies. Of fundamental work of more general application, there is at present comparatively little; but comments at various points in the report suggest that experience gained from these miscellaneous investigations is gradually indicating the directions in which more general research should be pursued. Topics in which work has already begun include the use of radioactive tracers for indicating the movements of silt or mud, the determination of the effect of wind on wave propagation, and a study of the factors affecting cyclic channel movements in an estuary and the development of meanders. The report generally is of the high standard of presentation and lucidity that one expects from a technical publication of the Department of Scientific and Industrial Research; but a more distinctive grouping of the various topics covered in it would make for an easier appreciation of the range of interests and activities of the Research Station.

## Measurement of Pressure with the Mercury Barometer

No. 9 in the series "Notes on Applied Science", of the National Physical Laboratory, Teddington, is entitled "Measurement of Pressure with the Mercury Barometer" (pp. 15+1 plate. London: H.M.S.O., 1955; 1s. net). Reference is made to the new rationalized system of barometer conventions which came into operation on January 1 (see *Nature*, 174, 1127 (1954), and British Standard 2520); but the main purpose of the pamphlet is to assist those workers in industry and in research laboratories who are concerned with the measurement of gas pressures by means of a mercury column. Pressures in the range 0–1,200 millibars are dealt with, and the accuracy considered is of the order of ± 0·1 millibar. The fundamentals of pressure measurement are briefly outlined, and then the two main categories of barometers, the Fortin and Kew types, are described, together with the factors which should be considered in choosing a barometer for a particular application. Valuable advice as to the proper methods of transport, storage and installation of barometers is given, and the observational procedure to be adopted and the various corrections to be applied to the readings taken are discussed and illustrated by a particular numerical example. Finally, a short description is given of the testing procedure followed at the National Physical Laboratory. This includes an illustration of the Laboratory's primary standard barometer, which is nearing completion.

## A Mobile Bone Meal Factory in Africa

THE deterioration of African livestock shown by lack of productivity, poor calves and lack of resistance to parasitic infestation is in large measure due to insufficient phosphorus in the diet. No matter how excellent the animal husbandry practices may be, that is, rotational grazing, manuring and water supply, full response cannot be expected without making good the deficiencies of calcium and phosphorus. Phosphorus deficiency is a fundamental environmental factor which cannot be remedied otherwise than by supplementation of phosphorus. A mineral survey of Kenya soil, pasture and beasts has shown that in most cases there is a phosphorus deficiency. This deficiency may be made good, either in part or completely, by using mobile bone meal factories as envisaged by Dr. I. Mann (*Colonial Plant and Animal Products*, 4, No. 4). These will make available on the spot substantial quantities of cheap phosphorus in the form of sterilized bone meal. The low capital expenditure necessary is entirely out of proportion to the benefits accruing to man and beast. Bones become a new and valuable cash crop, while the product offers the African the opportunity of improving his primitive husbandry and of rearing healthy and more productive livestock.

## Factors in Clover Nodulation

THE effect of certain adsorbents on the nodulation of clover plants has been investigated by E. R. Turner (*Ann. Bot.*, N.S., 19, 147; 1955). He has found that the addition of charcoal to the rooting medium of clover plants, inoculated with effective and ineffective strains of *Rhizobium*, leads to a stimulation in nodule production. The time-interval between inoculation and the first appearance of the nodules is reduced in the presence of charcoal. The author concludes that this stimulation is due to the adsorption by the charcoal of inhibitory compounds secreted by the clover roots. These compounds have, in fact, been eluted from the charcoal and have been shown to affect nodule production. It is suggested that, according to the concentration of the secretions in the eluates, either a stimulation or an inhibition of nodule formation may occur.

## Biochemical Synthesis and Isotopic Tracer Technique

A GOOD many monographs have appeared in recent years on the use of isotopes as tracers to find how the body builds up complex materials from the breakdown products of the food. Dr. G. Popják, in a recently published lecture entitled "Chemistry, Biochemistry and Isotopic Tracer Technique" (Lectures, Monographs and Reports of the Royal Institute of Chemistry, London: No. 2, 1955; pp. 59), discusses the way in which the techniques of organic chemistry and of enzymology have been linked with the tracer technique in such work. Instead of trying to cover the whole field, Dr. Popják deals mainly with certain major topics—namely, fatty acids, cholesterol and the porphyrins—and discusses them in sufficient detail to show the interdependence of the three methods of approach in throwing light on the problems of biochemical synthesis. He underlines the need for continued close collaboration between the organic chemist and the biochemist in work of this type.

## Museum Uses of 'Perspex'

IN the May number of the *Museums Journal*, Mr. R. A. Kennedy details two further uses for 'Perspex' in museum work. When this substance is used as a protective covering for labels, it is found that in course of time dust accumulates between the card and the 'Perspex', and periodical removal and cleaning are a time-wasting process of little permanent value. A more satisfactory result is obtained by using 'Perspex' liquid cement containing chloroform to seal the label, and Mr. Kennedy gives practical details for doing this. The second use is for the reproduction of flint tools. It was found that 'Perspex' flakes in a similar fashion to flint when kept cold or, even better, when chilled. It is thus only necessary to use 'Perspex' of the correct colour, and by a combination of cutting out, filing, flaking and scraping an excellent imitation of a flint implement can be obtained.

## Technical Hardness Measurement: International Conference in Bremen

An international conference on "Hardness Measurement in the Works" will be held in Bremen during September 22–23, in connexion with an exhibition there of modern hardness-measuring equipment of German and foreign manufacture. It is the second to be held in Bremen and is being arranged by the Arbeitsgemeinschaft fur Fertigungstechnisches Messwesen (Working Committee for Metrology in Production) and the Institut für Härteprüftechnik (Institute for Hardness-testing Technology). At the conference, representatives from Austria, France, Germany, Great Britain, Japan and the United States will discuss actual problems of hardness measurement according to Rockwell, low-load and micro-hardness measurements after Vickers, hardness measurement on internal surfaces, as well as the possibilities and advantages of using technical statistics in the field of hardness testing. It is hoped to contribute to the establishment of internationally comparable hardness values, which are of much importance for technical products. Further details regarding the conference can be obtained from AFM, Verein Deutscher Ingenieure, Prinz Georg Strasse, Düsseldorf, Germany.

## Association of Universities of the British Commonwealth

A Commonwealth Inter-University Conference will be held in Melbourne, Australia, during August 9–12, comprising the members of the Executive Council of the Association of Universities of the British Commonwealth, which holds an overseas meeting in the years between its quinquennial congresses. Similar meetings have recently been held in Canada (1949 and 1954), New Zealand (1950) and India (1951–52), but this is the first to be held in Australia. These conferences, which have been supported very generously by the Nuffield Foundation, provide the opportunity for discussion of matters of academic policy and Commonwealth inter-university relationships. The present meeting is to be presided over by Mr. A. P. Rowe, vice-chancellor of the University of Adelaide, and chairman this year of the Association of Universities of the British Commonwealth, and each Commonwealth country will be represented by one or more university executive heads, the United Kingdom party comprising Dr. R. S. Aitken (Birmingham), the Right Hon. H. U. Willink (Cambridge), Dr. D. W. Logan (London) and Mr. C. H. Wilson (University College, Leicester). The secretary of the conference is Dr. J. F. Foster, secretary of the Association of Universities of the British Commonwealth. The conference members while in Australia will visit other universities ther and will attend the inauguration ceremonies of th new University of New England at Armidale, Nev South Wales, on August 4.

## University of London

The title of professor emeritus in the Universit of London has been conferred on the following Prof. J. H. Dible, on his retirement from the chai of pathology at the Postgraduate Medical School o London; Prof. Herbert Dingle, on his retiremen from the chair of history and philosophy of scienc at University College; Prof. V. C. Illing, on hı retirement from the professorship of geology (o technology) at the Imperial College of Science an Technology; Prof. H. H. Read, on his retiremen from the chair of geology at the Imperial College o Science and Technology.

The title of reader in botany in the University o London has been conferred on Sir Nigel Ball, Bart. in respect of his post at King's College, and that o professor of physics in the University of London o Dr. W. C. Price, in respect of his post at King' College.

The following appointments in the Universit have been announced: Prof. J. Duchesne, directo of the spectroscopic radio-electric laboratory i the University of Liège, to the visiting professorship of Belgian studies in the University of Londo for a period during the second and third terms of th session 1955–56; Dr. Geoffrey Wilkinson, assistan professor of chemistry at Harvard University, to th University chair of inorganic chemistry tenable a the Imperial College of Science and Technology Dr. W. G. Overend, lecturer in chemistry in th University of Birmingham, to the University readership in organic chemistry tenable at Birkbeck College Dr. W. S. Pitcher, lecturer at the Imperial Colleg of Science and Technology, to the University readership in geology tenable at King's College.

## University of Leeds

The following appointments in the University o Leeds have been announced: Mr. D. C. Johnson, to be professor of mechanical engineering from January 1, 1956; Dr. D. Bradley, to be lecturer in mechanical engineering; Dr. D. A. Jones, to be lecturer in electrical engineering; Mr. S. C. Mitchell, to be lecturer in fuel technology; Dr. J. H. Robertson, Brotherton lecturer in the Department of Inorganic and Structural Chemistry, to be lecturer in the Department of Inorganic and Structural Chemistry; Mr. T. Wilson, to be lecturer in electrical engineering.

The University has acknowledged the following gifts, among others: £300 from the Yorkshire Agricultural Society, for the Department of Agriculture; £700 from Messrs. Joseph Booth and Brothers, Rodley, for the Department of Civil Engineering, to maintain a student for two years to undertake research work on the dynamic stresses induced in cranes; £3,000 for 1954–55 from the North-Eastern Division of the National Coal Board, for the Department of Mining; £940 from the Royal Society, for the Department of Physics, for research carried out by Dr. R. S. Tebble on the magnetic properties of metals and alloys at high temperatures.

## Salters' Institute of Industrial Chemistry: Awards

The Salters' Company has elected M. J. Stephen to be a Salters' Fellow for the year 1955–56. Mr. Stephen, who is a graduate of the University of the

Witwatersrand, Johannesburg, obtained an M.Sc. degree in 1953 and is at present studying for the degree of D.Phil. under Sir Cyril Hinshelwood at Oxford. During the coming year he will carry out research under Prof. C. A. Coulson, at Oxford, on the mechanisms and rates of reactions. The Salters' Company has offered a scholarship to a student from Canada, and, on the recommendation of the National Research Council for Canada, C. G. Miller, of Queen's University, Ontario, has been appointed; Mr. Miller will carry out research during the year of tenure of his scholarship under Mr. R. P. Bell, of the University of Oxford. The Court of the Company has also elected the following to be Salters' Scholars for the year 1955–56: M. McLeman (Imperial College, London); W. L. Wilkinson (Cambridge); D. Charlesworth (Hull); P. L. Levine (Imperial College, London); D. M. McMahon (Queen's University, Belfast); W. Kemp (Glasgow); B. B. Hunt (Cambridge).

## Colonial Service: Recent Appointments

The following appointments have been made recently in the Colonial Service: J. H. Gisborne (principal agricultural officer, Northern Region, Nigeria), assistant director of agriculture (research), Northern Region, Nigeria; T. N. Greeves (deputy director of agriculture, Sierra Leone), director of agriculture, Sierra Leone; T. S. Jones (senior agricultural officer, Sierra Leone), deputy director of agriculture, Sierra Leone; M. A. Blane and F. A. Leeds (senior agricultural officers, Gold Coast), assistant directors of agriculture, Gold Coast; C. R. Dickson, J. T. W. Gray, R. Mulholland, J. H. N. Pitman, W. Smith and T. M. Wiszniewski (agricultural officers, Gold Coast), senior agricultural officers, Gold Coast; P. Peterson (meteorological officer, Singapore), scientific officer, Royal Observatory, Hong Kong; W. G. G. Forsyth (principal scientific officer, Colonial Microbiological Institute, Trinidad), director of the Colonial Microbiological Institute, Trinidad; C. Turner, agricultural officer, Kenya; K. A. Exelby, chemist, Government Chemist Department, Tanganyika; D. McKie, mineralogical chemist, Tanganyika; R. N. Cope, geologist, Federation of Nigeria; J. R. Baker, scientific officer (protozoologist), East African Tsetse and Trypanosomiasis Research and Reclamation Organization; W. N. Beesley, scientific officer (parasitologist), Helminthiasis Research Unit, Kumba; P. E. S. Whalley, entomologist, Uganda; P. J. S. Anderson, veterinary officer, Tanganyika; A. T. Carey, assistant adviser on aborigines, Federation of Malaya.

## The Night Sky in August

Full moon occurs on Aug. 3d. 19h. 30m., U.T., and new moon on Aug. 17d. 19h. 58m. The following conjunctions with the moon take place: Aug. 19d. 0h., Mercury 7° N.; Aug. 24d. 04h., Saturn 5° N. Mercury is too close to the sun for observation during August. Venus, which rises about forty-five minutes before sunrise up to the middle of the month, rises almost at the same time as the sun at the end of the month, and is unfavourably placed for observation during August. Mars, in conjunction on August 17, cannot be observed during the month. Jupiter, in conjunction on August 4, is visible towards the end of the month when it rises about two hours before the sun, and can be seen in the constellation Cancer, in which it has an eastward movement. Saturn sets at 23h., 22h. and 21h. on August 1, 15 and 31, respectively; its eastward movement can be detected by comparing its positions at various times with the second-magnitude star α Librae from which it is receding. Its stellar magnitude varies from 0·7 to 0·8, the diminution in brightness being due to the increase in its distance from the earth by forty-five million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Aug. 6d. 01h. 18·4m., κ Aqr. (*R*); Aug. 7d. 01h. 56·8m., κ Psc. (*R*); Aug. 12d. 03h. 18·9m., *A* Tau. (*D*); Aug. 29d. 22h. 32 4m., 57 Sgr. (*D*). *D* and *R* refer to disappearance and reappearance, respectively. The Perseid meteors attain a maximum about August 10–13; moonlight will interfere to some extent with observations during that period.

## Announcements

Dr. A. Neuberger is resigning from the chairmanship of the Editorial Board of the *Biochemical Journal* on October 1, and will be succeeded by Dr. A. G. Ogston. The editorial office of the *Journal* will be transferred from the National Institute of Medical Research at Mill Hill to the Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W.1, as from September 1. Communications should be addressed from that date to Mr. F. Clark, secretary to the Editorial Board, *Biochemical Journal*, at the Lister Institute.

A symposium on "Cavitation in Hydrodynamics" will be held at the National Physical Laboratory, Teddington, Middlesex, during September 14–17. Attendance will be by invitation, and those interested are asked to communicate with the Director of the Laboratory.

The Universities Federation for Animal Welfare is holding its summer school this year at Westham House, Barford, Warwick, during September 24–October 1. There will be expeditions to a dairy farm, Dudley Zoo and a slaughterhouse, and lectures by experts on the following topics: animal behaviour, animals in zoos and circuses, slaughtering methods, animals in research, dairy husbandry and whaling. The fee for the school is five guineas (three guineas for students). Further information can be obtained from the Branch Organizer, UFAW, 7*a* Lamb's Conduit Passage, London, W.C.1.

The July–September 1953 number of the "Bibliography of Articles appearing in Turkish Periodicals", issued recently by the Turkish National Institute of Bibliography, Istanbul (pp. 116. Istanbul: Maarif Basimevi), contains a further seven hundred entries given, as previously, in French and Turkish and arranged under the first two figures in the Decimal Classification. Entries are limited to title, author and reference. There are an author index and a list of periodicals covered.

A report of the proceedings of the 1954 Conference of the Universities of Great Britain and Northern Ireland, held in London during December 17–18, 1954, is now conveniently available in pamphlet form (pp. 110. London: Association of Universities of the British Commonwealth; 1955; 2*s*. 6*d*.). It includes the text of the speeches of Dr. E. J. F. James and Prof. R. E. Peierls at the important discussion on the supply of teachers for mathematics and science, those of Mr. J. F. Wolfenden and Prof. H. S. W. Massey at that on whether undergraduate courses of study are overloaded, and of H. R. F. Harrod and Prof. J. F. Baker in opening the discussion on the retiring age for university teachers.

# BRITISH FOOD MANUFACTURING INDUSTRIES RESEARCH ASSOCIATION

## OPEN DAY

THE fine modern laboratories of the British Food Manufacturing Industries Research Association at Leatherhead, Surrey, were occupied in the latter part of 1950, and the opening ceremony performed in November of the following year was then made the occasion of an open day[1]. On June 21 last the laboratories were once again thrown open to representatives of member firms, while representatives of other research organizations, of the scientific, technical, trade and national Press, and others were present by invitation. Some three or four hundred visitors saw exhibits illustrating the course of research during the past four years and the main aspects of the current research programme.

The interests of the Research Association cover a wide range of manufactured foods, with the exception of flour-milling, bread and bakery products, dairy products, and fruit and vegetable canning, all of which are the concern of separate research organizations. The research programme may be divided into three main categories: analytical problems in the routine control of quality; problems directly concerned with particular aspects of food manufacture; and more general investigations into fundamental principles with a bearing on the quality of the manufactured foods concerned. Some aspects of the work having wider scientific interest are outlined below.

The rheological properties of certain foods, including such diverse products as toffee, margarine, chocolate (in its fluid state), and starch, gelatine, agar and pectin jellies, have received considerable attention. A number of experimental pieces of apparatus were displayed, each designed to measure the force required to deform, or cause flow in, margarine and its allied product, compound cooking fat. One of these in particular, the 'extrusion plastometer', shows much promise in relating plasticity and 'spreadability' to readings taken on the instrument. Chocolate is processed during manufacture in a liquid state, and measurement of its rheological properties is of great importance in the chocolate industry. It has been shown to behave as a Bingham material, and measurement of its 'viscosity' raises considerable difficulty in factory practice. A number of commercial and experimental instruments which have shown promise of proving useful in factory control were exhibited. Investigations into the pasting of starch have been carried out by means of the corn industries viscometer. The measurement of the properties of jellies of various types is of interest in a number of foodstuffs. The Research Association has recently contributed largely to the design of the F.I.R.A. jelly tester, which incorporates several refinements, particularly in respect of design of the spade and reduction of friction, in comparison with the older B.A.R. tester. Recent work on the gelling properties of agar has shown how the instrument may be used for characterizing jellies and obtaining information beyond the measurement of pure 'jelly strength'.

The Research Association is studying the plastic composition and crystallization behaviour of cocoa butter and other fats through determinations of the specific heats and heat contents over a wide range of temperatures. From the measurements obtained, the percentage of liquid phase at a given temperatur may be calculated. An adiabatic calorimeter ha been constructed for the purpose of these studies, description of which will shortly be published elsewhere by Mr. E. H. Steiner. The procedure followe is intermediate between that described by A. E Bailey *et al.*[2] and that of J. Straub and R. N. M. A Malotaux as adapted by S. V. Vaeck[3]. The investigation is important in the study of the tempering o chocolate and the use of alternative fats in certai types of confectionery. The control of particle siz is of importance in many food products, such as icin sugar, cocoa powder, chocolate and starch. Amon the exhibits were a commercial vortex sieve for coco powder, a modified Andreasen sedimentation apparatus for chocolate and a Lea and Nurse air-permeability apparatus for the determination of specifi surface of several materials.

In the field of biochemistry, a study of the natur of the changes undergone by meat products, particularly colour changes in sausages, ham and othe cured meats, is being made from a fundamental poin of view; a note on one aspect of this work wa recently published by J. I. Anderton and D. J Locke[4]. The separation and study of vitamin A an related substances in liver oils is being undertaken by the use of a 'short-path' molecular still, chromatographic methods and the use of the quartz spectrophotometer. Fruits for jam-making and brine vegetables for the manufacture of pickles are both subject to undesirable tissue breakdown under certain conditions. The part played by pectolytic enzyme of the fruits and vegetables and those produced by moulds naturally present on fresh fruit and vegetable is being investigated in this respect. The Research Association maintains an extensive microbiologica laboratory for the study of both the desirable organisms that are necessary to such processes as the curin of bacon and the preparation of pickles, and th spoilage organisms which are a source of trouble i canned meat and fish products, and in pickles an sauces. Investigations of the thermal death-rat characteristics of mould spores which may caus spoilage in jam and of the bacteria and yeast responsible for spoilage in pickles are being carrie out.

On the technological level, the Research Association maintains pilot plant for studying the rate o heat penetration into canned goods under commercial conditions, and a laboratory-sized apparatu for carrying out pasteurization tests on jars o pickled onions has recently been designed an constructed. The packaging of manufactured food is an integral part of the interests of the Researc Association. While it does not concern itself wit the study of the properties of the various wrappin and packaging materials, it is concerned with th choice of material best suited to particular products In this connexion, a number of studies are undertaken, such as measurement of the vapour pressur of confectionery products, the protection of meta closures on glass packages from any corrosive effect due to the nature of the product packed in them or conversely, discoloration of the product in contac with the closure, and the effects of transparency an air-permeability of wrappers for margarine. The permeability of rubber sealing rings to gases and volatile substances is a cause of deterioration in meat and fish pastes, and the most desirable formulation for such rubber rings is being sought in collaboration with the manufacturers.

See *Nature*, 168, 1108 (1951).
*Oil and Soap*, 21, 293 (1944).
*Int. Choc. Rev.*, 6, 350 (1951).
*Nature*, 175, 818 (1955).

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# RADIATION CHEMISTRY OF SOLUTIONS

THE fifth annual meeting of the Société de Chimie Physique was held in Paris during May 31–June 3, the subject of the meeting being the chemical effects of ionizing radiation. It was organized by Prof. G. Emschwiller and was attended by chemists and physicists from Europe, the United States and the U.S.S.R.

Radiation chemistry is complicated by the fact that the primary events are confined to the tracks of the ionizing particles. It was pointed out that in aqueous solutions the yield varies with radiation quality, the principal change occurring in the range 3·5–25 keV./μ mean linear energy transfer of the radiation. On the assumption that only those parts of the ionizing tracks where the linear energy transfer is greater than 25 keV./μ are effective, and taking δ-rays into account, a curve for the efficiency of different radiations has been calculated which is in good agreement with the experimental data for the molecular hydrogen yield (L. H. Gray). A tentative mathematical picture was given of the kinetics of radicals formed in a track (J. L. Magee). With increasing intensity, the tracks overlap and the kinetics of homogeneous solutions apply. This change was demonstrated using diphenylpicryl hydrazine in chloroform (A. Chapiro). There is a possibility that excited water molecules play a part in the indirect effects in dilute solutions (J. Weiss). However, the strict proportionality of fluorescence and sodium salicylate concentration in an aqueous solution exposed to α-radiation suggests the absence of indirect excitation of the solute (N. Miller).

The most useful system for the chemical measurement of dose is still a solution of 0·001 *M* ferrous ions in 0·1 *M* sulphuric acid. Several recent determinations for X-rays and β-rays have all favoured a value close to $G_{Fe^{+++}} = 15·5$ molecules per 100 eV. (N. Miller; A. J. Swallow; M. Cottin). An accurate determination has been carried out with 2 MeV. electrons and gives $G_{Fe^{+++}} = 15·45 \pm 0·11$ (R. H. Schuler and A. O. Allen, reported by N. Miller). The kinetics for the oxidation of $10^{-3}$ *M* ferrous ions in 0·1 *M* sulphuric acid are fairly well understood, but are totally inadequate to explain the high yield $G_{Fe^{+++}} = 63$ obtained in aerated solutions of $3 \times 10^{-3}$ *M* ferrous ions in 4 *M* sulphuric acid (Proskurnin, quoted by S. S. Medvedev). The sensitivity of yield to the presence of impurities was demonstrated with the $Fe^{++}$ system (N. Miller; C. Vermeil). For the measurement of exceptionally high doses, oxalic acid was recommended (I. Draganic). The measurement of dose by the ionization method depends upon the energy *W* required to form one ion-pair in air. Recent measurements with polonium α-rays give values close to *W* = 35·5 eV., in agreement with older data. New results for fast electrons obtained from a comparison of absolute counting-rates and ionization measurements of sodium-24, cobalt-60, gold-198, iodine-131 and phosphorus-32 lead to a value of *W* = 34 ± 1 eV. in air, differing slightly from *W* = 32·5 eV., the value widely used in radiological work (W. Emery, reported by L. H. Gray).

It was generally agreed that the initial products in the radiolysis of water are the free hydrogen and hydroxyl radicals and the molecular products hydrogen and hydrogen peroxide. The mechanism giving rise to the formation of the molecular products is not understood, but evidently it occurs in those parts of the tracks where the linear energy transfer is very high. The yields of molecular hydrogen are less affected than the yields of hydrogen peroxide by the presence of various solutes (M. Lefort and M. Cottin). New light was thrown on these processes by studies of radiation-induced polymerization and of the production of hydrogen peroxide in gas-free aqueous solutions of acrylonitrile. Both the monomer and polymer are inert to hydrogen peroxide, but readily combine with hydrogen and hydroxyl radicals. The yield of hydrogen peroxide varies with monomer concentration. It is at a maximum at $10^{-3}$ *M* and drops by a factor of 6 at the highest monomer concentration used, 0·5 *M*, when the monomer reacts with precursors of hydrogen peroxide even in the densest parts of the tracks (E. Collinson, F. S. Dainton and G. F. McNaughton). No similar demonstration of precursors of molecular hydrogen has yet been made. It might be formed directly from one water molecule, but the dependence of the yield on the linear energy transfer suggests a recombination process (M. Haïssinsky; G. Stein; M. Magat). Oxygen-18 has been used in a study of the production and decomposition of hydrogen peroxide by radiation (E. J. Hart, S. Gordon and D. A. Hutchinson).

Some of the aqueous solutions investigated are of biochemical interest. Irradiation of phosphoric acid esters of the homologous series of methyl to amyl alcohols shows that the larger molecules are more stable. The main products of decomposition are inorganic phosphate, acyl phosphate, aldehyde and hydrogen peroxide. All solutions show an after-effect if irradiated in the presence of oxygen. Analogous results with solutions of mononucleotides were reported (R. W. Wilkinson and T. F. Williams; G. Scholes; M. Daniels). Radiation effects on catalase in dilute aqueous solution show that quantitative results depend to a very large extent on the purity of the enzyme preparation. The enzyme is inactivated by hydroxyl radicals and not by hydrogen radicals as has been previously assumed (W. M. Dale and C. Russell; P. Bonet-Maury and F. Patti; H. C. Sutton, quoted by L. H. Gray). In contrast, reduction processes occur in solutions of methylene blue, coenzyme I and diphosphopyridine nucleotide (G. Stein; A. J. Swallow).

Irradiation of aqueous solutions of polyvinylpyrrolidine and other water-soluble polymers leads to degradation if the concentration is less than 0·3 per cent, and to cross-linking if more than 1 per cent (A. Charlesby and P. A. Alexander). The mechanism of cross-linking, however, is not yet understood (A. Henglein; Y. Landler). Irradiation of air-free solutions of methacrylic acid leads to polymerization which continues after the end of the exposure. The resulting polymer, dried and exposed to air for several hours, can still initiate polymerization in new unirradiated monomer solutions (M. Fox and P. A.

Alexander). Similarly, irradiated dry polymers can initiate polymerization in their own or different monomer solutions, even months after the exposure, thereby forming so-called graft polymers. These show a mixture of the physical properties of the parent substances (A. Chapiro; M. Magat). The reactions of diphenylpicryl hydrazine have been studied in great detail, showing that substitution occurs in the *p*-position of the phenyl groups (A. Henglein; W. Wild). Irradiated solutions of diphenylpicryl hydrazine show an after-effect lasting for several weeks. Some discrepancies between the experiments with this substance in Britain, France and Germany seem to have been due to differences in analytical procedures and conditions of irradiation (W. Wild; A. Chapiro; A. Henglein). The loss of colour of diphenylpicryl hydrazine, irradiated in mixtures of organic solvents, does not follow a simple additive law, indicating energy transfer from one solvent molecule to the other (A. Chapiro; S. S. Medvedev). Similar evidence of a non-additive effect has been observed in the luminescence of *p*-terphenyl induced by γ-irradiation in mixtures of benzene and *cyclo*hexane (M. Burton, P. J. Berry and S. Lipsky). The use of radiation as an energy source in preparatory organic chemistry was demonstrated in halogenation reactions of aromatic compounds and in the synthesis of methylene blue and other organic substances (D. E. Harmer, J. J. Martin and L. Anderson; J. Loiseleur).

Many of those who attended both this meeting and the Faraday Society Discussion on radiation chemistry in Leeds in 1952 felt that in Paris there was less controversy about possible radical intermediates, most of the new results falling into line with accepted schemes of radical formation and reaction. Even the concept of the 'molecular yield' which has had considerable prominence showed signs of giving way to interpretation in terms of these schemes.

M. Ebert
P. Howard-Flanders

# POLAROGRAPHIC INSTRUMENTATION

## FIRST SYMPOSIUM OF THE POLAROGRAPHIC SOCIETY

By invitation of Prof. F. S. Dainton, the first symposium of the Polarographic Society was held in the Chemistry Department of the University of Leeds on May 25. In its emphasis on the design of polarographic instruments, this meeting is believed to have been the first of its kind to be held in Great Britain. After Prof. Dainton had extended a welcome to the Society, the chairman mentioned the steps leading to its recent formation and briefly outlined its objects.

In most cases, those reading papers explained the essential principles of the circuits employed in their instruments. C. Wontner described a simple manual polarograph and demonstrated its use in obtaining current/voltage curves. These can be plotted with surprising speed because of the semi-automatic location of the voltage scale in a series of 10-mV. steps. By virtue of a magic-eye null-point detector, the manual polarograph described by G. O. Jolliffe measures the true maximum current and so eliminates assumptions about the detector's equation of motion. This instrument is also of interest to the polaro graphic research worker in that it contains facilitie for measuring both current and voltage potentio metrically.

A pen-recording polarograph, which possesses photovoltaic amplifier of very short time-constan was described by E. A. Wood and Mrs. B. Lamb The design of an associated condenser/resistanc differentiating unit for use in derivative polarograph was also explained. G. L. Young dealt with a pen recording instrument involving a different typ of amplifier and paid special attention to th theoretical aspects of an attachment which enable the instrument to record true derivative peaks b the a.c. polarographic method of Breyer and Gutmann

After dealing with the rather differently shape waves encountered in cathode-ray polarography G. F. Reynolds gave an outline of the theory b explaining the equations of Randles and Sevcik Apart from being more sensitive than conventiona instruments, the Chemical Inspectorate, Randles type, single-sweep polarograph can also be operate with greater speed and simplicity. In its resolutio of closely spaced steps and compensation for preceding step, the instrument's normal performanc is between that of the 'conventional' and th 'derivative' polarograph. However, the incorporatio of a derivative circuit enables it where necessary t achieve the resolution of the derivative polarograp together with a much greater sensitivity. Mr Reynolds expressed the view that, in general, th sensitivity and applicability of the cathode-ra polarograph are equal to that of the square-wav polarograph at its present stage of development The design principles of a single-sweep cathode-ra polarograph were then given by H. W. Rowe-Leete, who also dealt with the electronics in terms of block diagrams.

By way of a contrast to these purely instrumenta contributions, Mrs. N. Luthy read a paper on the application of the polarograph to pyrimidine chemistry, with particular reference to the detection o the —S—S— bond.

A. L. Glenn

# LIBRARY RESOURCES IN THE MANCHESTER AREA

A CONFERENCE on library resources for industry and commerce in the Manchester area was held in Manchester on March 10 by the Northern Branch of Aslib. The speakers were Mr. D. I. Colley, Manchester City librarian; Mr. V. D. Freedland, information officer of the British Hat and Allied Feltmakers Research Association; Mr. L. L. Ardern, librarian of the Manchester College of Technology; and Mr. R. Brightman, bibliographer of the Dyestuff Division, Imperial Chemical Industries, Ltd.

In his survey of the services provided by the City Library, Mr. Colley emphasized their diversity. The main point is that these services have to meet the varied need of the rate-payers who pay for them. The commercial and technical libraries, while important and highly developed, are but two sections. This dependence on local finance necessarily limits developments. This is unfortunate, he said, because a census taken during 1954 showed that some 40 per cent of the users of the reference libraries were not rate-payers. Moreover, an analysis of this 40 per cent showed that Manchester is not only providing a gional service but also a national, even international, ne. In these circumstances, Mr. Colley maintained, it oes not seem unreasonable to seek national support.

The major part of Mr. Freedland's paper consisted f an analysis of the holdings of some forty special braries situated within a radius of twenty miles of he centre of Manchester. It was based on some of he replies to a questionnaire issued by Mr. A. L. myth, of the Reference and Special Libraries North-west Group) of the Library Association. For onvenience of presentation, Mr. Freedland grouped hem under broad headings such as chemical production, textiles, engineering and the production and istribution of fuel and power. There are, he egretted, certain libraries which he was unable to nclude in his survey as they appeared to pursue a olicy of non-co-operation in any of the various hemes for mutual assistance and collaboration.

Mr. Ardern spoke on the Manchester College of echnology Library and its assistance to industry. t began in 1824 as the library of the Manchester Mechanics Institute, and it still has many hundreds f the original volumes, of particular interest being he collection which had belonged to J. P. Joule. A ew weeks ago the draft of a twelve-page letter which oule had written in 1853 to William Hopkins, the ambridge scientist, was found in one of these books. ne of Joule's note-books, which was not recorded when r. Lowery described them in 1931, is in the library.

The library carries a stock of forty thousand olumes, five hundred current periodicals and the heses awarded for the degree of master of technical cience in the University of Manchester. A large ollection of standards is maintained, including those f the American Society for Testing Materials, the ociety of Automotive Engineers and the Society of lastics Industry. Many loans are made to industry, nd the library will continue to welcome inquiries.

Mr. Brightman addressed the meeting as a library ser. The public library, he thought, will be most seful to the firm which already possesses its own nformation service, and its chief value is in meeting marginal needs. Such a service can only be given if he public library does not fall below a minimum ze. By co-operation, industry expands the public brary service, and this implies development upon a egional basis. But it is not possible wisely to plan egional developments without regard to the national brary system as a whole. The Royal Society's cientific Information Conference in 1948 urged the overnment to give increased support to central cientific libraries and stressed the need for cooperation in local areas. The Advisory Council on cientific Policy appointed its own Scientific and echnical Information Committee, which reported on he needs of a national library of science and invenons, and plans for a new science centre were pproved in principle by the Government in 1950. n December 1952, however, the Minister of Works nnounced the postponement of the whole scheme—ven its planning. Apart from a protest in *Nature* nd by Dr. Colgate in his Armstrong Memorial ecture, this decision was unchallenged.

Last year, however, the Advisory Council expressed he hope that steps would be taken without undue elay to implement the scheme, and endorsed a report y its standing committee that there is a need for a ew science lending-library outside London, preferbly in a place easily accessible to the industrial reas of the North and Midlands, and that this library hould be the centre of a regional loan system based on selected municipal libraries. It is understood that the Government is now considering this.

The discussion which followed the four papers concentrated on the possibilities of achieving closer co-operation between local libraries and on the ways of bringing pressure on the Government to proceed with the science centre. The Northern Branch Committee was urged to take the matter up.

A. R. Cameron

# RADIO COMMUNICATION BY WAVE SCATTERING

It has been known for some twenty years or more that in addition to the normal process of reflexion at the various regions of the ionosphere, by means of which most long-distance communication is conducted, radio waves could be scattered in various directions from the point of incidence on the ionosphere. Such scattered radiation is usually very weak and not easily detected by normal methods of reception. In 1952, however, a paper was published by a group of workers in the United States describing experiments conducted on a frequency of 49·8 Mc./s., during which easily measurable signals were obtained over an experimental path 1,245 km. long. While the strength of the observed signals passed through a maximum at about midday and a minimum at about 20 hr., there was no failure over a period of several months resulting from conditions in the scattering medium.

The success of such experimental transmissions relied on the concentration of the emitted radiation into a narrow beam directed at the correct angle to secure forward scattering from irregularities in the lower regions of the ionosphere. A narrow-angle receiving aerial was also used, directed so as to ensure maximum reception from the same portion of the ionosphere as was 'illuminated' by the radiation from the transmitter. Much interest was aroused by these and later experiments, which clearly offered the possibilities of opening up new channels in the very high frequency band between 30 and 100 Mc./s. for a limited range of distances between about 800 and 2,000 km.

While it has been known that further investigations were in progress in the United States, Canada and the United Kingdom, very little of the scientific or practical results obtained has so far been published. It is therefore of considerable interest to note the recent announcement by the Massachusetts Institute of Technology of the development of new methods of sending radio waves over useful distances for communications as a result of research conducted for the United States Air Force. Dr. W. H. Radford, head of the M.I.T. Lincoln Laboratory's communications division, is reported in *The Times* of July 18 to have said that the first application of these new systems would be in connexion with the defence of the United States and Canada. The use of very high frequency ionospheric scattering as referred to above is of particular advantage in high-latitude and arctic regions, where conditions in the ionosphere for normal high-frequency (30 Mc./s. and below) propagation are subject to storms, resulting in great variability and interruption of radio communications. It is understood that some circuits operating on these principles and using teletype transmission are already in operation.

In an analogous manner, radio waves in the ultra high frequency band above 300 Mc./s. can be used for communication over somewhat shorter, but still useful, distances of the order of 500 km., by forward scattering of the waves from irregularities in the troposphere at a height of a few kilometres. A similar use of high effective power, directive aerials and sensitive receivers is required but, on account of the higher frequency employed, a greater resulting band-width can be made available for normal radio telephony operation. Until more information is disclosed as to the scientific and practical results of the investigations in progress in various parts of the world, the full possibilities of communication systems based on the forward scattering of radio waves in the ionosphere and troposphere cannot easily be visualized. Further publication of the results of recent investigations in these fields will be awaited with interest by all those concerned with the future of radio communication.

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# VEGETATION OF THE ASSAM VALLEY

IN Vol. 9, No. 1, of *Indian Forest Records* (pp. iv + 87 + 4 plates. Delhi: Manager of Publications, 1954), J. B. Rowntree, formerly conservator of forests, Assam, writes on an "Introduction to the Vegetation of the Assam Valley". In 1938 Dr. N. L. Bor, on deputation among the head-hunters of the Aka Hills, Assam, wrote a detailed account of the vegetation of that area. A first attempt to classify the vegetation of India was made by Mr. (now Prof.) H. G. Champion in 1935 in "A Preliminary Survey of Forest Types in India and Burma". The area covered did not permit of great detail being given. The present work is an attempt to do the same for the whole of the Brahmaputra valley.

The object aimed at was to collect all the existing data on the subject, with additions from personal knowledge of all the communities described, especially
with respect to the *Dipterocarpus–Mesua–Michei*
association and the *Shorea–Schima–Lagerstroem*
pro-climax. To the north of the Brahmaputra t
river runs practically north and south, and from t
foot of the hills the land drops on a gentler slop
The hill areas are covered with forests; but, owi
to the prevailing habit of shifting cultivati
(*jhuming*), the climatic climax formation is but rare
met with, and the forest is mostly of secondary growt
In most of India this practice was stopped by t
British Government; but this action did not exte
to the remote Assam of those days. As in the ca
of Africa, so here; Mr. Rowntree states: "In old
times when the population was kept in check l
wars and disease no great harm was done, b
nowadays with the population increasing (in plac
at alarming rates) this is no longer the case". T
*jhuming* rotation is becoming shorter and short
and in places is down to three years. As a resu
the ground-cover appears to be retrogressing fro
tree growth to bamboos and finally to grass, the s
is decreasing in fertility and erosion increasing fro
year to year, with floods silting up valuable pla
land.

The main reserved forests lie along the foothi
with detached blocks on higher land in the plair
The tropical evergreen formation is in Upper Assa
and the *Shorea robusta* association in Lower Assa
Among biotic factors man, as has been shown, pla
a predominant part, followed by animals, gia
climbers and epiphytes, insects, soil algæ, bacter
and earthworms.

Having disposed of the factors of climate, geolo
and soils and so forth, Mr. Rowntree, in a seri
of chapters, deals with the classification of th
communities, the tropical *Cinnamomum–Amoor*
*Michelia* formation and its associates, the deciduo
*Shorea* formation and other groups, grasslands a
savannahs, and so forth. Appendixes give map
and there are a few illustrations. To the fore
officers and those interested in the flora of this littl
known part of the world, the work should pro
invaluable.

E. P. STEBBING

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# RELATIONSHIP BETWEEN CERTAIN COMPONENTS OF THE CYTOCHROME SYSTEM

By PROF. D. KEILIN, F.R.S., and DR. E. F. HARTREE
Molteno Institute, University of Cambridge

OF the components of a typical cytochrome system only cytochrome *c* has so far been isolated in a soluble and completely pure state. By a very simple procedure[1], cytochrome *c* containing 0·34 per cent iron can be obtained from heart muscle on a large scale, while further purification[2-4] yields fractions with iron contents of 0·43–0·45 per cent. Although the properties of this isolated or exogenous cytochrome *c* are in general independent of the method of extraction and of the degree of purification, its catalytic activity, as determined with a heart-muscle preparation of cytochrome oxidase[5], is much lower than that of the endogenous pigment present in this preparation[4,6-9]. Furthermore, only exogenous cytochrome *c* combines with cyanide within the physiological range of *p*H[10-14].

These differences between the two forms of cytochrome *c* appear to favour the view that it undergoes a marked change on extraction. However, two considerations militate against this view. (1) Cyt
chrome *c* which has been obtained by a very mi
method of extraction of washed heart-muscle min
with phosphate buffer has the same properties[15]
the pigment obtained by the usual, more drast
method[1]. (2) The catalytic activity of the cyt
chrome system in a particulate heart-muscle prepar
tion depends upon appropriate spatial distributi
of all components of the system; in other wor
upon an arrangement within the particles whi
assures their mutual accessibility. In this respe
endogenous cytochrome *c* is more favourably plac
for electron transfer reactions than is the exogeno
pigment. That there is no essential difference betwe
the exogenous and endogenous forms was demo
strated by a transformation of the former into t
latter[15]. This was achieved by adding extract
cytochrome *c* to a washed heart-muscle min
previously made deficient in cytochrome *c*, and th

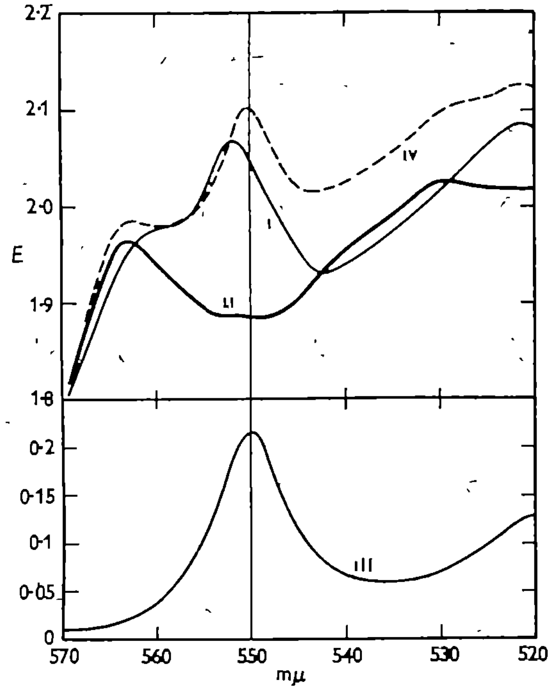

Fig. 1. Absorption spectra of heart-muscle preparation reduced with succinate or with succinate + antimycin *A*. Effect of adding cytochrome *c* to the latter. (i) Preparation + succinate. (ii) As (i) + 20 μgm./c.c. antimycin *A*. (The solution was aerated periodically to maintain all cytochromes except *b* in the oxidized state.) (iii) 16 μ*M* cytochrome *c* + sodium dithionite. (iv) Optical mixture of solutions (ii) and (iii). *E* = extinction (optical density)

obtaining from this mince our standard type of muscle preparation[8]. The now re-incorporated cytochrome *c* was found to be indistinguishable from the normal endogenous cytochrome *c* of such preparations[10].

## Variations in the Position of the c-Band of the Cytochrome Spectrum and Evidence for an Additional Cytochrome Component

While the α-band of reduced cytochrome *c* in solution lies at 550 mμ, the position of this band in preparations of heart muscle and other tissues, as well as in certain bacteria, has been recorded spectrophotometrically as 551–552 mμ[1-5].

The study by conventional spectrophotometric methods of heart-muscle preparations suspended in buffers is scarcely practical since the loss of light by scattering is much greater than the decrease arising from absorption. It has been customary to add bile salts to such preparations, which leads to a considerable degree of clarification and, in addition, to plot difference spectra (for example, oxidized against reduced forms) in order to reduce still further the effects of scattering. Since bile salts have inhibitory actions on some catalytic components of the heart-muscle preparation, we have used high concentrations of sucrose in place of bile salts.

In order to determine as precisely as possible the relative α-band positions for soluble cytochrome *c* (horse heart) and for endogenous cytochrome *c* in the heart-muscle preparation, we have used a Hilger 'Uvispec' spectrophotometer fitted with a glass prism. The resulting high dispersion allows wavelength settings to be made accurately to 0·1 mμ in the greater part of the visible region. By reading extinctions at 1 mμ intervals and constructing a smooth curve the band maxima could be estimated with an error of ≯ 0·3 mμ. A comparison between a calibrated didymium glass filter and a solution of reduced cytochrome *c* in phosphate buffer *p*H 7·3 at 20° gave the position of the α-band of soluble cytochrome *c* as 550·0 mμ. Heart-muscle preparations were suspended, after isoelectric precipitation[6], not in the customary phosphate buffer but in a sucrose phosphate solution (200 gm. sucrose in 100 c.c. 0·25 *M* disodium phosphate) and examined in 0·5 cm. cuvettes. The extinction of these suspensions was 1·5–2·0 at 550 mμ. Repeatable readings of these high extinctions were obtained by using the makers' high-intensity filament lamp, taking extinction (*E*) readings against a blank cuvette containing paraffin-soaked filter paper (*E* ~ 1) and correcting for the extinction of the latter. Under these conditions it was possible to work with a slit-width of 0·2 mm., which is equivalent to a 5 mμ band-width at 550 mμ.

The results of our experiments can be summarized as follows.

(1) The position of the α-band of cytochrome *c* in heart-muscle preparations reduced with either sodium succinate or sodium dithionite is near 552 mμ (Fig. 1, (i)), the mean figure from numerous experiments being 551·7 mμ. In no case was the band position modified by treatment with cyanide (1 m*M*) or carbon monoxide.

(2) The equivalent band in a cytochrome *c*-deficient heart-muscle preparation, which is measured as a shoulder on the short-wave side of the band *b*, lies between 553 and 554 mμ (Fig. 2, (ii)).

(3) When a solution of cytochrome *c* (α, 550 mμ) is added to cytochrome *c*-deficient heart-muscle preparation in amounts approximately compensating the deficiency and the mixture is reduced with succinate or sodium dithionite, the α-band of the added cytochrome *c* is seen to be at 552 mμ (Fig. 2, (iv)). This band-shift could conceivably be due to four causes: (i) A reaction between exogenous cytochrome *c* and some constituents of the heart-muscle preparation which affects the absorption

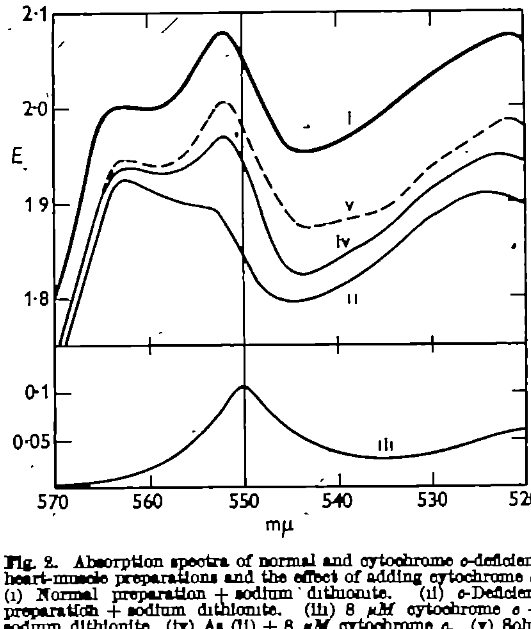

Fig. 2. Absorption spectra of normal and cytochrome *c*-deficient heart-muscle preparations and the effect of adding cytochrome *c*. (i) Normal preparation + sodium dithionite. (ii) *c*-Deficient preparation + sodium dithionite. (iii) 8 μ*M* cytochrome *c* + sodium dithionite. (iv) As (ii) + 8 μ*M* cytochrome *c*. (v) Solutions (ii) and (iii) in adjacent cuvettes (optical mixing). *E* = extinction (optical density)

spectrum of cytochrome *c*. (ii) An effect of the overlap of the α-bands of cytochrome *c* and cytochrome *b* (563 mμ). (iii) A result of light-scattering by the heart-muscle preparation. (iv) An effect of some other component with an absorption band close to that of cytochrome *c*. Each of these possible causes will be examined separately.

(i) The possibility of a reaction between exogenous cytochrome *c* and a constituent of the heart-muscle preparation was easily dismissed, since the shift of the α-band towards 552 mμ takes place not only when cytochrome *c* is added to cytochrome *c*-deficient heart-muscle preparation but also when they are mixed optically, that is, by placing a solution of cytochrome *c* and the deficient heart-muscle preparation in separate adjacent cuvettes in the light-beam (Fig. 2, (v)).

(ii) An effect of the absorption spectrum of cytochrome *b* can be readily eliminated. Thus, if a solution of cytochrome *c* is added to cytochrome *c*-deficient heart-muscle preparation and the mixture reduced with either ascorbic acid or cysteine, which do not reduce cytochrome *b*, the α-band of cytochrome *c* appears to be nearer to 552 mμ than to 550 mμ.

(iii) An explanation in terms of light-scattering is improbable since the addition of light-scattering material, such as milk, to a solution of reduced cytochrome *c* does not change the position of its absorption bands.

(iv) The shift of the α-band of reduced cytochrome *c* from 550 to 552 mμ must therefore be due to the presence in heart-muscle preparations of an extra pigment, which we shall temporarily refer to as *P*, with an absorption band lying near 550 mμ. The following experiments provide further evidence for this view and also reveal the nature and function of *P*.

(4) Since cytochrome *c* is the only cytochrome component which is known to be thermostable, it was of interest to determine the absorption maximum in the heart-muscle preparation after heat treatment. After heating heart-muscle preparation for twenty minutes at 70° and then reducing it with sodium dithionite or ascorbic acid, the only bands visible are those of cytochrome *c*, the α-band of which is now at 550 mμ.

(5) An optical mixture of reduced cytochrome *c* and untreated (that is, oxidized) heart-muscle preparation shows an α-band at 550 mμ. This indicates that *P* undergoes oxidation and reduction and that only its reduced form affects the spectrum of reduced cytochrome *c*.

(6) In an optical mixture of reduced cytochrome *c* in solution and heart-muscle preparation reduced in presence of antimycin *A* with either succinate or DPNH (reduced coenzyme I), the α-bands of cytochromes *c* and *b* are at 550 and 563 mμ respectively (Fig. 1). If it is assumed that *P* is a cytochrome type of pigment showing only diffuse absorption in the visible region when it is in the oxidized form, this experiment indicates that *P* remains oxidized while component *b* is reduced. In other words, the reduction of *P*, like that of cytochromes *a* and *c*, is inhibited by antimycin *A*.

(7) The positions of the *c* band in a heart-muscle preparation containing 1 m*M* cyanide and reduced with either 10 m*M* potassium ferrocyanide or a 10 m*M* mixture ferrocyanide/ferricyanide = 70 were at 551 and 550 mμ, respectively. Since cytochrome *b* remained completely oxidized in both cases, these results indicate that the oxidation-reduction potential of *P* lies between those of cytochromes *b* and *c*.

(8) The main properties of *P* can thus be enumerated as follows. (i) It is thermolabile. (ii) It can undergo oxidoreduction. (iii) It can be reduced in the heart-muscle preparation with those reagents which also reduce the cytochrome *c* of the preparation, for example, ascorbic acid, cysteine, sodium succinate and DPNH. (iv) Its reduction by succinate or DPNH is inhibited by antimycin *A*. (v) Its oxidation is catalysed by the cytochrome oxidase system; the compound is therefore not autoxidizable. (vi) It does not appear to react either with cyanide or with carbon monoxide. (vii) Its oxidation-reduction potential lies between those of cytochromes *b* and *c*. (viii) In the oxidized state it has a diffuse absorption spectrum, whereas in the reduced state it must show a strong absorption band lying between the α-bands of cytochromes *b* and *c* and close enough to the latter to shift its apparent maximum from 550 to ~ 552 mμ (Fig. 2). These points suggest that *P* is a thermolabile, non-autoxidizable, antimycin-sensitive cytochrome component with absorption bands in the reduced state lying near those of cytochrome *c*. Like other components of cytochrome, it forms an integral part of the electron transfer chain between activated substrate molecules and molecular oxygen.

## Identity of the Pigment responsible for the Shift in the *c*-Band with Cytochrome *e*

A component of cytochrome which exhibits the properties enumerated above is cytochrome *e*, which we discovered during spectroscopic examination of heart-muscle preparations, and of suspensions of different cells, at the temperature of liquid air[11,12].

The success of such experiments at liquid-air temperature (– 190°) depends upon the presence of glycerol in the suspending medium and upon the use of a low-dispersion (direct-vision) spectroscope. When the glycerol concentration exceeds 55 per cent (v/v) the suspension freezes to a translucent glass, while the absorption bands of pigments in the suspension become very sharp and move towards the blue end of the spectrum. Furthermore, groups of bands that cannot be resolved at room temperature become distinctly separate and may themselves show additional fine structure. When the glycerol concentration is 48–50 per cent, further band modifications can be observed. On rapid cooling to – 190° such suspensions freeze to a glass and show the same band-sharpening as was observed with higher proportions of glycerol. When these frozen samples are allowed to warm up slowly they devitrify to a microcrystalline mass which, after re-cooling in liquid air, shows the bands not only sharpened and shifted to lower wave-lengths but also very markedly intensified. Under these conditions a much lower concentration of material is required, but the devitrified mass, being opaque, can be studied only by means of a very low dispersion spectroscope (for example, microspectroscope or hand spectroscope) together with a powerful source of light.

Both methods of cooling have been applied to the study of cytochromes. Spectroscopic examination at low temperatures of the heart-muscle preparation reduced with succinate or sodium dithionite shows the recognized cytochrome components with very sharp bands displaced 2–3 mμ towards the blue. Thus the α-bands of cytochromes *a*, *b* and *c* now lie at about 600, 560 and 548 mμ, respectively. More-

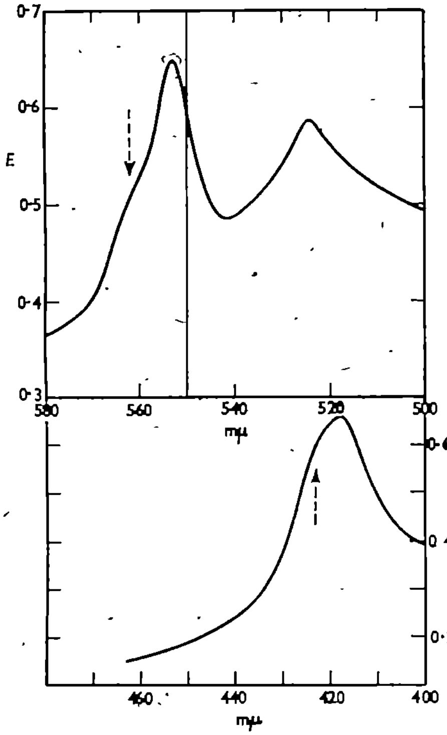

Fig. 3. Absorption spectrum of cytochrome $c_1$ (= cytochrome *e*) (reduced by sodium dithionite in presence of 0·4 per cent sodium cholate at pH 7·3). Upper curve: 2 cm. cuvette. Lower curve: 0·5 cm. cuvette. Shoulders to α- and γ-bands (arrows) represent residual cytochrome *b*

ver, the space between the *b*- and *c*-bands becomes learer and a very sharp band appears at about 551–552 mμ. As the temperature rises, this band isappears rapidly—well before bands *b* and *c* begin o lose much of their acquired sharpness. This and ther similar observations lead us to believe that – 190° is near the upper limit of a range of temperatures within which more dramatic changes of lready sharpened bands would be observed. It can eadily be shown that the sharp band at 551–552 mμ, bserved at low temperatures, belongs to the component which we called cytochrome *e* and is not an dditional peak in the sharpened absorption spectra f cytochromes *b* or *c*. Thus this band fails to appear n cooling a heart-muscle preparation in which only ne of the cytochromes, either *b* or *c*, is present in he reduced state. The '*c* only' spectrum was obtained y heat treatment and reduction with sodium ithionite, while the '*b* only' spectrum was obtained y aerating heart-muscle preparation in presence of uccinate and antimycin *A*.

As judged by the wave-length of the *c*-band in a ariety of cells and tissue preparations, the distribution of cytochrome *e* is very wide. Since cooling o liquid-air temperature shifts the positions of bsorption bands 2–3 mμ towards the short-wave nd of the spectrum, the position of the α-band of ytochrome *e* at room temperature should be at 553–554 mμ. By applying to a horse-heart muscle xtract a modification of the method used by mith and Stotz[13] for extracting cytochrome oxidase rom pig heart we have been able to obtain a clear olution of cytochrome *e* which shows the absorption axima α-553, β-524, γ-418 mμ. As will be shown ater, this compound is identical with the previously escribed cytochrome $c_1$. This solution is free from cytochrome *c* and contains only traces of cytochromes *a* and *b* (Fig. 3). Its absorption spectrum is unchanged by treatment with carbon monoxide.

## Limits to Resolvability of Groups of Absorption Bands

The question that now arises is whether the α-band of cytochrome *e*, lying in the region of 554 mμ between those of cytochrome *b* (563 mμ) and cytochrome *c* (550 mμ), should be detectable spectrophotometrically in a heart-muscle preparation.

Three possibilities can be considered. Thus the *e*-band might form a distinct maximum in the absorption curve, it might form a shoulder to the *b*- or *c*-bands, or it might fuse with the closely situated *c*-band to give a virtually symmetrical band with a peak at an intermediate wave-length. We shall assume that the α-bands of cytochromes *b* and *e* are of the same shape as that of cytochrome *c* and then consider to what extent the three bands would be resolvable if their relative heights were varied and if the position of the *e* maximum were varied over the range 553–555 mμ.

Fig. 4 shows four such absorption curves with peaks at 563 (*B*), 554 (*E′*), 553 (*E*) and 550 mμ (*C*), corresponding to the α-bands of cytochrome *b*, cytochrome *e* (two alternative positions) and cytochrome *c*. In Fig. 5 are shown curves obtained by summation of the curves in Fig. 4 as follows:

$l = B + E + C \qquad l' = B + E' + C$
$m = B + 0{\cdot}5\,E + C \qquad m' = B + 0{\cdot}5\,E' + C$
$n = 1{\cdot}5\,B + 0{\cdot}5\,E + C \qquad n' = 1{\cdot}5\,B + 0{\cdot}5\,E' + C$

The upper set of curves in Fig. 5 shows that a symmetrical '*c*-band' can be expected when the heights of the individual bands *C* and *E′* are equal (*l′*), but that a shoulder appears at about 554 mμ when the concentration of *E′* is reduced (*m′*, *n′*). Since the original spectroscopic observations on cytochrome *e* indicated that its concentration in heart-muscle preparation is less than that of cytochrome *c*[11], the absence of any shoulder to the *c*-band in spectrophotometric curves of heart-muscle preparations would suggest that the α-band of cytochrome *e* is less than 4 mμ from the α-band of cytochrome *c*. If a similar summation of α-bands is made on the basis of an *E′* maximum at 555 mμ, the *c*-bands of all three curves are very asymmetrical. Curves *l*, *m*, *n*, which are calculated from an *E*-band at 553 mμ,

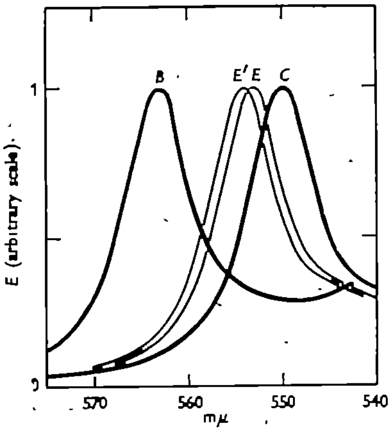

Fig. 4. α-Band of cytochrome *c* (*C*) together with the same band reproduced with maxima at 563, 554 and 553 mμ (*B*, *E′*, *E*)

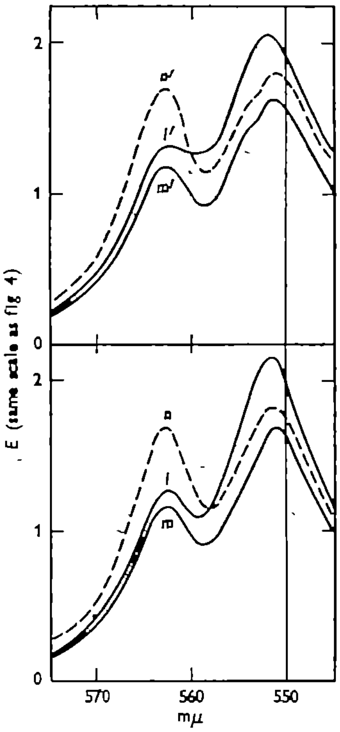

Fig. 5. Curves obtained by summation of curves in Fig. 4 as described in the text. Band peaks: *l*, 551·7; *m*, 551·0; *n*, 551·5 mμ

differ from *l'*, *m'*, *n'* mainly in the absence of shoulders to the *c*-bands. On the basis of experiments to be described elsewhere, the $B:E:C$ ratio represented in summation by curve *n* is considered to approximate to that in a normal heart-muscle preparation, and the wave-length of maximum extinction in this curve (551·5 mμ) agrees within experimental error with the wave-length found for heart-muscle preparation (551·7 mμ). Furthermore, the difference between the *c*-band maxima of *n* and *m* indicates that the *b*-band can influence the position of a maximum due to the fused bands of cytochromes *c* and *e*. This shift can be demonstrated experimentally with the cytochrome *c* - deficient heart-muscle preparation (Fig. 6). The difference spectrum *x* (heart-muscle preparation reduced with succinate *minus* oxidized preparation) shows the α-peak of cytochrome *b* at 562·5 and that of cytochrome *e* at 553·7 mμ. When succinate is replaced by ascorbate (*y*), cytochrome *b* is not reduced and the *e*-maximum now appears at 552·8 mμ, which is essentially identical with the 553 mμ maximum found for isolated cytochrome *e* (Fig. 3). (As stated above, the positions of band maxima could be determined to within 0·3 mμ.) The effect of liquid-air temperature is thus to shift the position of the *e*-band in the heart-muscle preparation from 554 to 552 mμ. An examination of isolated soluble cytochrome *e* (= cytochrome $c_1$) revealed a similar shift from 553 to 551 mμ. The outstanding difference between the summation curves of Fig. 5 and those obtained from the heart-muscle preparation lies in the more pronounced minimum between the *b*- and *c*-bands of the former. While the virtual absence of a minimum in heart-muscle preparation curves (see Fig. 2, (i)) may be the result of absorption by a so far unidentified pigment or of a minor contribution from cytochrome *a*, we hope to show, in a later publication, that the discrepancy arises more probably from the light scattering properties of the preparation.

## Cytochrome $b_5$ and Cytochrome *e*

Already at an early stage of the work on cytochrome it was recorded that the fat body of blowfl larvæ shows an absorption spectrum composed o three bands at 603, 558 and 524 mμ[14]. Thus th components *b* and *c* are replaced in this instance b a single component showing a protohæmochromoge type of absorption spectrum (α-558, β-524 mμ). A component with a similar absorption spectrum wa later found by Sanborn and Williams[15] to be generall distributed in tissues of the *Cecropia* silkworm an was described by them as cytochrome *x*. Anothe very similar pigment with bands at 557, 527 an 424 mμ was found by Strittmatter and Ball[16,17] to b the main cytochrome component of rat-liver microsome fractions. This pigment was probably responsible for masking the α-bands of cytochromes *b* and in our earlier cell-free preparations from liver an kidney[18], and, in fact, by modifying our procedur in such a way that the microsome fraction would b discarded, Slater[8] was able to obtain kidney preparations which showed clear *b*- and *c*-bands. Mor recently, the pigment from *Cecropia* silkworm midgut under the name of cytochrome $b_5$, was re-investigate by Pappenheimer and Williams[17]. According to thes authors, "cytochrome $b_5$ probably accounts for muc of the cyanide-, carbon monoxide-, and antimycin- resistant DPNH oxidation, not only in the insect but also in plant and animal tissues as well". Chanc and Pappenheimer[18], who believed they could identif cytochrome $b_5$ with cytochrome *e*, wrote, "The clea absorption bands of cytochrome $b_5$ as measured b the recording spectrophotometer are in considerabl contrast to the wide, indistinct band that is seen i the microspectroscope, on the basis of which Keili and Hartree identified the pigment as a specia cytochrome *e*. Thus the peculiar appearance of th

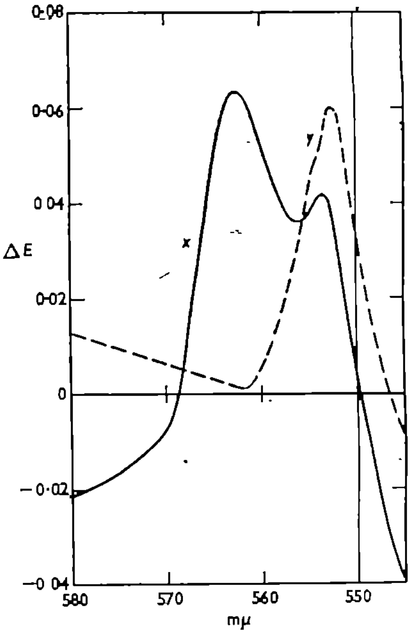

Fig. 6. Difference spectra of cytochrome *c* - deficient heart-muscle preparation. *x*: Preparation + succinate *minus* untreated preparation. *y*: Preparation + ascorbate *minus* untreated preparation

band of this pigment in the microspectroscope ould no longer be a bar to its identification with e cytochrome $b$ family in view of the clear cut band bserved in our recordings". This very misleading atement raises a number of points which call for iticism.

(1) Cytochrome $e$ was observed by us in cells, ssues and cell-free preparations only when they ere cooled to liquid-air temperature, and under ese conditions we described the α-band, as seen ith a microspectroscope, not as wide and indistinct ut as exceptionally sharp[21]. In fact, as we have own, it is the band sharpening at low temperatures hich makes possible the resolution of bands as close gether as those of cytochromes $c$ and $e$.

(2) Contrary to the view developed in the above otation, it is generally recognized that a band hich appears wide and indistinct when examined ith a low-dispersion spectroscope will appear still ss distinct when recorded with a spectrophotometer hich, of necessity, must have a much higher dis- ersion. As an example, we may consider the oulder at 563 mμ in Fig. 3, which appears as a istinct band when examined with a microspectro- ope. The same applies to the α-band of ferricyto- rome $c$ or other parahæmatin compounds which n be seen as a separate band with a microspectro- ope but which appears as a scarcely perceptible regularity on the long-wave side of the β-band in spectrophotometric curve.

(3) The view as to the identity of cytochromes $b_5$ nd $e$ put forward by Chance and Pappenheimer[22] is ot supported by a systematic comparison of these wo components. Thus it was previously shown that tochrome $b_5$ is autoxidizable, that its reduction by e succinic dehydrogenase system is very slow, that s reduction by DPNH is rapid but not affected by timycin $A$ and that its α-band lies at 558 mμ. We ave now shown that cytochrome $e$ is not autoxidiz- ble, that its reduction by the above systems is pid and inhibited by antimycin $A$, and that its band lies at 553 mμ. Moreover, where structural ements of cytoplasm could be separated, cyto- rome $e$, like cytochromes $a$, $b$ and $c$, was found to localized within mitochondria, whereas cyto- rome $b_5$ was found associated with the microsomes. hile cytochrome $b_5$ shows a marked resemblance to her components of the $b$-group, cytochrome $e$, as ill be seen, is more appropriately classified with tochrome $c$.

## Identity of Cytochrome e with Cytochrome $c_1$

If a cell-free ox heart-muscle suspension is washed ith acetate buffer ($p$H 4·6) and phosphate buffer H 7·5) and then treated with succinate and cyanide shows, according to Yakushiji and Okunuki[23,24], in dition to the absorption bands $a$ and $b$, a band at 2 mμ. They ascribed this band to the presence of new cytochrome component which they named tochrome $c_1$. In a normal heart-muscle prepar- tion they could not distinguish this component om cytochrome $c$. Cytochrome $c_1$ was separated y them from other components of cytochrome y extracting a heart-muscle preparation with dium cholate, fractionally precipitating the extract ith ammonium sulphate and dissolving the opropriate fraction in phosphate buffer $p$H 7·3. he main properties of cytochrome $c_1$ as given by ese workers can be summarized as follows. (1) In e reduced state it shows three absorption bands: 552, β-522 and γ-416 mμ; on oxidation the γ-band is shifted to 410 mμ. (2) It is not autoxidizable, but is rapidly oxidized by ferricytochrome $c$ or by a mixture of 99·25 per cent potassium ferrocyanide and 0·75 per cent potassium ferricyanide, which indicates that its oxidation-reduction potential lies between those of cytochrome $b$ and cytochrome $c$. (3) On treating this component with pyridine and sodium dithionite, its α-band shifts from 552 to 550 mμ, which is the position of the α-band of cytochrome $c$. (4) A similar compound can be obtained from heart muscle of other mammals, *Acetobacter pasteurianum*, baker's yeast, a red alga *Porphyra tenera*, and from other organisms.

The position of cytochrome $c_1$ in the electron transfer chain was represented by Yakushiji and Okunuki as follows:

$$\begin{tikzcd}
O_2 \arrow[r, dash] & \text{Cytochrome oxidase} \arrow[r, dash] & c \arrow[d, shift left] & c_1 \arrow[l] \arrow[dl] & b \arrow[l] \arrow[r, dash] & \text{succinic dehydrogenase} \\
 & & a \arrow[u, shift left] & & &
\end{tikzcd}$$

Our suggestion[7] as to the possible identity of cytochrome $c_1$ with the BAL (2:3-dimercaptopropanol)-sensitive factor[21], which forms an important link between cytochrome $b$ and cytochrome $c$, was not confirmed by Slater[22]. He repeated Yakushiji and Okunuki's experiments and also obtained their type of preparation, with the band at 552 mμ, from a heart-muscle preparation treated with BAL, which irreversibly destroys the 'factor'. We have re-examined this BAL-treated heart-muscle preparation and conclude that, since the wave-length of its $c$-band (551·8 mμ) is virtually identical with that shown by a normal preparation, the BAL treatment does not destroy the component responsible for shifting the α-band of cytochrome $c$ from 550 to 552 mμ. Furthermore, Slater[22] could find no clear evidence in support of the existence of cytochrome $c_1$, and he explained the position of the absorption band at 552 mμ as being due to displacement of the α-band of cytochrome $c$ by the presence of a band due to the denatured protein protohæmochromogen in such preparations.

Having repeated the experiments of Yakushiji and Okunuki and, by a similar method, obtained their cytochrome $c_1$ (Fig. 3), we were able to corroborate their main observations. The similarity in properties of cytochromes $c_1$ and $e$ described above strongly supports the view that these two components are identical. We have reached this conclusion despite the fact that the band positions given for cytochrome $c_1$ (α-552, β-522, γ-416 mμ) do not agree closely with those that we have found for cytochrome $e$ (α-553, β-524, γ-418 mμ). These differences are, however, very small and may be due either to the presence in their material of a small amount of cytochrome $c$ or to the fact that their spectrophotometric equipment lacked the precision of modern photoelectric instruments. While it is true that in attempting to follow the incompletely described method for preparation of cytochrome $c_1$ we obtained material containing protein protohæmochromogen, we do not believe that its presence could bring about a shift of the α-band of cytochrome $c$. Our analysis of the mutual interference to be expected from neighbouring absorption bands can be extended to show that the α-band of such a hæmochromogen, which would lie at about 558 mμ, could not bring about an apparent shift of 2 mμ in the position of a markedly stronger α-band of cytochrome $c$. On treating a solution of cytochrome $c_1$ with sodium hydroxide (0·1 $N$), pyridine and sodium dithionite, its α-band shifts to 550·4 mμ and the absorption spectrum is then indistinguishable from that of cytochrome c treated in the same way. Similar changes in the α-band of cytochrome $c_1$ are obtained when a cytochrome c - deficient heart-muscle preparation is warmed to 70° and reduced with sodium dithionite. It is conceivable that cytochrome $c_1$ occupies an intermediate position between cytochrome c and a more primitive protohæmochromogen precursor. However, problems involving the relationship between structure and absorption spectra of hæmoproteins must await solution until the reactions of hæms and hæmoproteins with different substances are better understood[33]. Since cytochromes $c_1$ and e appear to be identical, the term cytochrome e, proposed in 1949, should be replaced by cytochrome $c_1$, which was introduced in 1940. Furthermore, the designation $c_1$ more clearly indicates the relationship of this component with cytochrome c.

## Summary and Conclusions

(1) It is known that the extracted, soluble or exogenous cytochrome c differs in some of its properties from the endogenous form present within cells or cell-free preparations. That these differences do not reflect any marked change in the structure of cytochrome c during its extraction and purification is indicated by the ease with which extracted cytochrome c can be re-incorporated into cytochrome c-deficient heart-muscle preparations, after which it appears to re-acquire the properties of the endogenous pigment originally present in the preparation.

(2) The difference in the absorption spectra of these two forms of cytochrome c in the reduced state is of special interest since it has now been shown to depend upon the presence within cells or cell-free heart-muscle preparations of another component of cytochrome the α-band of which fuses with that of cytochrome c (550 mμ), forming a single band with a maximum at 552 mμ.

(3) This additional component is the cytochrome $c_1$ of Yakushiji and Okunuki[29,30], which we now identify with a component formerly described by us as cytochrome e [21].

(4) The evidence for the existence of cytochrome $c_1$ (= cytochrome e), which is based upon the study of absorption spectra at low temperatures, the displacement of the α-band of cytochrome c when it forms part of a complete cytochrome system and the isolation of component $c_1$ virtually free from other cytochrome components, can be summarized as follows.

(i) The α-band of cytochrome $c_1$ can be easily seen together with all other components of the cytochrome system in cells and cell-free heart-muscle preparations suspended in aqueous glycerol and cooled to the temperature of liquid air. It is the great sharpening of absorption bands at very low temperatures that resolves the fused α-bands of cytochromes c and $c_1$ into two distinct bands with peaks about 3 mμ apart.

(ii) The α-band of cytochrome $c_1$ can be seen at 553–554 mμ in a heart-muscle preparation made deficient in cytochrome c and reduced with ascorbic acid.

(iii) In an optical mixture of the reduced cytochrome c - deficient heart-muscle preparation and reduced soluble cytochrome c, the α-band of the latter is displaced from 550 to 552 mμ.

(iv) On the other hand, the α-band of endogenous cytochrome c (which represents a mixture of those of cytochrome c and cytochrome $c_1$) is shifted from 5 to 550 mμ when cytochrome $c_1$ is either denatured oxidized.

(v) A preparation of cytochrome $c_1$, rendere soluble by means of sodium cholate, has been isolat from heart muscle. It shows absorption maxima 553 (α), 524 (β) and 418 (γ) mμ.

(5) It has been shown that two absorption ban even as sharp as the α-band of cytochrome c cann be resolved spectrophotometrically if their maxim lie 4 mμ or less apart. However, two such ban with maxima only 3 mμ apart can be easily resolve if the bands are made much sharper by cooling th material to the temperature of liquid air.

(6) Contrary to the view put forward by som workers[28], cytochrome $c_1$ (= cytochrome e) is n identical with cytochrome $b_2$. These two component show marked differences in their localization withi cells, in their absorption spectra, in their reactio with biological reducing systems in presence and i absence of antimycin A, and in their reactions wit oxygen.

(7) Cytochrome $c_1$, like cytochrome c, is n autoxidizable, and its reduction by the succini dehydrogenase system or by DPNH (reduced c enzyme I) is inhibited by narcotics and by antimyc A. It reacts neither with carbon monoxide n with cyanide. Unlike cytochrome c, but like oth components of cytochrome, it is thermolabile an more intimately linked with structural elements the cell.

(8) Cytochrome $c_1$ (= cytochrome e) is a widel distributed component forming an integral part the intracellular electron transfer chain betwe activated molecules of substrate and oxygen.

We wish to thank Dr. F. M. Strong for a generou gift of antimycin A.

This work forms part of a general study of cellul biology supported by the Nuffield Foundation.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Function of the Bower of Bower-birds

There exist two widely divergent and irreconcilable theories concerning the nature and function of bower-building in bower-birds (Ptilonorhynchidae). The first, which may be called the traditional view, finds s expression in numerous writings (references in Marshall[1,2]) which describe bower-birds as intelligent and consciously æsthetic (in the human sense of the xpressions) in their collection of colourful display-things and in bower-building. This view involves lso the stated belief that bowers are built for recrea-onal purposes and are little concerned with reproductive processes, even though the latter may have accounted for the origin of display in the early history of the species.

The second view is that the bower and display-round form the centrepiece of the male bird's territory, and that to it is attracted a female to which the male displays (sometimes for several weeks) until the environment, and next the female's internal exual processes, come seasonally to a state appropriate for successful reproduction, after which copulation occurs. Thus, the copulation-date, and hence he ultimate timing of the breeding season, is con-idered to be controlled by environmental factors operating through the exteroceptor organs of the female.

In advancing the latter hypothesis Marshall[2] has written that it is not yet known what are the events that "cause sudden transference of the physical attention of the male from his display-things to the . . female which has been waiting alongside for so many weeks".

Observations made by me in the Cordeaux River area, south-eastern New South Wales, on October 2, 1954, perhaps supply these missing data.

A blue-black male satin bower-bird (*Ptilonorhynchus violaceus*) came to its highly decorated display-ground, renovated the bower, painted its walls (with charcoal mixed with saliva) and then flew to a tall *Acacia* tree near by, where he repeatedly produced a long-drawn territorial whistle for about half an hour. A female now came to the bower and, after moving around, went to the central avenue at the entrance facing the display-ground. Here she stood. The male then flew down to the display-ground and began to display (Fig. 1). After a few minutes the female assumed the peculiar squatting or flattened crouching attitude, shown approximately in Fig. 2. The male now intensified his performance. The female maintained the crouching position for no less than ten minutes, her only appreciable motion being a rotation of the head as her gaze followed the actions of the male. The male displayed back and forth, holding blue flowers in his beak. Then he moved quickly to the front entrance of the bower where copulation occurred, considerably disordering the bower. The male next departed, and then the female disappeared. Twenty minutes later the male returned and renovated his damaged bower.

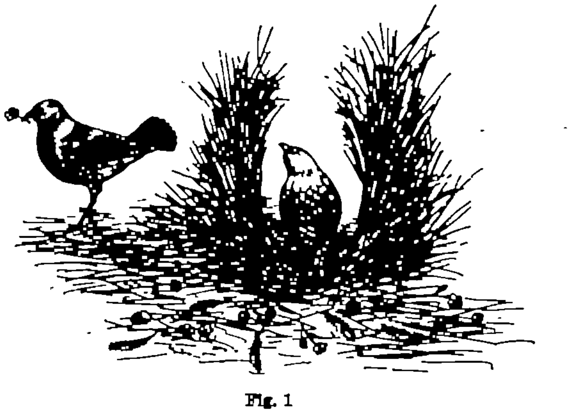

Fig. 1

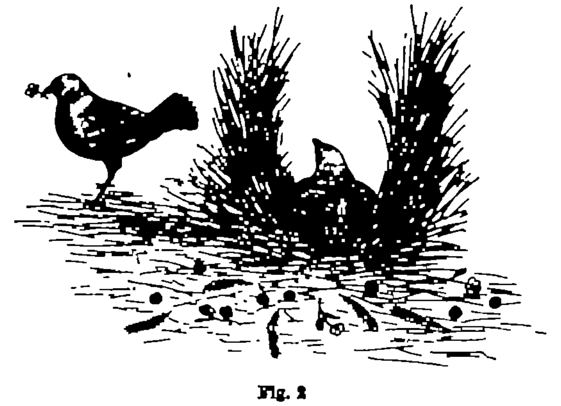

Fig. 2

Although several observers have reported the presence of a single female *Ptilonorhynchus* standing passively watching the displaying male, this appears to be the first occasion on which a female has been seen to strike a special attitude, and the first time, moreover, on which copulation has been observed, although it has been reported at the bower of the spotted bower-bird (*Chlamydera maculata*)[3]. It seems reasonable to suppose that it was the prolonged and peculiar crouching attitude adopted by the female at the bower that released in the male the drive towards coition.

No evidence that polygamy occurs in the above species was obtained. Only one female was seen near the bower; and I have never found more than one nest near a display territory.

A longer account of the present and allied observations will be published in *The Emu*, the journal of the Royal Australasian Ornithologists' Union.

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## Aphid Chromosomes

During the early years of this century several workers, notably Morgan[1] and Stevens[2], became interested in the chromosomes of Aphididae, mainly in connexion with their studies on the behaviour of the sex chromosomes and on the phenomenon of parthenogenesis. Shinji[3] wrote on the evolutional significance of the chromosomes of the Aphididae. He investigated some thirty-seven species of American aphids, of which the somatic chromosome numbers ranged from six to thirty-eight, and claimed that the number of chromosomes and the physical characteristics of a species are so closely correlated that the 'evolutional scale' of any aphid can safely be judged from its chromosome number.

Unfortunately, in view of the confused state of systematics and nomenclature of aphids at that time, together with the complete lack of descriptions, no reliance can be placed on Shinji's identifications, even though his general conclusions may retain some validity.

Owing to the recent advances in the study of aphid systematics, a general survey of chromosome numbers on the lines attempted by Shinji, but with reliably identified species, is now possible and is being conducted. This should provide interesting information on the evolution of Aphididae, and it is hoped also that new light will be shed on some of the problems connected with speciation, hybridization, the initiation of wing production in the viviparous generations, and the production of the sexual forms.

For several reasons it has been found best to work with diploid material. Though testis material would provide large numbers of dividing nuclei in suitable stages, and the counting of haploid numbers would be easier, in practice it is impossible to identify with sufficient certainty the naturally occurring male aphids in the early instars which alone are of use. Spermatogenesis is completed in the nymphal stages, and adult males contain only mature sperms. The use of males is further limited by the short period of the year during which they are obtainable. Hence, smears are made of the body contents of viviparous parthenogenetic females. These females are readily identifiable and, in addition to being available in large numbers from spring to autumn, can in many cases be cultured indoors during the colder months.

The advanced embryos removed from mature viviparous females themselves already contain parthenogenetic ova and embryos in the early stages of segmentation, and it is in these early cleavage divisions that the largest chromosomes are to be found. Even here, however, the average chromosome size during metaphase is only about 1μ, and the diameter of the metaphase plate is about 4μ.

Because of the small size and close approximation of these chromosomes, only the very best prophase and metaphase figures can be used for reliable counting and comparison. As such figures are relatively scarce in the preparations, large numbers of smears are necessary. Temporary preparations, though occasionally useful, are not suitable for mass production and lengthy examination, so permanent slides are the rule. Fixation and staining must be of high quality, and though many techniques have been tried, the best results have been obtained from permanent smears fixed in osmic acid and stained with crystal violet or by the Feulgen method.

The somatic chromosome numbers of the species of aphids so far investigated are multiples of four; for example, in *Aphis fabae* Scop., *Aphis rumicis* L., *Aphis viburni* Scop., and *Acyrthosiphon pisum* (Harris), $2n = 8$; in *Brachycaudus prunicola* Kltb., *Hyperomyzus lactucae* L., *Myzus persicae* (Sulz.) and *Pachypapella reaumuri* Kltb., $2n = 12$; and in *Brevicoryne brassicae* L., $2n = 16$.

Although the examples quoted are insufficient to show any general trends, it is obvious that the possession of the same chromosome numbers is not necessarily an indication either of close morphological relationship or of 'evolutional' affinity, despite Shinji's assertion to the contrary.

On the other hand, it appears that very clos allied forms, as, for example, members of the *Ap* *fabae* 'complex', a few of which have been investigat do have the same chromosome numbers. Furt comparison of such forms must be conducted on t basis of the relative sizes and shapes of individ chromosomes.

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## Regeneration of the Filtrable Forms of *Salmonella enteritidis* in Media containing Blood Plasma (Fibrin Structure)

THE experiments to be described were conduct with the purpose of attaining a more extensive generation of filtrable forms by modifying t technique. In analogy with the use of blood plasm in tissue cultures, we also added blood plasma media for regeneration, as it was thought th granules capable of regeneration would be adsorb on the submicroscopic network of fibrin, creati thereby more favourable conditions for assimilati processes than would be brought about had t granules settled to the bottom of the tubes.

In these experiments 'regeneration' was understo to mean growth through intermediate forms, aft a period longer than 72 hours in media enriched wi native proteins, as compared to the sterility of t control media.

There were three series in which filtrable forms we obtained partly by ageing of the cultures and part by exposure to a sublethal dose of penicillin[1]. Filtr tion was through Seitz *S* filters at a negative pressu of 10–15 mm. mercury for about 10–15 min.

One part of the filtrate was then centrifuged 9,600 r.p.m. for 45 min. in an angle centrifuge (Vif Stockholm, type *B*). This was done for the followi reasons: (1) to obtain an inoculum containing unusually high number of filtrable forms per un volume; (2) to make the sterility tests even mo

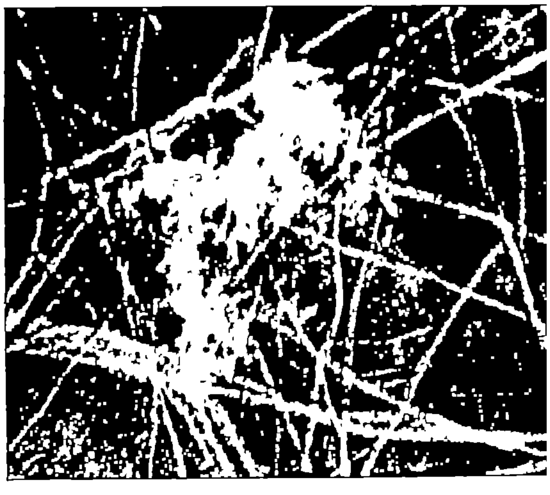

Fig. 1. Granules from the filtrate on the fibrin network. (Th electron micrograph was taken by M. D. Egyessy, of the Electron Microscope Laboratory, Hungarian Academy of Sciences, t whom we express our thanks)

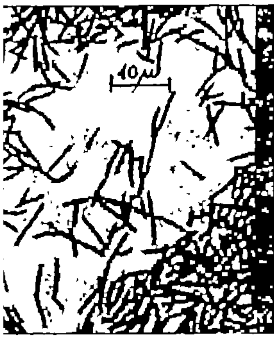

Fig. 2. Atypical *Salmonella* regenerated from filtrate

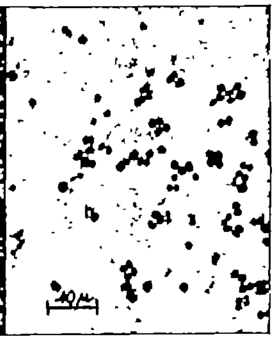

Fig. 3. Polymorphous culture of cocci grown from filtrate

luable and convincing. It is obvious that even only a few bacteria pass through the filter, they will easily detectable in the sediment; (3) to obtain preparation which is pure and concentrated for ctron microscopic studies.

The inocula were: the filtrate, the sediment and e supernatant fluid obtained by centrifugation. ch of these was inoculated into the following dia: (*a*) serum broth; (*b*) serum broth containing proximately 5 per cent chicken plasma; (*c*) comnly used media for sterility tests aiming at tecting the eventual presence of *Salmonellae*.

In none of the control media could we demonstrate e growth of *Salmonella* or any related organism. To avoid subsequent contamination, the closed bes were kept in an incubator at 37° C. and reained unopened until cloudiness or formation of a posit visible to the naked eye could be seen in em.

Irrespective of the method used for inducing trable forms (ageing or penicillin treatment), the edia containing blood plasma proved to be superior serum broth so far as the reversion of filtrable forms microscopically visible forms was concerned. In edia enriched with plasma, regeneration was more arked, and the cultures grown in them resembled e initial strain more closely than those grown in rum broth. Moreover, complete reversion to the itial strain resulted exclusively in the serum broth ntaining plasma in the above experiments. The verted strains were identified on the basis of rphological appearance, fermentation and serogical (agglutination) tests and ouse pathogenicity.

Regeneration took place in thiren of a total of fifteen plasma ltures; of these, complete rersion occurred in two cases; cillary cultures differing mainly rologically and pathologically m the original *Salmonella* strain ose in six cases; polymorphous lture consisting of coccoids and ds in one case; coccoid cultures four cases and only in six of total of fifteen serum broth ltures (yielding all coccoid cultres).

Further experiments are necessary to elucidate whether the role fibrin in the process of regeneran as a network is a purely chanical one or whether it has chemical implications as well.

As in similar experiments by other workers, in the series reported upon here, evidence was obtained to show that bacterial life-cycles exist and that bacteria are extremely variable. It appears to be beyond doubt that in many cases the transformation of bacteria will take place through filtrable forms.

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## Manganese Requirement and Carbon Source in *Chlorella*

Photosynthesis of unicellular green algae (*Chlorella*[1], *Ankistrodesmus*[2], *Scenedesmus*[3]) requires the presence of small quantities of the micronutrient manganese ($Mn^{++}$). Manganese-deficient cells show a much-reduced photosynthesis, which can be rapidly brought to normal by addition of manganese (short-term recovery effect). This effect of manganese has been shown to occur both in strong and in weak light[2,3].

During a comparative examination of the mineral requirements of auto-, hetero- and mixo-trophically grown *Chlorella vulgaris*[4] the role of manganese has also been followed. As Fig. 1 shows, manganese deficiency (manganese being omitted from the solution, which was not specially purified) has no influence upon growth in green heterotrophic culture in darkness (1 per cent glucose, air + 3 per cent carbon dioxide); however, cells of this culture show an inhibited photosynthesis in light and give the well-known recovery effect. Cells cultivated autotrophically and mixotrophically (glucose + light) are strongly inhibited in their growth by manganese deficiency. In mixotrophic cultures the glucose is not completely used up. If transferred to darkness, the manganese-deficient mixotrophic cells continue glucose consumption and growth. Conversely, growth and glucose consumption are stopped when heterotrophic cells from manganese-deficient cultures are transferred from darkness into sufficiently strong

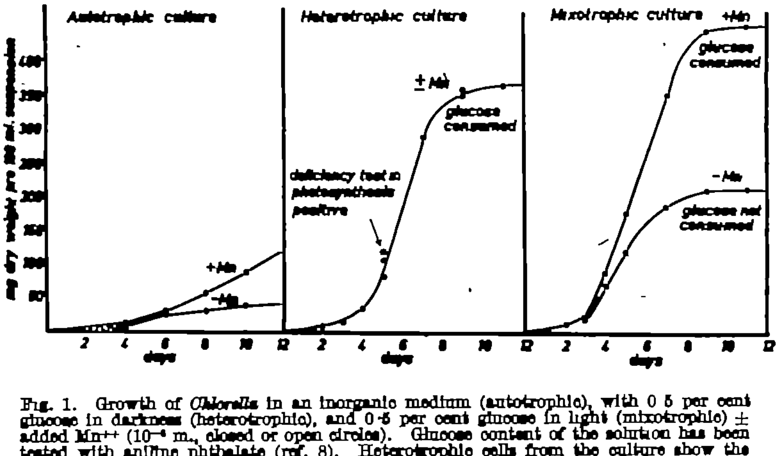

Fig. 1. Growth of *Chlorella* in an inorganic medium (autotrophic), with 0·5 per cent glucose in darkness (heterotrophic), and 0·5 per cent glucose in light (mixotrophic) ± added $Mn^{++}$ ($10^{-4}$ m., closed or open circles). Glucose content of the solution has been tested with aniline phthalate (ref. 8). Heterotrophic cells from the culture show the typical photosynthetic symptoms of manganese deficiency, when transferred to light at the time marked by the arrow

light. The question why mixotrophically grown manganese-deficient cells in the light are prevented from adopting the heterotrophic form of nutrition is being explored at present. The available data suggest a photometabolism of glucose, which is different from that in darkness, and which is linked to the photosynthetic apparatus of the cell[3]. Other results obtained with normal and deficient cells point in the same direction[4].

Whether the photometabolism of glucose can be compared with the consumption of organic material by green and purple bacteria[5] during anaerobic photosynthesis must be further studied. *Chlorella*, which has been grown anaerobically without carbon dioxide but with glucose in the light[7], proves, according to our observations, to have the same requirement of manganese as autotrophic and mixotrophic cultures. Manganese deficiency manifests itself in all the cases examined, where the cells make use of their photosynthetic apparatus.

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March 15.

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## Genetics of Endosperm

In *Trillium grandiflorum* and other species of the same genus, cold treatment reveals differences between homologous chromosomes with regard to number and/or length of heterochromatic segments[1]. In our experiments, differences have been found in the $B$-, $C$- and $E$-chromosomes (Figs. 1, 2$A$). According to the number and length of these segments, the following types of chromosomes have been distinguished: $B_1$, $B\frac{1}{2}$, $C_1$, $C_2$, $E_2$ and $E_3$ (where the suffixes give the number or length of the heterochromatic regions).

In order to learn how eu- and heterochromatic blocks are carried over into daughter plants, crosses between individuals of *T. grandiflorum* differing in the structure of homologous chromosomes have been made (for example, $C_1C_2 \times C_1C_1$).

Fig. 3 illustrates the embryo sac development of *T. grandiflorum* and the possible ways of distribution of the homologous chromosomes $C_1$ and $C_2$ in the cross $C_1C_2 \times C_1C_1$. It will be evident that the chromosomal differences in *T. grandiflorum* may serve as markers in a 'tetrad analysis' if endosperms are used as $F_1$-progeny. All $C_1C_1C_1$- and $C_1C_2C_2$-endosperms are the product of a first-division segregation, whereas the $C_1C_1C_2$-endosperms arise as the result of a second-division segregation of the heterochromatic region (Fig. 2$B$).

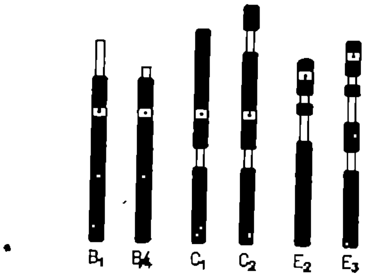

Fig. 1. Chromosomes of *Trillium grandiflorum* (euchromatin in black, heterochromatin in white; centromere region dotted). × 5,000

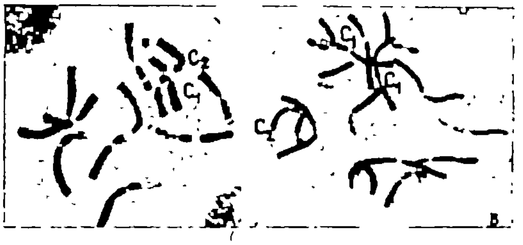

Fig. 2. Chromosomes of *Trillium grandiflorum*, × 800. ($A$) Metaphase from a cold-treated root tip, ($B$) metaphase from a cold-treated endosperm of the cross $C_1C_2 \times C_1C_1$ ($C_1C_1C_2$ indicating second-division segregation)

In our experiments, all three types of endosper occurred (see Table 1). In agreement with expecta tion, the ratio of the two types of first-divisio segregation, $C_1C_1C_1$ and $C_1C_2C_2$, was found to b around 1 : 1. The frequencies of second-divisio segregation, of type $C_1C_1C_2$, proved to be fairly hig ($x = 37$, $y = 28$, $z = 42$). Mather[2] has shown tha in the absence of interference, the frequency c second-division segregation approaches a randor value of 2/3 when the distance between the centrc mere and a given locus becomes large. In two case our experimental data do not deviate significantl from this theoretical value ($P_x < 0{\cdot}2$, $P_y < 0{\cdot}3$). I the third case, however, the observed proportion c second-division segregation is significantly highe

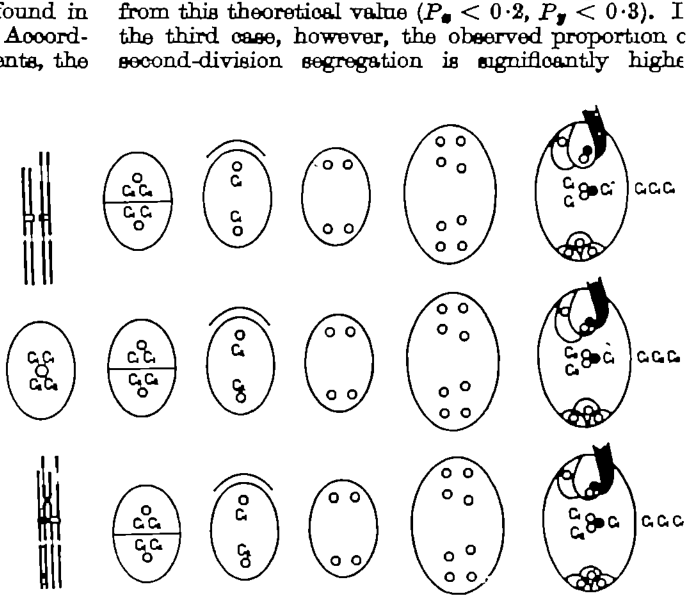

Fig. 3. Illustration of embryo-sac development in *Trillium grandiflorum* (*Allium*-type), showing distribution of homologous chromosomes (sperm nuclei and pollen tubes shown in black)

ble 1. DISTRIBUTION OF HETEROMORPHIC CHROMOSOME PAIRS IN ENDOSPERMS OF *Trillium grandiflorum*

| Parent plants and cross | Endosperms | | | Second division segregation (per cent) |
|---|---|---|---|---|
| 1. $C_1C_2 \times C_1C_1$ | $C_1C_1C_1$ | $C_1C_1C_2$ | $C_1C_2C_2$ | |
| $G$ 3 × $G$ 42 | 3 | 15 | 4 | |
| $G$ 3 × $G$ 4 | 0 | 20 | 3 | |
| $G$ 55 × $G$ 42 | 6 | 27 | 7 | |
| $GH$ 1 × $G$ 19 | 0 | 1 | 1 | |
| $GH$ 2 × $G$ 19 | 0 | 4 | 0 | |
| $GH$ 6 × $G$ 45 | 1 | 7 | 2 | |
| $GH$13 × $G$ 49 | 0 | 4 | 0 | |
| Total | 10 | 78 | 17 | 37 |
| 2. $B_1B_2 \times B_1B_1$ | $B_1B_1B_1$ | $B_1B_1B_2$ | $B_1B_2B_2$ | |
| $G$ 40 × $G$ 4 | 3 | 8 | 6 | |
| $G$ 40 × $G$ 23 | 2 | 6 | 0 | |
| $G$ 72 × $G$ 45 | 4 | 11 | 3 | |
| $GH$ 2 × $G$ 19 | 1 | 3 | 0 | |
| $GH$13 × $G$ 49 | 0 | 0 | 3 | |
| Total | 10 | 28 | 12 | 28 |
| 3. $B_1B^t \times B_1B_1$<br>$G$ 23 × $G$ 36 | $B_1B_1B_1$<br>4 | $B_1B_1B^t$<br>57 | $B_1B^tB^t$<br>7 | 12 |

$_s < 0{\cdot}01$), suggesting the presence of interference or localized chiasmata in our material.

This type of tetrad analysis, which is based on the esence of one product of the first meiotic division ly, has independently been used by Leupold ersonal communication) for determining second-vision segregation frequencies in the surviving rogeny of monosomic segregants derived from traploid yeast strains.

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## Influence of the Origin of the Isolate of *Rhizoctonia solani* on its Pathogenicity

THE fact which has received most attention in nnexion with investigations on the pathogenicity *Rhizoctonia solani* strains is the influence of the igin of the isolate on its pathogenicity. The results these investigations are rather contradictory. hus, Wellman[1], Gram and Webber[2] and others aim that each isolate is most pathogenic to that ant species and its close relations from which it has en obtained. On the other hand, the results ported by Storey[3], Peltier[4], Houston[5], Bosch[6], innasalmi[7] and others seem to oppose this theory of ecificity.

In the present investigation, *Rhizoctonia* strains olated from Ashmouny and Giza '30' cotton rieties, tomato, water-melons, *Phaseolus* and *isum* damped-off seeds and seedlings were used. he different strains were inoculated separately into erile soil in the usual way. Seeds of the different ants mentioned above were sown in soils containing ch of the *Rhizoctonia* strains after adjusting their oisture content to 60 per cent water-holding cap- ity. Controls were kept in sterile soil at the same oisture-level. The containers were incubated at vo temperature-levels, namely, 9°–15° C. and 21°– ° C., for a period of four weeks, during which nergence, post-emergence damping-off and survival ounts were made.

Examination of the results obtained from the high-temperature series showed that: (1) Within the same plant species, for example cotton, isolates obtained from Giza '30' variety showed a striking difference in their pathogenicity from that of Ashmouny. Thus, two isolates obtained from Giza '30' cotton were almost non-pathogenic to tomato and slightly pathogenic to the other hosts. The isolate obtained from Ashmouny cotton, on the other hand, proved to be very pathogenic to the two cotton varieties and *Pisum*. The other three hosts, namely, tomato, *Phaseolus* and water-melon, showed appreciable susceptibility to this isolate. (2) The isolate from water-melon proved to be weakly parasitic, if at all, on the various host plants used. (3) The isolate from *Phaseolus* was very active against water-melon and *Pisum* and moderately active against the rest of the host plants. (4) The isolate from tomato attacked all seedlings of the two cotton varieties and about 60 per cent of the seedlings of *Phaseolus*. On tomato seedlings themselves this isolate proved to be a weak parasite, particularly as a cause of pre-emergence damping-off, although it was quite active as a post-emergence damping-off causal agent. (5) The most active isolate was that of *Pisum*. It destroyed the seedling stands of five host plants completely and the sixth, that is tomato, was badly injured.

The results of the low-temperature series showed that: (1) The pathogenicity of the isolate obtained from Giza '30' cotton, the isolate from Ashmouny cotton and that from water-melon followed, more or less, the same trend as that at high temperature. (2) The isolate from water-melon again proved to be non-pathogenic to the various host plants used. (3) The isolates from tomato, *Phaseolus* and *Pisum* were destructive to all host plants.

The hosts used in this investigation are of very widely separated families of the angiosperms, and yet all, or nearly all, of them were destroyed by several isolates obtained from unrelated plants. This fact supports the view that there is no specificity of the attack of *Rhizoctonia* isolates on the host plants. The facts that the isolate of Ashmouny cotton destroyed the whole stand of *Pisum* seedlings and was only moderately pathogenic at high temperature to *Phaseolus*, which belongs to the same family, and that the isolates of tomato and *Phaseolus* revealed the same effect at both temperature-levels may be taken as circumstantial evidence supporting the view of non-specificity of *Rhizoctonia* isolates.

The results of the present investigation also refute the view that the isolate is usually most active on the plant species from which it has been obtained, since it can be seen from the results of the high-temperature series that the isolates from tomato and *Phaseolus* were more active on other hosts than the respective plants from which they were obtained.

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## Apparent Reciprocal Exchange of Characters between the *Mel* and *NWS* Strains of Influenza *A* Virus in the Brain of One-day Old Mice

EVIDENCE has accumulated in the work of Burnet and his colleagues[1,2] that some form of genetic interchange takes place between two strains of influenza virus that have been inoculated into a susceptible host in adequate amounts. However, information about the interaction between the non-neurotropic, *Mel*, and the neurotropic, *NWS*, strains of influenza *A*, which was among the first to be described[1], remained deficient in some important respects.

The recombinant recovered from this system was *N-M* (neuro-*Mel*) virus; but mouse-neuropathogenic *N-M* strains were recovered only from doubly infected mouse brain, not from the infected allantoic cavity of the chick embryo. They were recoverable only after four days had elapsed from the time of intracerebral inoculation[1]. The yield of *N-M* strains from the allantoic cavity was always too small to permit its recovery by direct dilution of the primary product of double infection[3]. No non-pathogenic strain of *WS* serological type was obtained either from the mouse brain or from the allantoic cavity[4]. All this cast some doubt on the mode of origin of *N-M* strains.

In order to investigate these deficiencies, experiments were undertaken to determine how early, after double infection of brain, recombinant strains could be obtained, to find out to what extent neuropathogenicity was transferred at this stage and to search for non-neurotropic viruses of the *WS* type which could be regarded as the 'reciprocal recombinants' to *N-M* in the *NWS* – *Mel* recombination system.

Double intracerebral infection of the one-day old mouse provided a successful method. Such a site of genetic interaction has several disadvantages. The original inoculum is not confined to the site of inoculation[5]; there is no hope of preventing the product of the first cycle of multiplication from being similarly dispersed or from initiating a second reproductive cycle; the cerebral tissue, unlike the allantoic membrane, is heterogeneous and some cells may support the growth of one virus strain better than another. On the other hand, tł unadapted *Mel* strain will grow for at least oı reproductive cycle[6] and the growth of *NWS* ougł to be favoured by this environment.

In spite of these complexities, direct titration ɛ the limit of infectivity of suspensions of braı harvested at various intervals after the inoculatic of approximately $10^{7\cdot6}$ $ID_{50}$ of each strain of virı revealed the presence of virus strains which cou be regarded as reciprocal recombinants of the tw parent strains *Mel* and *NWS*.

Table 1 shows their origin, the time after inoculatic at which they were found and the properties by whic they are ordinarily distinguished. The numbere fluids were obtained by two successive passages ɛ limiting infective dilution from the original suspensic of infected brain, and the properties to which tł table refers were tested on freshly harvested fluic prepared from the numbered fluids by one furth allantoic passage at the limit of infectivity in elever day old chick embryos.

The interesting features of the results are:

(1) Recovery of non-neurotropic virus of the *W* type at a slightly earlier stage than that at whic *N-M*'s were isolated. It is recognizable *in vitro* t some degree of stability against heating at 56° C. fo 30 min. and by its lack of sensitivity, when heate to the inhibiting effect of ovomucin.

(2) *N-M* strains were recovered after 12 hr. I this time it is unlikely that spontaneous mutatıc and selection by the favourable environment ɛ nervous tissue could account for their origin in suc numbers.

(3) The distribution of pathogenicity in the *N-1* strains extended over a wide range, from three straiı which were non-pathogenic to the chick embryo c chorio-allantoic inoculation, but which proved leth intravenously, to two strains which were fully leth for both the chick embryo and the adult mous This distribution at an early stage in the series ɛ reproductive cycles is similar to that of fourth-da fluids and to that obtained for other recombinaı systems by Lind and Burnet[7].

(4) The total yield of recombinants as compare with the proportion in the chick allantoic cavity aı the recovery of a possible *WS* recombinant sugge that the opportunities for genetic interaction ɛ these two strains may vary from one tissue to anothe

Table 1

| Fluid No. | Source (mouse brain No.) | Time recovered after infection (hr.) | Titre: Unheated | Titre: Heated 56° C. 30 min. | Serological type | Indicator phase to ovomucin | Pathogenicity: To chick via chorioallantois | Pathogenicity: To mouse intracerebral |
|---|---|---|---|---|---|---|---|---|
| 4,422 | 358 | +18 | 480 | 30 | *Mel* | + | *P* | *L* |
| 4,579 | 358 | 18 | 40 | 12 | *Mel* | + | *P* | *L* |
| 4,491 | 358 | 18 | 520 | 55 | *Mel* | + | *P* | *P* |
| 4,597 | 358 | 18 | 20 | 12 | *Mel* | + | *P* | *P* |
| 4,564 | 358 | 18 | 240 | 100 | *Mel* | + | *P* | 0 |
| 4,499 | 358 | 18 | 60 | 20 | *Mel* | + | *P* | 0 |
| 4,590 | 358 | 18 | 60 | 25 | *Mel* | + | 0 (*P*) | 0 |
| 4,151 | 341 | 18 | 160 | 80 | *Mel* | + | *P* | *P* |
| 4,232 | 314 | 12 | 30 | 15 | *Mel* | + | *P* | *P* |
| 4,185 | 342 | 18 | 300 | 120 | *Mel* | + | 0 (*P*) | 0 |
| 3,901 | 308 | 19 | 40 | 10 | *Mel* | + | 0 (*P*) | 0 |
| 6,205 | 312 | 12 | 140 | 50 | *NWS* | – | 0 | 0 |
| 6,185 | 314 | 12 | 800 | 400 | *NWS* | – | 0 | 0 |
| 6,411 | 312 | 12 | 280 | 60 | *NWS* | – | 0 | 0 |
| 6,610 | 339 | 12 | 300 | 160 | *NWS* | – | 0 | 0 |
| 6,582 | 332 | 8 | 320 | 80 | *NWS* | – | 0 | 0 |
| Stock *Mel* | | | 800 | 800 | *Mel* | – | 0 | 0 |
| Stock *NWS* | | | 400 | 0 | *NWS* | + | *P* | *L* |

+ = Hæmagglutination inhibited by high dilution of ovomucin; – = hæmagglutination not inhibited by ovomucin; *L* = lethal with 10 days after intracerebral inoculation of $10^{4\cdot5}$ $ID_{50}$; *P* = producing symptoms, specific either for chick embryo or for mouse; (*P*) = produc symptoms only after intravenous inoculation of chick embryo; 0 = no symptoms or lesions produced.

(5) The demonstration of the indicator phase in eat-sensitive *NWS* will be described elsewhere. This haracter of *NWS* has only been assumed to exist ntil now[7].

This work was supported by a grant from the dvisory Committee on Medical Research (Scotland) nd will be reported in detail later.

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March 21.

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## A New Species of Sporozoan ?

In the course of research on digestion in *Cardium dule*, Mr. G. Owen, of this Department, noticed tructures, which he termed 'spicules', occurring in he epithelia of the ducts of the digestive diverticula, tomach and midgut. I believe these 'spicules' to be stage in the life-cycle of a coccidiomorph sporozoan, ut can find no account of them in the literature. he following description of them is offered in the ope that if they have already been described I will ceive notice of it.

The 'spicules' are slender cylindrical structures bout 1·5μ in diameter, tapering quite sharply at ne end (the proximal end) and more slowly at the ther. They range in length from 10μ to 50μ and are ound intracellularly, with the long axis perpendicular o the plane of the epithelium (Fig. 1).

The nuclear region (so designated on the strength f Feulgen-positive staining) is situated about one-fth of the overall length from the proximal end, that s, the end in the basal region of the epithelium. The pparent structure of this region varies somewhat, epending on both the state of development of the picule' and the staining method used. In any event seems to consist of a capsule 2–7μ in length con-aining a Feulgen-positive particle or particles 1–4μ in length. The 'spicule' is a little swollen in this region.

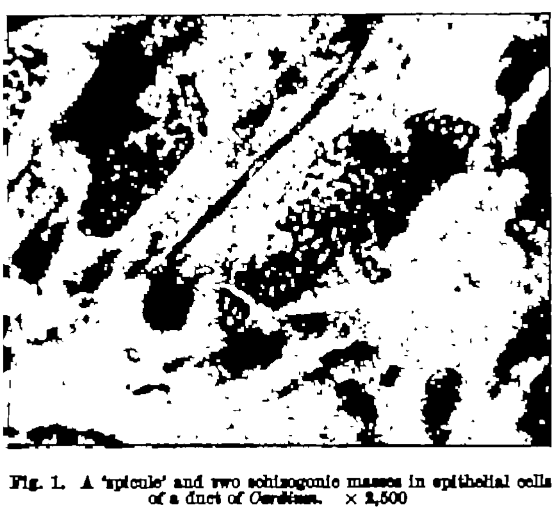

Fig. 1. A 'spicule' and two schizogonic masses in epithelial cells of a duct of *Cardium*. × 2,500

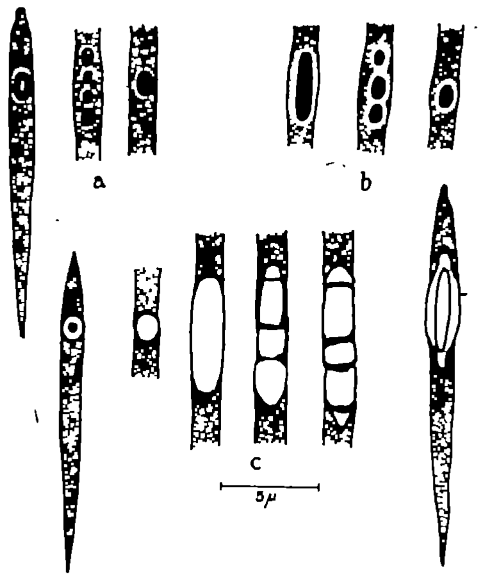

Fig. 2. Appearance of nuclear region produced by (*a*) iron haematoxylin; (*b*) Feulgen; (*c*) crystal violet

Epithelia in the ducts of the digestive diverticula contain many schizogonic masses, in highly hypertrophied cells, besides the 'spicule' stage. These schizogonies make the interpretation of feeding experiments very difficult unless the material fed is quite characteristically distinct from them in staining properties. Still other stages can be seen in the connective tissues and amoebocytes between the ducts.

Practically 100 per cent incidence of infection has been recorded in specimens of *C. edule* from Plymouth, Bangor and Millport. The infection is frequently so heavy that it obliterates much of the epithelium.

A full and complete description of the organism will be published later.

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March 17.

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## Glacial Shore-lines

The transition of the shore-line in the neighbourhood of a large ice sheet has been calculated on the assumption that the Earth behaved under the load as an elastic spherical shell enclosing incompressible fluid. The analysis is an extension of that of Niskanen[1], who considered uniformly thick and terraced ice caps, but who calculated the shore-line movement only at the centre, at the edge, and 90° from the centre of these caps.

In the present calculations, the ice load was taken to be that of two polar caps the thickness of which is given by

$$h = h_0 \left( \frac{P_2 (\cos \theta) - P_2 (\cos \theta_0)}{1 - P_2 (\cos \theta_0)} \right)$$

where $h_0$ is maximum thickness of either cap; $\theta_0$ is angular radius of either cap; $\theta$ is latitude of any point on the sphere measured from the North Pole; $P_2$ is a Legendre polynomial of order two.

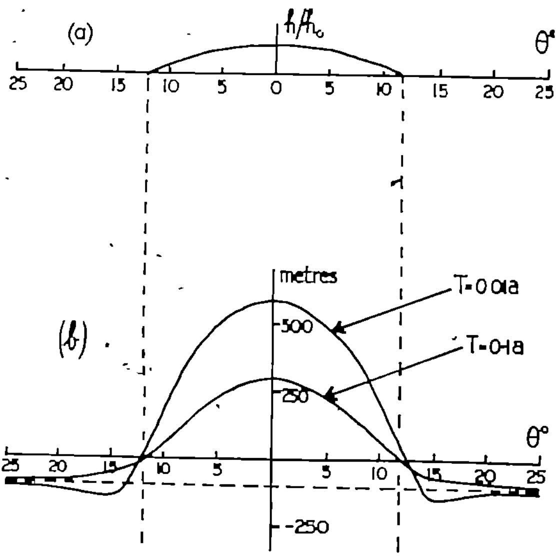

Fig. 1

Fig. 1a shows the shape of the northern cap when θ = 12°.

In order to simplify the problem further, it was assumed (following Niskanen) that where there is no ice there is ocean, and that there occurs in this oceanic region a general or eustatic lowering of the sea corresponding to the abstraction of water to form the ice caps. This removal of water from the ocean affects the elastic solution only very slightly, so that in the final calculation of the shore-line movement one may insert any reasonable value of the eustatic lowering without vitiating the elastic solution. In the present case, the volume of ice in two polar caps of maximum thickness 2,500 m. and of angular radius 12° actually corresponds to a eustatic lowering of only 50 m. over the remaining portion of the Earth's surface.

The transition of the shore-line at any point in the oceanic region was obtained by adding algebraically the four quantities: $U$ (radial elastic displacement of the originally spherical surface of the Earth), $\zeta_1$ (radial displacement of the geoid produced by the elastic displacement $U$), $\zeta_2$ (radial displacement of the geoid produced by the gravitational attraction of the ice cap) and $d$ (eustatic lowering of sea-level). The effect of the mutual attraction of the rearranged water was negligible. A correction to $\zeta_1$ was made to account for the effect of compressibility of the elastic crust.

The rigidity of the crust was taken to be $3 \times 10^{11}$ dynes per sq. cm., the density to be 3·3 gm. per c.c. and the density of the fluid interior to be 4 gm. per c.c. The transition of the shore-line was calculated for the two cases $T = 0{\cdot}1a$ and $T = 0{\cdot}01a$, where $T$ is the thickness of the elastic shell and $a$ is the mean radius of the Earth. In both cases the eustatic lowering accompanying the glaciation was assumed to be 100 m.; Fig. 1b shows the present position of the former glacial shore-line in the northern hemisphere. The glaciated region was not, of course, affected by the eustatic lowering; but if the sea had had access to that area, the present position of the shore would be that shown in the diagram.

It can be seen that, in the area over which there was no ice, there ought now to be raised beaches very near the edge of the former ice cap; but th farther off, the glacial shore-lines should now submerged. For the case $T = 0{\cdot}01a$, the prese depth of these shore-lines increases rather rapid with increasing θ (in the northern hemisphere), un it reaches a maximum at about 300 km. from t edge of the cap. Thereafter, the depth decreases a approaches the eustatic limit (100 m.) from bel and is nearest to that depth on the equator. For $T$ 0·1$a$, the maximum depth of the shore-line is d placed to θ = 30° approximately. It is clear, howev that beyond θ = 45° the departures of the transit from the eustatic limit in either case will be sma and that measurements of the depth of submerg glacial shore-lines made in middle latitudes so to spe will give $d$ fairly accurately. But over a considerab area in the neighbourhood of a former ice cap, t present depth of glacial shore-lines may diff appreciably from that calculated by assuming se level changes there to have been wholly eustatic.

Applying these results to south-west England, f example, and to Devon in particular, which i about 1,600 km. from the centre of the Scandinavi ice cap, we find that the present depth below se level of the glacial shore-line should be either 137 ($T = 0{\cdot}01a$) or 56 m. ($T = 0{\cdot}1a$), both nearly 40 p cent different from the value of the eustatic lowerin

This work was carried out while I was a resear student in the Department of Geodesy and Ge physics, University of Cambridge, and I am indebt to Dr. R. Stoneley for much helpful criticism.

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## Slow Disappearance of Fluorescence in Thionine on Addition of Abietic Acid

THE quenching of fluorescence in solution by adde substances is generally regarded as an almost i stantaneous process[1]. We have observed that a quench ing process takes a considerable time for completio affording thereby an opportunity of a very detaile study of the process. If an alcoholic solution abietic acid be added to a solution of thionine i the same solvent, a slow and continuous decrea of fluorescence occurs until it is practically com pletely quenched. The change has been measure fluorimetrically, and a few typical results are repr sented graphically in Fig. 1.

It can be seen from Fig. 1 (curves 1, 2 and 3) tha the higher the concentration of the acid or the dy the more rapid is the quenching. Curve 4 shows tha a higher temperature brings about faster quenchin and curve 5 shows that the medium strongly i fluences the process, $n$-butyl alcohol bringing abou faster quenching than ethyl alcohol.

The most likely explanation seems to be that slow chemical reaction takes place with the formatio of a thionine–abietic acid complex which provide little scope for any intermediate transition to th metastable energy-level responsible for fluorescenc The structures of thionine and abietic acid, howeve do not readily suggest a hitherto known type chemical combination. But the chemical interactio if there be any, must be a very pronounced on since the equilibrium mixture eventually obtaine

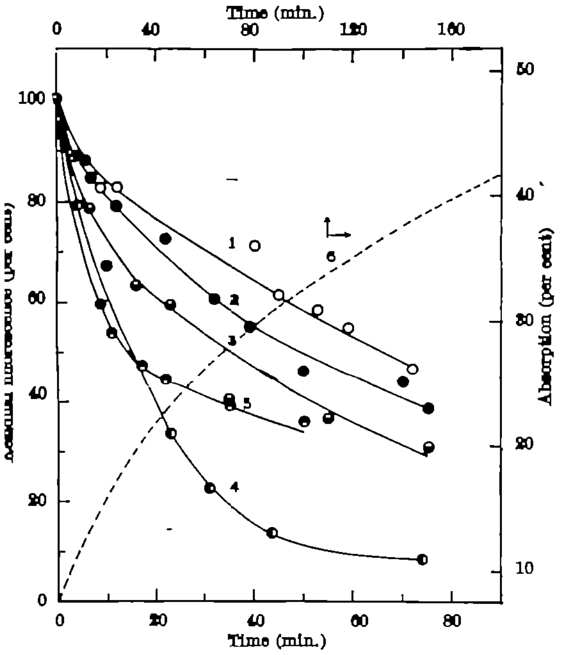

Fig. 1. Change in fluorescence of thionine with time in the presence of abietic acid

| Curve No. | Concentration of thionine ($M$) | Con. of abietic acid ($M$) | Temp. | Solvent. |
|---|---|---|---|---|
| 1 | $10^{-5}$ | $10^{-3}$ | 25° C. | Ethyl alcohol |
| 2 | $10^{-4}$ | $0\ 25 \times 10^{-3}$ | 25° C. | Ethyl alcohol |
| 3 | $10^{-4}$ | $10^{-3}$ | 25° C. | Ethyl alcohol |
| 4 | $10^{-4}$ | $10^{-3}$ | 35° C. | Ethyl alcohol |
| 5 | $10^{-4}$ | $10^{-2}$ | 25° C. | $n$-Butyl alcohol |
| 6 | Change of absorption coefficient with time, under the same conditions as curve 3 ($\lambda$ = 635 m$\mu$) | | | |

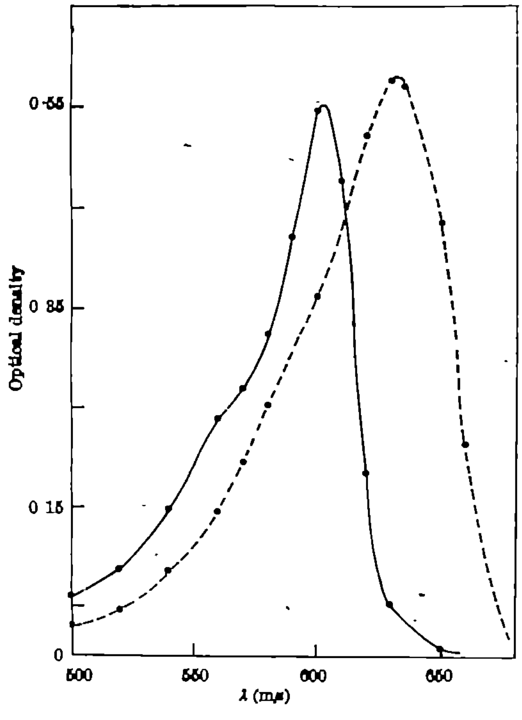

Fig. 2. Change in the absorption spectra of thionine due to quenching by abietic acid. ———, thionine ($10^{-5}$ $M$), max. at 602 m$\mu$; - - - -, quenched thionine, max. at 631 m$\mu$

contains practically no free thionine. On a rough computation, the energy of activation is about 15,000 cal. Moreover, the interaction seems to be highly specific, as a large number of organic substances have been tested by us and found to have no such effect on thionine. Even dihydroabietic acid (differing from abietic acid in one double bond) and its lactone do not quench the fluorescence of thionine. The last observation gives significance to the particular double bond in the abietic acid molecule. Unsaturation, however, is by itself not a factor for quenching, as oleic acid and styrene have been found to be ineffective.

Absorption spectra of thionine in alcohol (Fig. 2) show that, concomitant with quenching by abietic acid, there is also a small shift of about 30 mμ of the absorption maximum towards longer wavelengths. As a result of this shift, absorption is also markedly higher near the new peak, and it is possible to follow the kinetics by measurement of absorption in this region. A typical case of change of absorption with time observed at 635 mμ, which goes parallel with the quenching process, is shown as a dotted curve in Fig. 1 (curve 6).

The above observations thus provide us with a method of studying precisely the kinetics of an addition reaction at extreme dilutions ($10^{-4}$–$10^{-6}$ $M$ or less), and this may have some importance in connexion with biochemical studies involving thionine and similar compounds which are known to affect tissue oxidation and other physiological processes strongly[2]. Also the striking selectivity of abietic acid as described here may be made the basis of a method of its estimation. Detection and estimation of abietic acid have commercial importance since rosin, containing about 85 per cent abietic acid, is very often used as an adulterant to costlier gums such as shellac.

Further investigation is in progress, and detailed results will be published elsewhere.

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## Micro-determination of Phosphorus

The increasing application of chromatography to the separation of phospholipids[1] has emphasized the need for greater sensitivity in the estimation of total phosphorus.

Sensitive methods have been described for inorganic phosphate, for example in serum[2], using small volumes of reagents; but they are not readily applicable to the perchloric acid digests obtained in the total phosphorus method, where the volume of acid cannot easily be reduced to less than 2 ml. The method of Allen[3] has proved satisfactory for routine use, but the transference of the digest to a standard flask for development of the molybdenum blue colour results in a final volume of 25 ml. of solution for measurement. The procedure described by Allen for inorganic phosphate in turbid or coloured solutions utilized extraction of the blue compound with isobutyl alcohol, and this principle can be used for simplifying the method for total phosphorus and for increasing its sensitivity about tenfold.

Following digestion with perchloric acid, the colour is developed in the digestion flask as described by Allen and, after 5 min., 3 ml. methyl*iso*butyl ketone is added and the flask shaken for 1 min. To facilitate removal of the coloured ketone layer by pipette, the contents of the flask are poured into a ½-in. diameter test-tube, or the interface is brought into the neck of the digestion flask by adding water saturated with the ketone. The blue colour tends to fade slightly during the first thirty minutes after extraction, but then remains constant for at least one hour and is read during this period.

The calibration curve is linear and passes through zero; 10 μgm. phosphorus gives an extinction of 0·57 at 680 mμ in a 1-cm. cell. As described above, as little as 1 μgm. phosphorus can be estimated; by taking less of the extracting solvent and using micro-cuvettes, the limit could be lowered.

This work was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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[1] Lea, C. H., Rhodes, D. N., and Stoll, R. D., *Biochem. J.* (in the press).

[2] Horwitt, B. N., *J. Biol. Chem.*, 199, 537 (1952).

[3] Allen, R. J. L., *Biochem. J.*, 34, 858 (1940).

## Infra-Red Spectra and the Polymorphism of Glycerides

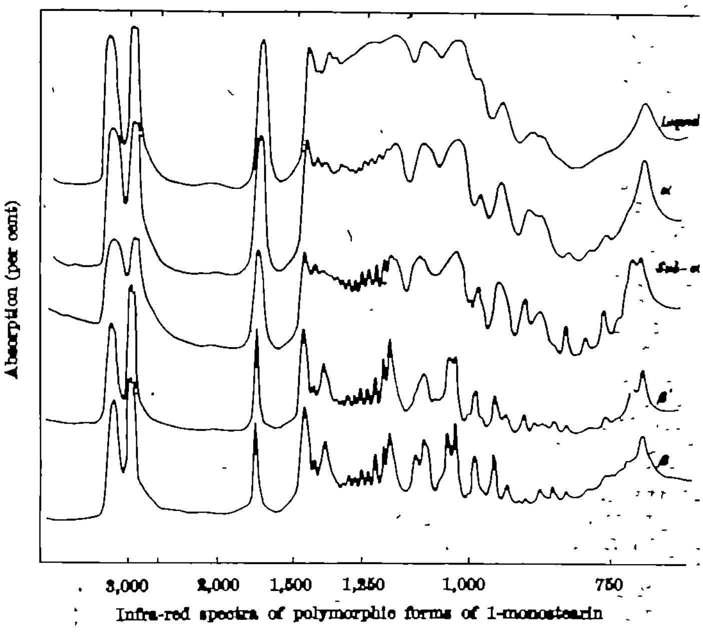
ALTHOUGH it is known that abrupt changes can occur in the infra-red spectra of the crystalline phase when polymorphic transitions occur[1], comparatively little use has been made of this fact to investigate polymorphic changes themselves. The purpose of this communication is to point out that the use of the infra-red technique can be extremely valuable in such cases. The speed of obtaining a spectrum can be useful in those cases where transitions are fairly rapid. Furthermore, information about the molecular structures, for example, hydrogen bonding, etc., can be obtained, and in some cases perhaps even the site symmetry of the molecules in the various polymorphic forms can be deduced.

The polymorphism of some 1-monoglycerides has been investigated using this technique. These glycerides are thought to exist in at least three different forms[2,3], namely, a low melting α-form (vertical rotating chains), two higher-melting forms β′- and β- (inclined chains, alternating melting points). Lutton and Jackson[3] state that the α-form is reasonably stable down to a lower transition temperature, at which point it changes into a new crystalline modification, sub-α, giving a distinctive set of short spacings. Controversy exists over whether the sub-α form is, or is not, crystalline, whether the sub-α α-transformation is genuinely reversible, and wheth the α-form is stable down to the lower transitic temperature.

The infra-red spectra of 1-monostearin in the liqu state and in various polymorphic forms are shov in Fig. 1. These spectra show that quite distinctr differences exist between the various forms. particular, differentiation between the sub-α and t β′-forms is easy, whereas clear differentiation difficult using X-ray powder photographs. T spectra of the liquid, the α- and the sub-α forms we obtained by using a heated infra-red cell *in situ* the infra-red beam. By this means it was possil to observe the transformation of the α- to sub-α for at the transition point 47° C., and the transformati appears to be reversible. The α-form was observ to be quite stable down to this temperature. T spectrum of the α-form indicates clearly that rotati is occurring in this phase, while considerable orient tional freedom is indicated in the sub-α form in t high-temperature regions. An indication of t crystallinity of the sub-α form may be obtained l observing that a band near 720 cm.$^{-1}$ in the α-for is single; but in the sub-α form it splits into tv components.

An analogous situation exists with solid *n*-paraffi in this region of the spectrum. In the liquid state, single band is observed, near 720 cm.$^{-1}$; this bar increases in intensity at the solidification point, ar at a lower transition point two components occu Between the solidification and transition points, t paraffin exists in a hexagonal form, and rotation the hydrocarbon chains about their axes takes plac whereas below the transition point the crystal syste becomes orthorhombic. It can also be compar with the spectrum of polythene, where a band 725 cm.$^{-1}$ is single in the amorphous or liquid stat but double in the crystalline form. The doubling he occurs because of coupling between the two molecul in the unit cell.

Crowe and Smyth, in an investigation of t dielectric behaviour of 1-monoglycerides[4], suggest orientation of various molecular segments in ord



Infra-red spectra of polymorphic forms of 1-monostearin explain the wide distribution of relaxation times erved in the sub-α phase despite the order observed X-ray methods. However, even in the orthombic form of *n*-paraffins, rotation of the hydrobon chains can occur, perhaps even 30 per cent room temperature. This could also occur with hydrocarbon chains of the sub-α form, and would consistent with the sub-α spectrum. The sub-α m was found to be quite stable at room temperae, in agreement with the observation of Lutton l Jackson[3]. The β- and β′-forms were obtained n solvent by slow and rapid crystallization pectively from light petroleum. X-ray and melting nt data were used to confirm the identity of the ms. The spectra of the β′- and β-forms were ained by dispersing the material in 'Nujol'. In the er monoglycerides, for example, monolaurin, the nsformation from the α-form to the final stable orm was followed by means of the spectra.

)ther glycerides (di- and tri-) have been investigated a similar manner and detailed results will be blished elsewhere.

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March 8.

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## Strain in 6,8-Thioctic Acid

N 1952 Calvin[1] advanced the hypothesis that the ilable energy of the excited chlorophyll molecule rts photosynthesis by splitting the disulphide ıd of thioctic acid into the biradical. As the ilable energy of the chlorophyll molecule is only 40 kcal. and the disulphide bond-energy lies newhere between 60 and 70 kcal. per mole, this cess would not be possible were it not for the sence of strain in the 1,2-dithiolane moiety of the octic acid molecule. Thus the strain in a 1,2-hiolane ring becomes important.

Recently, Barltrop, Hayes and Calvin[2] calculated strain of 1,2-dithiolane in three different ways. study of the ultra-violet spectra of straight-chain ılphides and 1,2-dithiolanes was used to deduce naximum value of the strain of 27 kcal. mole$^{-1}$ in five-membered ring system. An analysis of the bable structure of dithiolane combined with an imation of the magnitude of different strain factors to a minimum value of 11 kcal. Finally, a kinetic dy of the equilibrium between benzyl mercaptan l 1,2-dithiolane indicated a much smaller value the strain energy, namely, 6·5 kcal. mole$^{-1}$.

From general considerations it seems to be difficult reach a definite decision between the two lower ues of the strain energy. The high value obtained m the spectra should be rejected, because the umptions involved are not very realistic. The uctural analysis ought to be reliable; the method well established and the potential barrier against rotation around the S—S bond seems to be dy well known. The accuracy of the equilibrium investigation may suffer from the fact that the reaction studied is not very well defined.

The most direct way to get information on the energy of the 1,2-dithiolane ring system relative to that of a normal straight-chain disulphide is the calorimetric experiment. We have therefore studied the heat of oxidation of a number of thiols to disulphides, using iodine in 90 per cent ethanol as oxidant. The thiols were used in 20 per cent excess, thus assuring quantitative reduction of the iodine. They were of high purity (better than 99·5 per cent) with one exception, the 6,8-dimercapto-octanoic acid (a gift from Dr. L. C. Gunsalus, University of Illinois), which showed 87 per cent purity—as judged from iodine titrations.

The reaction products were analysed spectrophotometrically. Full agreement with Calvin's results on the 1,2-dithiacyclo-pentane and -hexane was achieved, showing that monomer ring disulphides were the only identifiable products.

The heat equivalent of the calorimetric system was determined electrically and the reproducibility of the measurements was better than 0·5 per cent.

The actual reaction, for which the heat of oxidation was measured, was

$$2\,R.\text{SH (liq.)} + I_2 \text{ (50 ml. 0·1 } N \text{ sol. in 90 per cent ethanol, 10 per cent water)} \rightarrow RSSR \text{ (sol.)} + 2\,\text{HI (0·1 } N \text{ sol.)} - \Delta Hr.$$

The following table gives the results in kcal. mole$^{-1}$.

| Thiol | Disulphide | $-\Delta Hr$ (kcal. mole$^{-1}$) |
|---|---|---|
| 1-Propanethiol | 4,5-Dithiaoctane | 29·85 |
| 1-Pentanethiol | 6,7-Dithiadodecane | 29·85 |
| 1,4-Butanedithiol | 1,2-Dithiacyclohexane | 29·45 |
| 1,3-Propanedithiol | 1,2-Dithiacyclopentane | 25·75 |
| 6,8-Dimercapto-octanoic acid | Thioctic acid | 26·20 |

Taking the heat of oxidation of *n*-propyl and *n*-amyl mercaptans as 'standard' (representing by definition the formation of strainless reaction products), we conclude that under prevailing conditions: (1) the strain in 1,2-dithiolane (parent ring structure) is 4 kcal.; (2) the strain of the substituted 6,8-thioctic acid is about 0·5 kcal. less—in agreement with the fact that substituents stabilize a strained-ring structure; (3) the strain in the six-membered ring 1,2-dithia*cyclo*hexane is on the borderline of significance and probably about 0·5 kcal. mole$^{-1}$.

The small strain in the coplanar—or almost coplanar—1,2-dithiolane structure is difficult to explain from the results of the strain analysis. However, it should be remembered that the strain analysis is valid for gaseous molecules, assuming zero intermolecular interaction. The calorimetric experiments have been carried out in a condensed phase and the conditions for intermolecular interactions may be significantly different for a normal disulphide with a dihedral angle of about 100° and a 1,2-dithiolane ring with the dihedral angle equal to or near zero.

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March 14.

[1] Calvin, M., and Barltrop, J. A., *J. Amer. Chem. Soc.*, **74**, 6153 (1952).

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## Autoxidation of Catechin

A MECHANISM is proposed for the autoxidation of catechin to a polymer (catechin tannin) which has for a long time been recognized to have tanning properties.

Empirical study of the fate of catechin at 100° has revealed two interesting reaction processes. In agreement with Freudenberg's interpretation[1] of phlobaphene formation, at $pH < 2$, a buff-coloured phlobaphene, which gave the colour reactions of catechol and phloroglucinol, was rapidly formed both in the presence and absence of oxygen. Between pH 4 and pH 8, however, catechin is autoxidized to red catechin tannin. Autoxidation was arrested by sodium hydrogen sulphite, and only epimerization occurred in absence of oxygen. Catechin tannin had phenolic properties, but it lacked the characteristic properties of catechol and phloroglucinol. Under more alkaline conditions another reaction, possibly ring-fission[2] leading to humic acids, intervened.

Catechin in phosphate buffer (pH 8) was shaken at 35° to constant oxygen uptake; when no catechin could be detected in the paper chromatogram of the reaction mixture, the polymer formed was absorbed on alumina and the hydrogen peroxide in the eluate estimated. The results were: total oxygen uptake 1·59, hydrogen peroxide formed 0·38; oxygen balance, 1·4 moles/mole catechin. Oxygen absorption was represented by a sigmoid curve; but as the rate was slow, namely, 0·0006 mole oxygen/mole catechin/min., an induction period was not detected.

When the autoxidation of catechin in phosphate buffer was followed spectrophotometrically, no intermediate was detected, and the resulting catechin tannin had $\lambda_{max.}$ 400 mμ (pH 6) and $\lambda_{max.}$ 420–430 mμ (pH 8). Silver oxide oxidation of dioxan solutions of catechin and catechol gave compounds of $\lambda_{max.}$ 370 mμ (*o*-benzoquinone ($C_6H_4O_2$) $\lambda_{max.}$ 370 mμ). Catechin tannin was formed when a solution of the corresponding *o*-quinone was shaken with oxygen in phosphate buffer, and by silver oxide oxidation of catechin in phosphate buffer.

It is now suggested that the main reaction sequence involves formation of *o*-quinone followed by oxidative condensation. Formation of *o*-quinone probably involves a free radical mechanism, since the reaction takes place in non-polar solvent. Hydrogen peroxide is associated with quinone formation, and its accumulation results from the difference in velocity of the radical processes, conveniently summarized as:

$$H_2Q + O_2 = Q + H_2O_2 ; \quad H_2Q + H_2O_2 = Q + 2H_2O$$

The autoxidation of polycyclic hydroquinones has afforded unpublished results (D. E. H.), which confirm formation of hydrogen peroxide in oxidations leading to quinones. Autoxidation of catechin is slow, since the oxidation to quinone is inhibited by phenols[3]. Previous evidence[4] for intermediate formation of *o*-quinone includes an attempted isolation of a dianilino-derivative (no analysis or melting point) when tea oxidase acts on catechin. The oxidative condensation is an ionic process requiring dissociating medium, in which addition of phenol to quinone occurs, with CO bond formation between one of the electrophilically activated sites (2′,5′,6′) of the quinone and one of the nucleophilically activated sites (6,8) of another quinone molecule or with the (6,8,2′,5′,6′) sites of a catechin molecule. Addition of phenol to quinone involves transfer of two hydrogen atoms to afford diphenylol, followed by oxidation to the corresponding quinone by means of oxygen, hydrogen peroxide or another molecule of quinone. T oxygen balance agrees with this reaction sequen which permits the formation of a highly irregu three-dimensional polymer, although certain CC bo are excluded on steric considerations. It is signific that since catechol is not bifunctional, it does undergo a similar polymerization. A number catechin derivatives are now being synthesized model substances with which to test these gene conclusions. This reaction sequence has also b postulated to explain the formation of melanin[5] a purpurogallin[6]. It is relevant to a suggestion[7] for formation of condensed tannins in Nature. By action of an oxidase on catechin there results quinone, which is normally reduced by an oxyg acceptor, for example ascorbic acid; but enzy oxidation of *o*-quinone to catechin tannin occ whenever the reduction mechanism is intercept This explanation is similar to that proposed[8] the action of tyrosinase on tyrosine, and the acti of plant polyphenolases on catechin is bei investigated.

We thank Dr. H. Phillips, director of the Brit Leather Manufacturers' Research Association, his advice and encouragement, and the Council the Association for permission to publish t communication.

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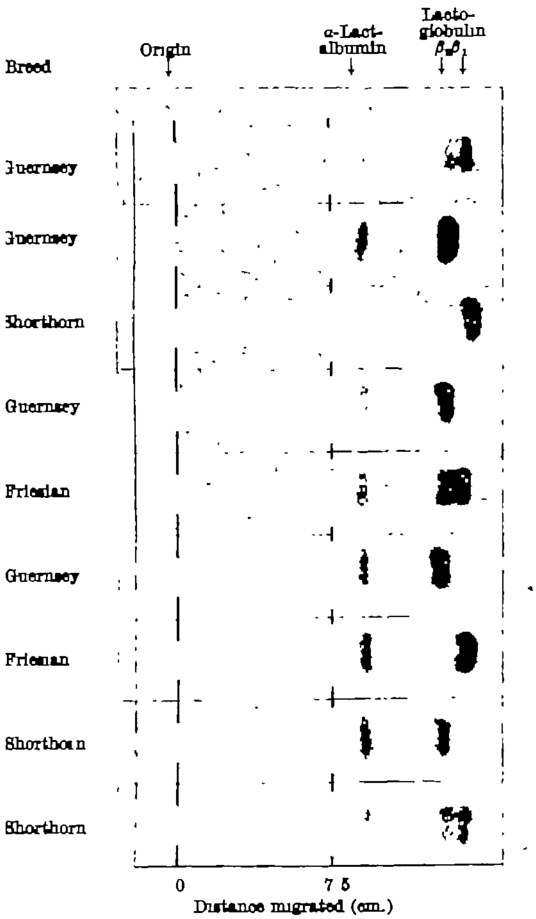
## Occurrence of Different Beta-Lactoglobuli in Cow's Milk

DURING the past twenty years, numerous physic chemical investigations of crystalline β-lactoglobu prepared from cow's milk have revealed a degree heterogeneity puzzling in a protein considered to 'pure' (see the recent discussion of this problem Ogston and Tilley[1]). In general, mixed milk has be used as the starting material, and it has been taci assumed that the β-lactoglobulin synthesized by t mammary gland is the same for all cows. This not the case.

When a suitably prepared fraction of the milk single cows (for example, the proteins soluble 20 per cent sodium sulphate) was subjected to elect phoresis on filter-paper in barbitone buffer at pH 8 $I = 0{\cdot}05$, using an apparatus of the type describ by Flynn and de Mayo[2], and applying 230 V. 16 hr., we found that individual cows produce eith a mixture of two electrophoretically distinct β-lac globulins or only one or the other of these, as sho in Fig. 1, which gives examples of each type. The t single components will be termed $\beta_1$- and $\beta_2$-lac globulin, following the nomenclature suggested Polis, Shmukler, Custer and McMeekin[3], and t mixture of the two in the milk of an individual co



g. 1. The β-lactoglobulins in the milk of nine individual cows (bromo-phenol blue staining)

l be termed $\beta_{1,2}$-lactoglobulin. In most instances, mixture contains more $\beta_1$- than $\beta_2$-lactoglobulin. So far as can be ascertained from our limited trophoretic data for the milk of the same animal mined on different occasions during one, two or ee lactation periods, the type of β-lactoglobulin duced is characteristic for a given cow. Up to the present, 27 Shorthorn, 22 Friesian, 12 Ayrshire and 9 Guernsey cows belonging to the Institute herds have been typed: 30 were found to produce $\beta_{1,2}$-, 7 $\beta_1$- and 33 $\beta_2$-lactoglobulin. The $\beta_{1,2}$- and $\beta_2$-forms were found with all four breeds, but the $\beta_1$-lactoglobulin as yet only in the milk of Shorthorn (3) and Friesian (4) cows. We have also examined the milk of eight sets of one-egg twin heifers. In each set the two animals produced the same type of protein, four sets giving $\beta_{1,2}$-, two $\beta_1$- and two $\beta_2$-lactoglobulin. It thus appears that the synthesis of these β-lactoglobulins is genetically determined; but much further work is clearly required on possible breed or breeding differences.

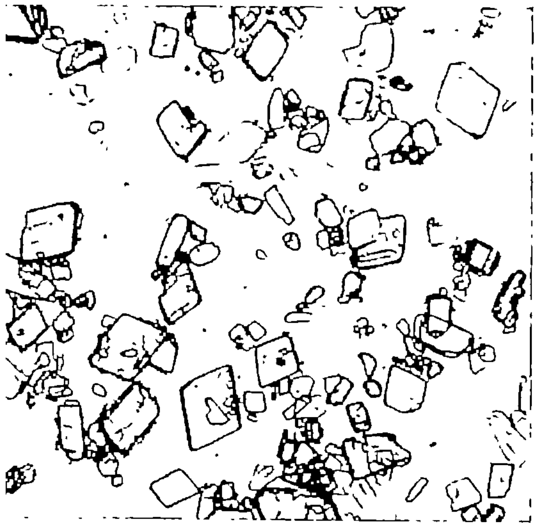


Fig. 2. Crystals of $\beta_2$-lactoglobulin. (× c. 100)

Starting from appropriately selected milks, $\beta_1$- and $\beta_2$-lactoglobulins have been prepared in the crystalline state for investigation of their physico-chemical properties. The crystals were found to be distinctly different; $\beta_1$-lactoglobulin forms rectangular plates indistinguishable from the well-known crystals hitherto prepared from mixed milk, and first photographed by Palmer[4], whereas $\beta_2$-lactoglobulin forms diamond-shaped plates, as illustrated in Fig. 2. The $\beta_1$-component may be identical with the fraction isolated in small yield from the β-lactoglobulin of mixed milk by Polis *et al.* Preliminary results point to other measurable differences between the $\beta_1$- and $\beta_2$-forms, for example, in the isoelectric point and solubility.

Further work on the properties of the isolated β-lactoglobulins and on the occurrence of the various forms in the milk of individual cows, with special reference to twins and to dams and their daughters, is now proceeding.

We are grateful to Mr. N. Gruber for the photographs.

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## Action of Insulin on Thiamine Phosphorylation *In vitro*

Previous work has demonstrated that in pancreatic diabetes a disturbance of the thiamine phosphorylation processes occurs and that the administration of insulin enhances the phosphorylation of thiamine provided that a sufficient amount of this substance is available to the organism[1].

It is known that insulin increases the synthesis of adenosine triphosphate and of phosphocreatine in muscle[2] and in liver[3], and thus directly or indirectly influences all phosphorylation reactions connected with adenosine triphosphate or phosphocreatine.

In order to show a direct action of insulin on the enzyme system phosphorylating thiamine, Foa *et al.*[4] studied the effect of insulin *in vitro* by adding this hormone, together with thiamine, to liver homogenates from normal and diabetic rats and then determining the formation of thiamine phosphates. Addition of insulin to homogenates from alloxan diabetic rats enhanced the phosphorylation of thiamine, thus lending weight to the hypothesis that insulin acts directly on thiamine phosphorylation.

Table 1. AMOUNT OF COCARBOXYLASE (µGM./GM. FRESH LIVER) FORMED IN THE INCUBATION MIXTURE

| Incubation | Normal rats | | | Diabetic rats | | |
|---|---|---|---|---|---|---|
| | No. of experiments | No added insulin | With added insulin (1·2 units) | No. of experiments | No added insulin | With added insuli (1·2 units) |
| *A* | 24 | 0·68 ± 0·10 | 0·72 ± 0·11 | 23 | 0·54 ± 0·08 | 0·57 ± 0·11 |
| *B* | 20 | 0·61 ± 0·11 | 0·59 ± 0·10 | 21 | 0·46 ± 0·07 | 0·47 ± 0·09 |

(*A*) Liver homogenate in isotonic potassium chloride solution (1 gm. of tissue + 3 ml. of potassium chloride solution). Incubation mix contains: liver homogenate corresponding to 200 mgm. of fresh liver; thiamine hydrochloride, 100 µgm.; magnesium $2 \times 10^{-3}$ mole; gluta acid 0·2 m.mole; cytochrome *c* $3 \times 10^{-5}$ mole; sodium adenosine triphosphate $5 \times 10^{-4}$ mole; creatine $5 \times 10^{-4}$ mole. Made up to a volume of 4 ml. with potassium chloride solution. Incubation at 38° for 40 min.

(*B*) Liver homogenate in isotonic potassium chloride – potassium phosphate buffer pH 7·5 (1 gm. of tissue + 4 ml. of isotonic soluti the suspension dialysed for 2 hr. against the same buffer. Incubation conditions as in (*A*).

Table 2. AMOUNT OF COCARBOXYLASE (µGM./3 ML. OF INCUBATION MIXTURE) FORMED IN THE INCUBATION

| Incubation | Normal rats | | | Diabetic rats | | |
|---|---|---|---|---|---|---|
| | No. of experiments | No added insulin | With added insulin (0·7 unit) | No. of experiments | No added insulin | With added insuli (0·7 unit) |
| *A* | 18 | 0·26 ± 0·04 | 0·27 ± 0·05 | 20 | 0·20 ± 0·03 | 0·19 ± 0·03 |
| *B* | 20 | 0·24 ± 0·03 | 0·28 ± 0·06 | 21 | 0·19 ± 0·03 | 0·36 ± 0·04 |
| *C* | 20 | 0·31 ± 0·05 | 0·36 ± 0·06 | 22 | 0·20 ± 0·03 | 0·34 ± 0·05 |

Results are means ± the standard error of the means.

(*A*), (*B*), (*C*): Liver thiaminokinase preparations according to Leuthard and Nielsen (ref. 6). Incubation mixture in 0·05 mole potas phosphate buffer, pH 7·4, containing thiamine hydrochloride 50 µgm.; thiaminokinase (dry powder) 3 mgm.; magnesium $2 \times 10^{-3}$ m glutamic acid 0·2 mole; sodium adenosine triphosphate $5 \times 10^{-4}$ mole. Final volume 4 ml. with potassium phosphate buffer.

Insulin was added to the incubation mixture: in (*A*) directly; in (*B*) after incubation at 38° for 30 min. in 0·5 ml. normal rat seru in (*C*) after incubation at 38° for 30 min. in 0·5 ml. diabetic rat serum.

We carried out experiments with liver homogenates under conditions very similar to those reported later by Foa *et al.*[4] (Table 1,*A*), and further work was then undertaken adopting the same experimental conditions as stated by these authors (Table 1,*B*). In neither case could their claims be confirmed.

The discrepancy in the results obtained by us and those of Foa *et al.* may be attributed to a different method in estimating the level of thiamine phosphorylation. While in our experiments cocarboxylase, enzymatically determined[5], has been assumed to be the index of thiamine phosphorylation, Foa *et al.*[4] analysed the materials by means of the thiochrome method, which determines both thiamine mono- and pyro-phosphate. The crude homogenate represents a very complicated enzymatic system, containing many interfering factors, which cannot always be estimated. Even if thiamine phosphorylation were found to be enhanced in such a system, this is not sufficient evidence for a direct action of insulin.

In other experiments, therefore, the action of insulin on thiamine phosphorylation using a much simplified system such as that described by Leuthard and Nielsen[6], which exhibits a strong thiaminokinase action, has been studied. The results of these experiments are reported in Table 2.

The addition of insulin to thiaminokinase preparations from normal and alloxan diabetic livers does not, however, exhibit any positive effects. Thus no significant difference in thiamine phosphorylation between samples with and without the addition of insulin was observed (Table 2,*A*).

Weil-Malherbe and also Bornstein and Park[7] have observed that the presence in blood of factors inhibiting or activating the hexokinase reaction is closely related to the hypophysial and adrenal cortical hormones and also to insulin. Hence further experiments were carried out in which insulin was added to the thiaminokinase preparations after incubation with serum from normal or from diabetic rats (Table 2,*B*,*C*). Little or no effect is observed when insulin, previously incubated in serum, is added to the thiaminokinase preparations from normal rats, whereas cocarboxylase formation is remarkably enhanced when thiaminokinase extracts from diabetic rats are used. This effect of insulin is evident o when the hormone is previously incubated both serum from normal and diabetic animals. Ser itself, without addition of insulin, does not exert a appreciable effect on thiamine phosphorylation.

Since the thiaminokinase preparation used in th experiments is a very purified enzymatic system, may be concluded that insulin exerts a direct acti on thiamine phosphorylation.

Amorphous insulin powder was kindly supplied Eli Lilly and Co.

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## Lumi- and Meta-Rhodopsin

ON exposure to light, rhodopsin (visual purple, t photo-receptor pigment of low-intensity vision) changed to lumi-rhodopsin and thence by a therm reaction to meta-rhodopsin[1]. The exact nature these substances is unknown, other than that th consist of retinene (vitamin A aldehyde) joined some way to a protein, opsin. In order to expla the characteristic chemical and spectroscopic b haviour of lumi- and meta-rhodopsin, workers in th field have suggested[1] that one, or both, of lumi- a meta-rhodopsin may be free radicals.

This idea can be investigated by the technique paramagnetic resonance absorption. Free radica are characterized[2] by a line less than 10 gauss wi with a *g*-factor differing from 2·0023, the fr tron value, by only a few parts in the third mal place.

od outer segments from cattle eyes were prepared[2] freeze-dried in dim red light. 51 mgm. of the d powder, containing $1 \cdot 4 \times 10^{-7}$ mole of rhodop- was examined; first, before exposure to light, that containing rhodopsin; again, after exposure to t at 90° K., which converts rhodopsin to lumi- lopsin; and finally, after warming to room tem- ature, to convert lumi- to meta-rhodopsin. In e of these preparations was the resonance line racteristic of free radicals detected, although the itivity of the apparatus used was sufficient to ect considerably less than $10^{-7}$ mole of free radical ie line was as narrow as expected. On the assump- that all free radicals show such a line, it must concluded that neither lumi- nor meta-rhodopsin free radical.

he displacement of the retinene absorption peak 384 mμ to near 500 mμ in rhodopsin, lumi- and a-rhodopsin lacks an explanation. Since free icals cannot be invoked, it is necessary to look a conventional auxochrome linking retinene to tein.

Ve are grateful to Prof. R. A. Morton and Dr. B. aney for their interest and advice.

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## -Ray Emission Spectrography using Ion Exchange Membranes

HE spot-test technique of X-ray emission spectro- phy[1] for microgram amounts of elements has been ended to lower concentrations of metal ions by ng ion-exchange resin membranes to concentrate elements present as ions in dilute solution, and ct as a carrier for the sample in the spectrograph. he following technique was employed. Pieces of ion exchange membrane ('Amberplex C-1' cation mbranes, Rohm and Haas Co., Philadelphia, Pa.) n. square were placed in 100 c.c.–1 litre of solutions taining 1–100 μgm. amounts of various cations stirred. It was found that equilibrium was ched in several hours, and the time required ended on the thickness of the membrane. The hange was substantially complete, that is, after ilibrium was established, there were less than ectable amounts of the ion left in solution. Com- e extraction of the metal ion from solution by membrane occurred whenever the exchange acity far exceeded the total amount of the ion in tion. Thus the method is best suited to analysis high dilution.

he following example is illustrative. A piece of 'Amberplex' cation membrane 1·3 cm. × 1·3 × 0·1 cm. in its acid form was stirred with 1 litre solution containing 1 μgm. of cobalt (II) ions (a centration of 1 in $10^9$) for 48 hr. Analysis of the nbrane in the X-ray spectrometer indicated that ad absorbed by ion exchange 1·0 μgm. of cobalt with an error of ± 0·1 μgm. Similar results were obtained using other ions. It appeared that the rate of equilibration was approximately logarithmic, and the half-time for membranes 0·1 cm. thick was about 2–3 hr. Thinner membranes reached equilibrium faster, had a lower background in the spectrometer, and showed less absorption of the characteristic radiation of the several elements measured.

As an illustration of the applications of this method to trace analysis of heavy metals in foods, 100 c.c. of maple syrup was diluted to 1 litre and extracted with a piece of the 'Amberplex' cation exchange membrane. Approximately 0·5 μgm. each of zinc and manganese and 1 μgm. of iron was extracted by the membrane along with lesser amounts of other ions.

When a piece of the membrane was equilibrated with 100 c.c. of a solution containing 10 μgm. of cobalt, and 10 c.c. of versene solution (tetrasodium salt of ethylene diamine tetra acetic acid), the cobalt was retained in solution by the chelating agent. The same reagent removed zinc but not iron from a membrane containing ions of these metals. It was observed also that the equilibration of membranes in 40 per cent sulphuric acid was very effective in reducing the background of all heavy-metal ions present including iron.

We feel that the ion-membrane technique extends the utility of X-ray emission spectrography into new areas beyond the range of previous methods. It can be easily adapted to analyses for anions and to various other studies such as the determination of stability constants of complex ions in solution.

We thank the Rohm and Haas Company for co-operation in supplying some special thin ion-exchange membranes for this study.

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## Radio-Frequency Radiation from the Rosette Nebula

A RECENT radio survey of the galactic anti-centre region, made at 242 Mc./s. with the Ohio State University radio telescope, has revealed an intense extended radio source in the constellation of Monoceros. The co-ordinates of the radio source agree closely with the position of the Rosette nebula surrounding the galactic cluster *NGC* 2244. Also the width in right ascension of the radio source is comparable with the diameter of the nebula. Thus, it is presumed that the radio source may be identified with the Rosette nebula.

The antenna of the Ohio State telescope has a half-power beam width of 1·3° in right ascension and of 8° in declination. The right ascension of a source is determined by the time at which the maximum intensity is received, while the declination is determined by comparing records taken at several different declinations. The equivalent angular size[1] of a source is obtained by comparing the beam-width of the source signature with the beam-width for a point source.

The position and angular size of the radio source and of the nebula are compared in Table 1. The total intensity from the nebula is about $2 \times 10^{-24}$ w. m.$^{-2}$ (c./s.)$^{-1}$ (± 25 per cent).

Table 1. (1950·0)

| | R.A. | Declination | Angular diameter |
|---|---|---|---|
| Radio source | 06h. 30·3m. ± 0·5m. | + 5° ± 1° | 1·5° ± 0·5° |
| Rosette nebula (*NGC*2244) | 06h. 30·0m. | + 4° 54′ | 1·33° |

In studies of the Rosette nebula with the 48-inch Schmidt telescope, Minkowski[2] found a fairly symmetrical sharp-edged disk of emission 80′ in diameter around the galactic cluster *NGC*2244. He indicated that the luminosity of the nebula is due to the ultra-violet radiation of four *O*-type stars in the central cluster. According to new data[3], he indicates that the average electron density is about 14 cm.$^{-3}$.

Our radio observations show an apparent black-body temperature over the nebula of approximately 200° K. Assuming an electron temperature of 10,000° K. in the nebula, the average optical thickness at 242 Mc./s. over this region is then 0·02. According to the analysis of Greenstein and Minkowski[4], this corresponds to an emission measure of 3,000, assuming thermal emission by free-free transitions. Considering that the nebula is a Strömgren sphere at a distance of 1,400 parsecs, with a corresponding linear diameter of 37 parsecs, this leads to an average electron density in the nebula of 9 cm.$^{-3}$.

A sketch of the outline of the Rosette nebula in relation to the position of the radio source is presented in Fig. 1. A signature of the radio source taken on February 18, 1955, with the antenna beam directed to Dec. + 6° is also shown.

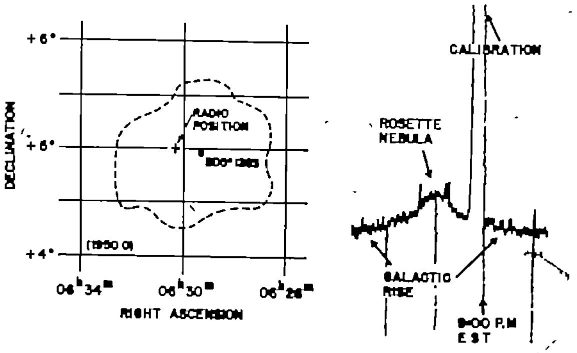

Fig. 1. Outline of the Rosette nebula (dashed line) compared with the radio position (cross); and signature of the Rosette nebula as obtained on February 18, 1955, with the Ohio State University radio telescope

During the survey of the galactic anti-centre region in which radiation was detected from the Rosette nebula, eighteen other intense radio sources were also found. Half of them show angular diameters of 1° or more, and their distribution shows a marked concentration along the galactic plane. A more detailed description of this work will be published separately.

This work has been aided by continuing grants from the Development Fund and the fund for basic research of the Ohio State University, and also by a grant from the National Science Foundation.

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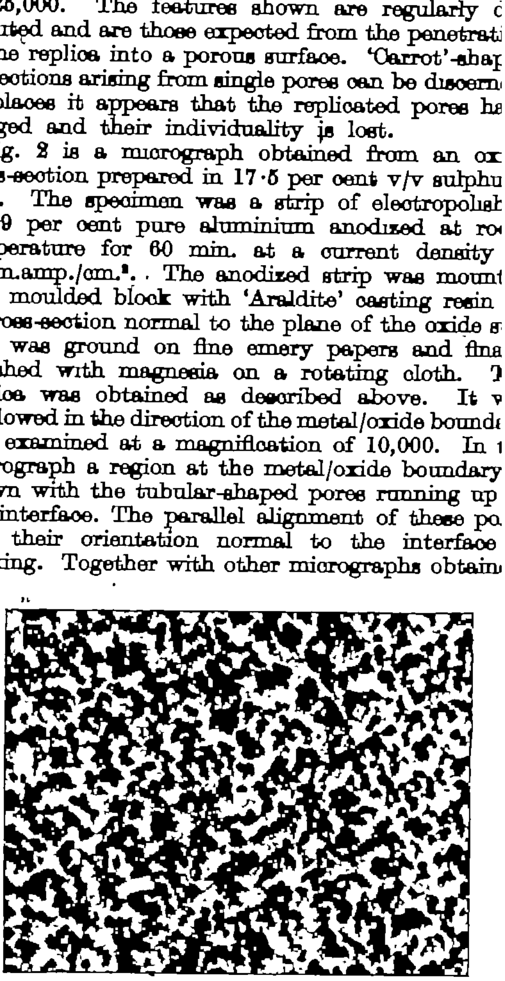
## Electron Micrographs from Thick Oxid Layers on Aluminium

The thicker protective coatings of oxide forr
on aluminium by anodizing in acid electrolytes h
long been of importance in industry. The por
nature of these layers has been indicated by tl
electrical and adsorptive properties. Howe
electron microscopic investigation has been alm
entirely confined to extremely thin (less than
oxide layers[1] due to the limitations of the transmis
method of examination. By using the recer
developed evaporated carbon film technique[2], we h
been able to obtain electron micrographs of both
top surface and the cross-section of thick oxide lay
These clearly show the porous structure.

Fig. 1 is a micrograph obtained from the top
face of an oxide layer prepared in 5 per cent chro
acid. The specimen was electropolished 99·99
cent pure aluminium strip anodized at 40° C.,
voltage reaching 90 V. at the end of 100 min.
nitrocellulose-backed 'Formvar' replica was strip
from the surface on scotch tape and a carbon f
evaporated on to it. This was shadowed *in situ* w
gold-palladium alloy at an angle of approximat
20°, the replica then being mounted on a cop
specimen grid and the plastic dissolved away w
organic solvents. The shadowed carbon replica tl
prepared formed a 'negative' of the original surfa
and was examined at a magnification of 12,4
The micrograph has been enlarged to a magnificati
of 25,000. The features shown are regularly
tributed and are those expected from the penetrati
of the replica into a porous surface. 'Carrot'-shap
projections arising from single pores can be discern
In places it appears that the replicated pores ha
merged and their individuality is lost.

Fig. 2 is a micrograph obtained from an ox
cross-section prepared in 17·5 per cent v/v sulphu
acid. The specimen was a strip of electropolish
99·99 per cent pure aluminium anodized at ro
temperature for 60 min. at a current density
50 m.amp./cm.$^2$. The anodized strip was mount
in a moulded block with 'Araldite' casting resin
A cross-section normal to the plane of the oxide s
face was ground on fine emery papers and fina
polished with magnesia on a rotating cloth.
replica was obtained as described above. It
shadowed in the direction of the metal/oxide bound
and examined at a magnification of 10,000. In
micrograph a region at the metal/oxide boundary
shown with the tubular-shaped pores running up
the interface. The parallel alignment of these po
and their orientation normal to the interface
striking. Together with other micrographs obtain



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appears that the pore structure is only revealed this way at places where minute fragments have en chipped out of the oxide layer during the eparation of the specimen surface.

This investigation is being continued and forms part a research programme of the Food Investigation ganization of the Department of Scientific and dustrial Research on the development of the rry capacity-resistance hygrometer. The work being carried out to ensure that an instrument of ndard characteristics, free from hysteresis and ble over a wide range of operating conditions, will produced. It is hoped to publish a fuller account the work elsewhere.

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## activity of Freshly Formed Steel Surfaces

It is now an established fact that freshly formed etal surfaces have an inherently high reactivity. probable confirmation of this fact was noticed ently when specimens of mild steel were broken impact at sub-zero temperatures. Fracture was edominantly of the cleavage type at the temperares concerned, and the work undertaken necessited an examination of the fracture surface. It was ticed that this surface corroded far more rapidly an would normally be expected in the laboratory mosphere. Ten minutes after fracture, definite rrosion films could be detected and the well-known st-coloured deposit appeared shortly afterwards.

Undoubtedly the fracture surface would be covered a film of adsorbed moisture and, in view of the cent work on the production of hydrogen peroxide freshly formed metal surfaces[1], it is likely that the idation mechanism was associated with hydrogen roxide formation as suggested by Haber and eiss:

$$H_2O_2 + Fe^{++} \rightarrow Fe^{+++} + OH^- + OH$$
$$OH + Fe^{++} \rightarrow Fe^{+++} + OH^-$$
$$Fe^{+++} + 3OH^- \rightarrow Fe(OH)_3$$

Whatever the corrosion mechanism, the fact remains that freshly cleaved steel surfaces are extremely reactive. The method of cleaving specimens at an appropriate temperature would probably be useful in the investigation of the reactivity of metal surfaces.

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## A Method of locating Interfaces in Oil Pipelines

It is often desirable to locate or follow the interface between two oils or fuels during transmission along a pipeline. Present methods include those based upon sampling techniques or radioactive labelling of the interface. The first of these is tedious and slow, and the second method involves the injection of a radioactive marker substance at the interface, with the attendant difficulties of handling radioactive material in the product itself.

An alternative method utilizes the variation of hydrogen content of the two liquids. Hydrogen contents of bulk liquids may be easily compared by the use of a neutron-backscatter or transmission technique. A portable source of fast neutrons can be placed outside the pipe. The neutrons entering the liquid are moderated by scattering from the hydrogen atoms, and the concentration of slow neutrons which emerge from the pipe (either in a forward or backward direction) will be dependent on the hydrogen content of the liquid in the pipe. These can be measured with the use of standard equipment incorporating a boron trifluoride counter.

Preliminary laboratory tests indicate that the measurement of either scattered or absorbed neutrons can differentiate between premium and commercial grade fuels by a 5 per cent change in reading. A further change of 10 per cent occurs between commercial fuel and paraffin.

In the event of the two liquids having the same hydrogen content, if the interface could be labelled with minute quantities of a salt of boron, gadolinium or other suitable material, then it could be located very easily, since these additives absorb the slow neutrons very strongly.

These methods have the great advantage over standard radioactive methods that they do not involve the inconvenience of handling radioactive material in solution, or the necessity of obtaining a regular supply of radioactive isotopes.

The preliminary work carried out on neutron-scattering methods indicates their considerable potentialities, and techniques will be further investigated.

D. B. Smith
G. R. Church

Atomic Energy Research Establishment,
Harwell, Nr. Didcot,
Berkshire.
May 31.

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (Grade II) or SENIOR LECTURER (Grade I) IN THEORETICAL PHYSICS—The Registrar, The University, Bristol 8 (August 6).

LECTURER or ASSISTANT LECTURER IN BOTANY—The Registrar, The University, Birmingham 15 (August 6).

ASSISTANT (preferably with a veterinary qualification) IN THE DEPARTMENT OF VETERINARY PHARMACOLOGY—The Secretary, Royal (Dick) School of Veterinary Studies, The University, Edinburgh (August 8).

RESEARCH DEMONSTRATOR IN PURE MATHEMATICS—The Registrar, The University, Sheffield (August 10).

RESEARCH WORKER (with a university degree, preferably in forestry, and some practical forestry and research experience) to undertake a special study of the problem of planting mining refuse heaps in Scotland—The Secretary, The University, Edinburgh (August 15).

SENIOR LECTURER or LECTURER IN BIOCHEMISTRY at University College, Ibadan, Nigeria—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (August 15).

PHYSICIST or MATHEMATICIAN (with a good honours degree in physics, mathematics or equivalent professional qualifications, proved research ability, and preferably experience in strain measurements and/or mechanical properties of materials), at the Central Research Establishment, National Coal Board, Isleworth, to lead a group carrying out research on underground transport of coal—National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting 88/34 (August 16).

BIOCHEMIST (with a Ph.D. degree or equivalent, and preferably with experience in microtechniques) to be a member of a team investigating the growth and metabolism of cells obtained from tumours and from normal organs and grown in culture—The Director, Strangeways Research Laboratory, Wort's Causeway, Cambridge (August 20).

LECTURER IN PSYCHOLOGY—The Registrar, The University, Sheffield (August 20).

ADMINISTRATIVE ASSISTANT (with a scientific degree, preferably in physics, and administrative experience), for work in connexion with the International Geophysical Year—Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (August 30).

LUCAS CHAIR OF ENGINEERING PRODUCTION—The Registrar, The University, Birmingham 15 (August 31).

STAFF TUTOR IN SCIENCE in the Department of Extra-Mural Studies—The Registrar, The University, Nottingham (August 31).

LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN PHYSICS—The Registrar, College of Technology, Manchester 1 (September 1).

LECTURERS (2) IN CHEMICAL ENGINEERING, and DEMONSTRATORS IN CHEMISTRY—The Registrar, College of Technology, Manchester 1 (September 1)

ASSISTANT (with a degree in science or agriculture) IN THE CHEMISTRY DEPARTMENT at Auchincruive, for work mainly relating to the analysis of agricultural materials other than soils—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (September 12).

JUNIOR ORGANIC CHEMIST—(with a first- or second-class honours degree in chemistry and two or three years' research experience in organic chemistry) IN THE DEPARTMENT OF SUGAR CHEMISTRY AND TECHNOLOGY, Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (September 17)

READER IN ZOOLOGY at Royal Holloway College, Englefield Green, Surrey—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 20).

SENIOR LECTURER (preferably with special qualifications in embryology and/or cytology) IN ZOOLOGY at the University of Western Australia—Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 30).

BIOCHEMIST (with an honours degree in chemistry or biochemistry, and with one or two years' biochemical research experience), to assist in research work in the Special Unit for Juvenile Rheumatism—The Secretary, Canadian Red Cross Memorial Hospital, Taplow, near Maidenhead

BRITISH NYLON SPINNERS LIMITED RESEARCH FELLOW to work on the structure of wool and nylon staple fibre fabrics—The Principal, Technical College, Bradford 7.

ENTOMOLOGISTS (2) (with a degree in zoology and a sound knowledge of entomology and botany), with the Sudan Government, to carry out a survey of the tsetse areas of the Sudan and undertake research work—The Sudan Agent in London, Cleveland Row, St. James's, London, S.W.1, quoting "Entomologist 2204"

LABORATORY TECHNOLOGIST (with a general degree in science or agriculture, with main interest in chemistry, or an honours degree in chemistry) IN THE DEPARTMENT OF AGRICULTURE, Kenya, to carry out investigational work on problems of agricultural chemistry related to coffee culture—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.63/7/09.

PASTURE AGRONOMIST (male, with a university degree in science or agriculture, a special interest in animal husbandry problems and experimental methods used in feeding and grazing trials, and a knowledge of systematic botany to enable ecological surveys to be undertaken) IN THE DEPARTMENT OF VETERINARY SERVICES, Uganda, to conduct feeding and grazing trials, with particular reference to the effect on the animal, and field investigation into the management of grassland systems of grazing and livestock management—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.67/9/08.

PHYSICIST (with at least a second-class honours degree) to carry out fundamental research work on the behaviour of textile materials as barriers to (a) the flow of fluids, and (b) radiation, including heat and light; and a PHYSICIST (or Chemical Engineer) (with at least a second-class honours degree), to conduct research on the drying of textiles, including fundamental work on the mechanism of drying and applied research on the improvement of old methods and the
development of new—Dr. F. C. Toy, British Cotton Industry Rese
Association, Shirley Institute, Didsbury, Manchester 20.

PRINCIPAL SCIENTIFIC OFFICER (with at least a second-class hon
degree in physics, mathematics or engineering, or equivalent quali
tions) IN THE RESEARCH AND DEVELOPMENT BRANCH of the
Atomic Energy Authority, Risley, to lead a group engaged on
calculation of critical dimensions of plant containing fissile mate
and to advise design offices and factories concerning the safety of
plant—Recruitment Officer, Industrial Group Headquarters, Ri
Warrington, Lancs, quoting "1,049".

SCIENTIFIC OFFICER (honours graduate in chemistry or bioch
istry) to collaborate in fundamental biochemical research, with sp
reference to the synthesis and degradation of isotopically lab
compounds and the application of chromatography and other analy
techniques to their isolation and purification—The Secretary, Nat
Institute for Research in Dairying, Shinfield, Reading, quoting 5

SENIOR EXPERIMENTAL OFFICER (Electronics) (with at least H.
in science subjects or equivalent qualifications, together with
experience of the application of electronics) IN THE RESEARCH
DEVELOPMENT BRANCH of the U.K. Atomic Energy Authority, W
scale, Sellafield, Cumberland, to take charge of a small section eng
on design and construction of various electronic equipment for
chemistry, metallurgy, engineering and physics laboratories—Rec
ment Officer, Industrial Group Headquarters, Risley, Warring
Lancs, quoting "1,048".

SENIOR LECTURER (with an honours degree in mathematics,
preferably with research experience) IN MATHEMATICS—The Princ
West Ham College of Technology, Romford Road, Stratford, Lon
E.15.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class hon
degree in physics, a background of experience in solid-state phy
and at least three years' postgraduate research experience), to
vestigate certain physical aspects of the detonation of solid
explosives and the propagation of intense shock waves through s
and gases—Senior Recruitment Officer, Atomic Weapons Rese
Establishment, Aldermaston, Berks, quoting 709/WGB/2.

# REPORTS and other PUBLICATION

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Ovaltine Research Laboratories. Annual Report (1954). Pp.
(London: A. Wander, Ltd., 1955.)

Council for the Preservation of Rural England. Twenty-Ni
Annual Report, 1954–55. (Vol. 16, No. 3.) Pp. 60+4 plates. (Lond
Council for the Preservation of Rural England, 1955.)

A Bibliography of Colour Television. Supplement, 1955. Pp.
(London: Television Society, 1955.) 1s. 6d.

Physical Society. Report of the Physical Society Conference on
Physics of the Ionosphere, held at the Cavendish Laboratory, C
bridge, September 1954. Pp. iv+406. 40s. Report of the Conferenc
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tory, University of Bristol, July, 1954. Pp. iv+430+27 pla
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## Other Countries

British Territories in Borneo: Geological Survey Departme
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Sadong Valleys, West Sarawak, including the Klingkang Range C
By N. S. Haile. Pp. xii+150+36 plates and 1 geological map
Malayan dollars; 14s. Memoir 2: The Coal Deposits and a summar
the Geology of the Silimpopon Area, Tawau District, Colony
North Borneo. By P. Collenette. Pp. vi+74+12 plates and 1 geo
gical map 6 Malayan dollars; 14s. Annual Report of the Geolog
Survey Department for 1954. By F. W. Roe. Pp. v+188+60 pla
3 Malayan dollars; 7s. (Kuching: Government Printer, 1954
1955.) [

Fondation Universitaire. Trente Quatrième Rapport Ann
1953–1954. Pp. 165. (Bruxelles: Fondation Universita
1955.) [

East African Meteorological Department. Summary of Meteor
gical Observations for 1953. Part 1: Kenya. Pp. 29. Part 2: T
ganyika. Pp. 32. Part 3: Uganda. Pp. 17. Part 4: Zanzibar. Pp
(Nairobi: East African Meteorological Department.) [

United Nations—Commission on the Status of Women. National
of Married Women—(Report submitted by the Secretary-Gener
Pp. vi+83. (New York: United Nations; London: H.M. Station
Office, 1954.) 0.50 dollars; 3s. 9d.; 2 Swiss francs. [

Berichte des Deutschen Wetterdienstes. Nr. 15 (Band 2): Fro
bekämpfung in Weinbau. (Mit den Ergebnissen der Frostschad
kartierungen in Nordwürttemberg und Nordbaden im Auftrag
Ministeriums für Ernährung, Landwirtschaft und Forsten für Bad
Württemberg.) Von Wolfgand Baier. (Mit 9 Abbildungen und
Tabellen im Text sowie 9 Anlagen.) Fachbeiträge von Wilhelm Eng
hardt, Otto Dinkelacker und Otto Linsenmaier. Pp. 48+385.
D. marks. Nr. 16 (Band 3): Ein meteorologischer Beitrag zu Gru
problemen der Medizin-Meteorologie. Von Hans Ungeheuer. Pp.
4.40 D marks. Nr. 17 (Band 3): Monats-, Jahres- und Tagessum
des Niederschlags in Bayern bis 1950. Von Karl Brose. Pp. 2
A192+4 tafel. (Bad Kissingen: Deutschen Wetterdienstes, 1955.)

Fonds National de la Recherche Scientifique. Vingt-septiè
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Body and the Principal's Report for 1953–54. Pp. 54+4 pla
(Trinidad and London: Imperial College of Tropical Agricultu
1955.)

Tobacco Research Board of Rhodesia and Nyasaland. Inter
Report No. 4: Control Measures for Tobacco Diseases. By R.
Stephen. Pp. 24. (Salisbury: Tobacco Research Board of Rhode
and Nyasaland, 1955.)

# THE UNITED NATIONS AND THE PEACEFUL USES OF ATOMIC ENERGY

N a broadcast address at the end of last year on man's peril from the hydrogen bomb, Lord ussell expressed the opinion that the human race d reached a point when it must abandon war as an strument of policy or accept the possibility of al destruction. It was essential for this to be derstood on both sides of the Iron Curtain, and he ggested that one or more neutral powers should point a commission of experts, all neutrals, to epare a report on the destructive effects to be pected in a war with hydrogen bombs, among utrals as well as among belligerents. This report s to be presented to the Governments of all the eat Powers with an invitation to express their reement or disagreement with its findings. In this y, he thought, all the Great Powers could be led agree that a world war could no longer serve the rposes of any of them, since it would be likely to terminate friend and foe alike as well as neutrals.

The essential point of this appeal—that we must rn to think in a new way because in any future r nuclear weapons will certainly be employed and eir use threatens the continued existence of mannd—is reiterated in a statement made public by rd Russell on July 9. The statement, which was gned by Lord Russell, Prof. P. W. Bridgman, Prof. bert Einstein, Prof. L. Infeld, Prof. J. F. Joliot-rie, Prof. H. J. Muller, Prof. C. F. Powell, Prof. J. otblat and Prof. H. Yukawa, was sent simulneously to Sir Anthony Eden, President Eisenwer, Marshal Bulganin, Mr. Chou En-lai, President ty of France and Mr. St. Laurent, the Prime inister of Canada. The statement concludes with draft resolution which, it is suggested, could be opted by a conference of scientists summoned to termine impartially and without political prejudice e facts about the consequences of exploding nuclear eapons. This resolution urges the Governments of e world to acknowledge publicly that their purposes nnot be furthered by a world war, and consequently find peaceful means for the settlement of all atters in dispute between them.

The resolution is, in essence, a recapitulation, in a w context, of the Kellogg Pact for the renunciation war as an instrument of national policy. Prosals for a conference of scientists received incidental ention in the debates in Parliament on defence rly this year, and in one form such a conference as warmly supported in an outstanding speech by e Archbishop of Canterbury. Much confused inking was evident, however, over the issues volved, nor has the confusion been removed when e proposal has been made in connexion with what popularly known as "Atoms for Peace", though a mposium of articles, including an introduction by rd Russell, contributed to the ninetieth anniversary ue of the New York periodical, *The Nation*, under at title should assist to clarify thought.

The problem of nuclear weapons and their control or renunciation is seen in its true perspective not so much against the special problems of nuclear power and its potentialities for mankind, as against the historical background of such proposals as the Kellogg Pact and the attempts of the League of Nations to achieve disarmament. An understanding of the reasons for these earlier failures illuminates the failure of post-war efforts to achieve a practical scheme for the control of nuclear weapons and may, perhaps, suggest a promising line of advance. Indeed, it will be noted that this new appeal by Lord Russell specifically contemplates an agreement to renounce nuclear weapons as part of a general reduction of armaments.

The celebration of the tenth anniversary of the signing of the Charter of the United Nations at San Francisco appeared to attract little real interest in Great Britain; but a review of the ten years experience of the working of the United Nations may have some value in assessing the usefulness of some of the suggestions made regarding international agreement on atomic energy and in overcoming the difficulties which at present hinder its realization. It should be remembered, moreover, that, in spite of the unique character of the San Francisco Conference, which was attended by delegates of fifty nations, all of whom exercised their vote on the Charter, no extravagant hopes were entertained. There was a sober realization that no international instrument or constitutional specific would suffice of itself to maintain peace.

That much has been fully attested by ten years of what was to be a real regime of collective security under the responsibility of the Security Council, and by a concerted effort under the General Assembly to promote world welfare and particularly that of the lesser-developed or privileged parts of the world. Wherever the Great Powers were prepared to use the Council constructively, the United Nations organization has functioned as an instrument of peace, and to some extent the obstructiveness and negative attitude of the Soviet Union have been offset by the greater readiness of the United States to co-operate and to assume responsibilities of leadership. Moreover, special regional organizations under the ægis of the United Nations have come into being to offset the limitations imposed on the Security Council by the restrictive use of the veto.

On the welfare side, too, there have been disappointments, where the General Assembly and the Special Agencies responsible to it, such as the United Nations Educational, Scientific and Cultural Organization, the Food and Agriculture Organization and so on, have been used irresponsibly or diffusely. As under the League of Nations, the technical organizations have indeed proved far more successful than the political agencies in achieving co-operation and understanding; and for all the disappointments, much more progress has been made by the United Nations as a centre for international welfare than might have been expected ten years ago. However, it must be recognized that some of the important developments have come from outside the United Nations, notably the Point Four Plan of President Trueman, the Colombo Plan for Co-operative Economic Development in South and South-East Asia and the earlier Marshall Aid, from which President Trueman's proposals arose.

At times it has seemed doubtful whether the lessons of military and economic co-operation in the Second World War have been learned. The trusteeship system has proved disappointing, largely through the way in which it has been used by those who bore no responsibility for the consequences of their words. If, however, the hopes originally entertained in regard to research and the encouragement of development have been falsified, much that it was hoped might have taken place under the Trusteeship Council has come into being outside the United Nations; thus a noteworthy advance towards co-ordination and co-operation in research has been made in Africa in this decade. Moreover, even when used irresponsibly, the United Nations and its Agencies have proved a medium for the constant and thorough interchange of thought and ideas which, as wisdom is acquired in their use, should increasingly promote a better and more tolerant understanding among nations and among peoples.

With the work of most of these Specialized Agencies many scientists have been closely concerned, and whatever reservations may be felt about some aspects of the work of the United Nations Educational, Scientific and Cultural Organization, it has probably assisted the International Scientific Unions to function earlier and more widely than might otherwise have happened. It has also contributed notably to the task of creating a world opinion which clearly understands the price to be paid for peace, and the restraints to be accepted as the alternative to anarchy—indeed, the limitations as well as the opportunities of world organization. Such an informed opinion, clearly understanding what is involved, is the first condition for any world organization to function effectively.

If, however, the celebrations at San Francisco on June 26, when all the Great Powers, save China, were represented by their Foreign Ministers, together with those of thirty-four other States, justify greater confidence that this is being achieved, it is probably due less to the work of the United Nations itself than to what has flowed from the advent of nuclear weapons of war. It is not always realized that when the Charter of the United Nations was signed, the atomic bomb was unknown to the world at large, and only slowly have the tremendous implications which nuclear fission may hold for the future of civilization been grasped. That in recent months the nature of the choice which faces mankind has become clear is due at least in part to scientists who have recognized their special responsibilities, in addition to their common rights as citizens, and used their opportunities to let the world know, in the light their intimate and expert knowledge, their views c the uses which the world should make of this gre new gift of science to mankind, and both its promi and its threat to humanity.

The prescience of Sir Henry Dale's observatio in 1945 on this subject, and on the implications nuclear fission and the conditions under which it w achieved, both for science and for humanity, ma in his presidential address that year to the Roy Society, have been amply attested, and many curre proposals might well be considered in their conte The nations have, as Sir Henry remarked, to deci how they intend to use the powers and resourc which science stands ready to offer in growi abundance. Either they must let science work aga and henceforward in freedom, as an internation community, and use what it offers for raising mankind to new levels of material prosperity and culture, or, by binding science to secrecy for th competitive invention of more effective means destruction, they can hold civilization in insta peril of dissolution.

That alternative the Conference on the Peacef Uses of Atomic Energy, opening in Geneva o August 8, may be expected to emphasize, in spite the dominantly technical character of the papers t be presented. Indeed, the range of technical topi to be discussed should of itself demonstrate th importance of full and free discussion for the advan of both science and technology, and help to brea down the secrecy in which nuclear science has bee shrouded and the effects of which are as detriment to science itself as they are to international relatio and understanding between peoples. Nor should be forgotten that scientists are already inquiring int the biological hazards of radiation, and there is n reason for anticipating that, in the present clima of opinion, their findings will not be presented to th world in much the same way that Lord Russell an his co-signatories suggest in respect of nuclear wa fare generally. The Government has already promise to publish the Medical Research Council's report o the subject as a White Paper.

A glance over the ten years work of the Unite Nations thus facilitates sound judgments as to th prospects and possibilities of the recent Geneva Co ference of the Great Powers, of that on Peaceful Uses Nuclear Energy, and of proposals such as Lord Russe and his co-signatories have sponsored, and the simil resolutions passed by eighteen Nobel Prize winne during the course of a meeting held at Mainau o July 15. Of the three broad conceptions which wer to the shaping of the United Nations and i activities, it is fair to say that only one—that of th United Nations as a centre of economic and techn logical activity—has stood the test of this decad The hopes for the organization as a body boun together by the observance of certain standards international decency have, by and large, prove illusory, as also those of it as an attempt t "put teeth into the Covenant of the League Nations".

But even these two conceptions have not been ite without value. In certain conditions, the ited Nations is clearly capable of keeping the ace, and, given agreement and mutual undernding between the two great blocks of nations, it ild largely achieve its declared purposes. It is ially clear that such agreement does not yet ly exist, in spite of the Geneva Conference. The rld would indeed be in much worse shape without e United Nations, which remains as a place where e two great power blocks and those who try to be utral can come together to find ways of reconciling eir different outlooks before it is too late.

Nor is this all. There is some evidence, and not ast in the talks at the recent Four-Power Conferce at Geneva, that some international standards e gaining wide acceptance, at least to the extent lip-service if not actual practice. That process ight be encouraged if there were less disposition to critical, and if the critics were more careful that eir own practice matched the standards they lvocate. Co-existence implies tolerance; but what required above all is realism—a clear recognition what the United Nations can, and cannot, do.

Two positive aspects in particular seem important considering appeals such as Lord Russell and hers have launched. The United Nations, as has ist been indicated, has demonstrated its value as a rum for the discussion of international problems id the creation of world opinion. This is a slow rocess; but it is important that all that is posle should be done to assist and accelerate it. econdly, the United Nations and its Specialized gencies have demonstrated their value as a potential rce for the dissemination of technical knowledge nd assistance. Their effectiveness in that respect ill be increased as they are more wisely used, and s greater care is taken to increase the efficiency with hich such non-political activities are organized.

Lord Russell's appeal does not appear to show ill cognizance of this position. In thanking Lord ussell for his letter, the Prime Minister wrote that e agreed that only the abolition of war could finally emove the perils which threaten the future of manind, and welcomed the recognition in the statement hat it is war itself and not simply nuclear weapons hich must be abolished, and that the renunciation f nuclear weapons must form part of a general eduction of armaments. What the statement fails o do, however, is to make clear that this is the olicy which the British Government has consistently ollowed. It is also important to note the reservation hich Prof. F. J. Joliot-Curie made regarding the uggestion that war should be abolished. It reveals ow far we are still from convincing those on the astern side of the Iron Curtain that nuclear war nvolves universal destruction.

The problem which this division involves is not airly faced by Lord Russell and his co-signatories; hough if all the leading Governments could be rought to subscribe to the declaration only good ould result. None the less, the educational value of he statement is important and that can equally be said of the "Atoms for Peace" issue of *The Nation* and of a pamphlet "Atoms for Peace—not War" (published by Science for Peace, 16 Ulster Place, London, W.C.1. Pp. 31. 1*s*.) prepared by a group of scientists who believe that the threat of nuclear warfare can be removed. The latter pamphlet, to which Prof. C. F. Powell contributed a foreword, gives a brief review of the present situation in regard to the peaceful use of nuclear energy and of the discussions on abolition of nuclear weapons before summarizing the extent of agreement on international control. This account, however, is a little biased against the United States, and the suggestion that insistence on international ownership is the real obstacle, rather than the objection of the U.S.S.R. to a system of inspection and refusal to accept any sacrifice of national sovereignty, is unrealistic. The treatment of President Eisenhower's original "Atoms for Peace" proposal of December 8, 1953, is likewise ungenerous; but with those reservations the pamphlet indicates clearly the stage which has been reached in negotiation and the really decisive changes since the first proposals for the control of nuclear energy were made in 1946.

Those changes are the disappearance of the monopoly of nuclear weapons by the United States; the development of thermonuclear weapons by both the United States and the U.S.S.R.; the extensive development of means of delivering nuclear weapons using unpiloted rockets and the availability of such weapons to ground forces; and above all the devising of a 'breeding' process for atomic piles which has made development of large-scale nuclear power economic. The "Atoms for Peace" issue of *The Nation* is concerned more especially with these latter implications, and includes in particular an article by J. G. Beckerley, director of classification of the U.S. Atomic Energy Commission for five years, on the importance of limiting secrecy requirements to the minimum.

Scientists can probably best contribute to the education of the community as to the implications of nuclear weapons and the sacrifices or restraints on national sovereignty that are involved by articles such as that on the hydrogen–uranium bomb contributed by Prof. J. Rotblat to the *Bulletin of the Atomic Scientists* last May, or by Prof. M. Westergaard on "Man's Responsibility to his Genetic Heritage" in the June issue of *Impact of Science on Society*, rather than by such statements as that which Lord Russell has sponsored, or the Nobel Prize winners' appeal already referred to. Something beyond technical papers will be required before we can, as Sir Richard Livingstone has said, master atomic energy, and see that civilization is enriched and not cheapened by the indiscriminate gifts of technology, while the most difficult problems, economic, social, political and moral, are pressing for solution.

None the less, the contribution of science must be primarily factual, though imaginatively alive to the human social issues and keenly aware of the experience of the past gained not only in the United Nations but in the League of Nations and earlier.

Indeed, unless injudicious and premature attempts to force a system of world government, through which alone effective control of nuclear energy could ultimately be achieved, wreck the United Nations, that organization may well play a larger part in international affairs in its second than in its first decade. Apart from its impact on military science, the development of nuclear power for peaceful purposes is likely to demand and encourage co-operation and goodwill between the nations, and thus to prepare the way for a workable system of world-wide inspection and enforcement of nuclear disarmament. Any such system will be virtually impossible except under the auspices of the United Nations, simply for the technical reasons that methods for detecting radiation must be applied all over the world, and that advances in nuclear weapons will ultimately enable the smaller States also to possess them.

Meanwhile, scientists should be considering what further constructive part they can play in the education of world opinion as to the conditions under which the world can enjoy the full benefits of nuclear power, and the imperative necessity for fresh thinking about national sovereignty and international relations in this age of technology. Apart from making clear the price which has to be paid and the discipline and restraint demanded, there are many technical problems to which they must make the decisive contribution. Some of these problems are to be discussed at Geneva in the forthcoming Conference on the Peaceful Uses of Atomic Energy. There are many others, some of which have political aspects in which the scientific or technical contribution is equally decisive. While the preparation of world opinion for the sacrifice of national sovereignty proceeds, constructive thought is needed as to the details of an effective inspection system, for example, which would provide a practical alarm, without seriously hampering the conduct of internal affairs or invoking large surrender of sovereignty. Clear thought as to the essentials which should be known might well enable a small group of inspectors, at key points, to provide the surveillance of major production activities which would provide ample warning of mobilization, for example.

The contribution of science to world peace and the utilization of nuclear energy should be essentially practical. Apart from the task of education and of giving clear warning of the dangers attendant on abuse of the powers which are now placed in man's hands, it should above all be mindful of the conditions upon which the advance of science itself depends. In proportion as full freedom of interchange of knowledge across frontiers is re-established and science regains its international position, the risk of misunderstanding and abuse will diminish. A first duty of every scientist, and the most important contribution he can render to the cause of peace, is to take up the challenge which Sir Henry Dale threw down at the anniversary meeting of the Royal Society when the United Nations was but a few months old.

# ORIGINS OF THE TORSION BALANCE

**Roland Eötvös**

Gesammelte Arbeiten. Herausgegeben von P. Selén
(Im Auftrage der Ungarischen Akademie der Wisse
schaften.) Pp. lxxx+384. (Budapest: Akadémi
Kiado, 1953.) n.p.

THIS volume contains eleven of the princip papers of Baron Roland Eötvös (1848–191 The reputation of Eötvös as a physicist rests on tw really original ideas worked out over a period thirty years with great skill and thoroughness. Th first idea concerns the forces acting on a torsio balance. Eötvös realized that even when no outsi couple was deliberately applied, the variation in th direction of gravity from one end of a suspende beam to the other would produce a couple, and th this couple could be detected and measured if th whole instrument, including the torsion head and th case, were turned into several azimuths in successio and the position of the beam relative to the ca noted in each. The couples depend on the spa gradients of the components of the force of gravit of which only five are independent. Eötvös showe that four of these quantities could be obtained fro the measurements and that these were equivalent t determining the rate of change of the force of gravit along a level surface, the difference of the tw principal curvatures of the level surface and th directions of the principal curvatures. All this i worked out in his papers with the greatest completeness.

Having demonstrated that the torsion balanc would measure the gradients of gravity, he develope a portable instrument and applied it to geologica problems, in particular to the search for oil-bearin structures in Hungary. After the death of Eötvös the instrument was widely used in the United State and elsewhere; but from about 1937 its use rapidl declined in favour of the gravimeter, partly becaus of the much greater speed of operation of the latte and partly because of the lesser disturbance which i suffers from very local irregularities in density. It i possible that the present neglect of the instrumen is a passing phase and that, if the speed of operatio were increased by the use of electronic techniques, i might again find applications.

The second original idea of Eötvös was that th torsion balance could give a very precise verificatio of the constancy of the ratio of gravitational t inertial mass. His method depends on the 'force o gravity', as observed on the earth, being compounde of a part due to the attraction of the earth, and a part due to rotation. The former depends on gravitational mass, the latter on inertial. If the ratio i not the same for the masses at the two ends of th beam of a torsion balance, the beam will experienc a couple. The extreme sensitivity of the balanc enables a limit of about one part in $10^8$ to be set t the variation of the ratio from one substance t another.

These are the main themes of the work of Eötvös, though in reading the papers one finds many othe beautiful things; for example, a demonstration tha a sheet of lead 5 cm. thick does not absorb the forc of gravity by more than two parts in $10^{11}$, and th discovery that the rate of change with temperature of the product of the surface tension of a liquid and two-thirds power of its molecular volume is ghly the same for all liquids.

Ötvös was clearly a man of great ability and rgy, whose work has been too little known. stein, for example, remarks that when he first ught about the equivalence of gravity and leration he knew of the experiments of Newton Bessel on gravitational and inertial mass, but of those of Eötvös. It is to be hoped that the lication of these papers will make his work more ely known.

he book includes an interesting life of Eötvös by l Selényi. The delicate task of writing a foreword ving a suitable idealogical lesson from the fact the greatest Hungarian physicist was a baron been undertaken by K. Novobátzky.

E. C. BULLARD

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# TREATISE ON INORGANIC CHEMISTRY

## mprehensive Inorganic Chemistry

ited by Prof. M. Cannon Sneed, Prof. J. Lewis ynard and Prof. Robert C. Brasted. Vol. 2: pper, Silver and Gold. By J. W. Laist; pp. x+ ; 35s. net. Vol. 3: The Halogens. By Prof. bert C. Brasted; pp. x+250; 35s. net. New York: D. Van Nostrand Company, Inc.; ndon: Macmillan and Co., Ltd., 1954.)

HE editors of this series of volumes on inorganic chemistry state that their aim is to emphasize emical properties and relationships and their erpretation in terms of theoretical concepts". This vides us with a canon of judgment. It is the ge and depth of such interpretations that dis-guish the inorganic chemistry of to-day from that even a quarter of a century ago. Valency theory, rmodynamics and other disciplines help us to est what used to be a great mass of unrelated ts. How far, we are entitled to ask, do these two umes, the second and third in the series, assist digestions ?

ol. 2, on copper, silver and gold, commences with useful table of the physical properties of the ments in question, followed by a brief intro-tion in which electronic structures, valencies, ., are discussed, and the stable and radioactive opes are tabulated. It then deals with each up $IB$ element in turn. Nearly half the pages concerned with the extraction metallurgy and h the alloys of the elements—a somewhat high portion. These sections, however, are quite well e, though one wishes that the treatment was less ely descriptive and more physico-chemical; there , too, inaccuracies in the section on the concen-tion of copper ores.

he remainder of the volume consists of a com-ation of facts about the chief compounds. It tainly does not go very far along the road of oretical interpretation, and though accurate ugh, it is distinctly haphazard. For example, the ts of formation of $CuF_2$, $Ag_2S$ and $AgF_2$ will be nd, but not those of any other compound, let ne any systematic discussion of the thermo-mistry. Again, the radius of the cupric ion does seem to be quoted anywhere, though that of the rous ion is; yet ionic sizes are fundamental to understanding both of crystal structure and of nplexes in solution. In short, although this volume contains much quite recent information, it is disappointingly old-fashioned in outlook.

After an introduction like that of Vol. 2, Vol. 3 proceeds first to the elementary halogens, including astatine; then in turn to the hydrohalides; the oxycompounds of the halogens; positive halogens, interhalogens and polyhalide anionic complexes; and finally to the pseudohalogens, such as cyanogen. It is more successful than Vol. 2 in carrying out the editors' programme of "interpretation in terms of theoretical concepts", and the choice of data seems more systematic. The much larger number of tables is a sign of this. There is good coverage, too, of the interesting new features of halogen chemistry that have been brought to light in recent years, such as the existence of positive halogen ions in solution and the solvent properties of bromine trifluoride. Technological developments—for example, in the handling of fluorine—are well described, though mention should have been made of the fact that anhydrous fluorine can be handled in glass apparatus.

The volume is unfortunately not free from blemishes. For example, it is a little sad to find the following sentences about hydrochloric acid in a modern text-book. "The equivalent conductance of a 0·001 $N$ solution is 377 and is 300·5 for a 1·0 $N$ solution (at 18°C.). This variation represents a change in apparent ionization from 99 to about 79 per cent". The word "apparent" may justify the letter of this statement; but in spirit it is pre-Debye–Hückel.

Nevertheless, Vol. 3 is an attractive one on the whole, and, like Vol. 2, it is well produced and remarkably free from printing errors.

H. A. C. MCKAY

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# FUNDAMENTALS OF PHYSICAL METALLURGY

## Theoretical Structural Metallurgy

By Prof. A. H. Cottrell. Second edition. Pp. viii+251. (London: Edward Arnold (Publishers), Ltd., 1955.) 25s. net.

DURING the seven years that have passed since the appearance of the first edition of Prof. A. H. Cottrell's book, activity in the field of physical metallurgy has been considerable. The greatest progress has been in the study of the structural defects occurring in solids, such as grain and twin boundaries, vacant lattice sites, and dislocations, and the effect of these defects on diffusion and deformation. Important work has also appeared dealing, for example, with theories of metallic cohesion, the distribution of electrons in alloys, ferromagnetism, and the electronic structure of transition metals. In order to accommodate much of this material in a book of approximately the same length, Prof. Cottrell has rewritten the entire text, and has included an extra chapter. Naturally, some of the original has had to be condensed or rearranged, but this has been accomplished without loss of clarity, and is offset by an increase in the number of illustrations from 96 to 132.

In the first five chapters, which lead from the structure of the atom, through interatomic forces, to the zone theory, increased emphasis has been placed on quantum mechanics in order that the band structure of metals might be more fully understood. Since these chapters lead logically to the applications of the electron theory in Chapter 6, I feel that much of the chapter on metallic crystals, especially the nature and surface tension of grain boundaries, might well have been placed later. Chapter 6 includes superconductivity, Zener's ideas of the exchange interaction in ferromagnetism, and a more lengthy discussion of domain structures and of cohesion.

The following five chapters, which range from equilibrium and the rate of approach to equilibrium, to the equilibrium diagram, are notable for an extended treatment of the equilibrium concentration of vacancies and of the structure of liquid metals. Here also are included the Laves phases, the work of Raynor on aluminium and the transition metals, a much-enlarged section on interstitial phases, and a brief mention of Friedel's work on the bound states existing in copper, silver and gold-base alloys.

Considerable effort is being devoted at the present time to studies of diffusion in metals and alloys, being aimed especially at the mechanism of the process and the effects of grain boundaries, dislocations and chemical inhomogeneities. An understanding of the process of nucleation and growth has also been sought. A survey of this work is contained in the relevant sections.

Prof. Cottrell's eminence in the field of deformation makes the extra chapter, which is entitled "Shear Processes in Metal Crystals", most valuable. The types of diffusionless changes occurring by shear processes—such as slip, deformation twinning and the martensitic-type transformation—are described, together with the mechanism of simple shear. This leads on naturally to dislocations, to the types and properties of dislocations, spiral structures, dislocation networks, and to the Frank–Read source.

The general construction of the book remains much the same as the first edition, and the price has increased by only four shillings. It contains references up to 1954. As a work dealing with the fundamentals of physical metallurgy it can only be described as excellent, and may be recommended without qualification to all students of metallurgy.

J. A. CATTERALL

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# RADIOBIOLOGY

## Fundamentals of Radiobiology

By Prof. Z. M. Bacq and Peter Alexander. Pp. xii + 389 + 14 plates. (London: Butterworths Scientific Publications, 1955.) 40*s*. net.

RADIOBIOLOGY is a mixed marriage of biological and physical sciences. The offspring of this union—radiobiologists—tend to suffer with psychological complexes which arise from a difficult upbringing. Formally trained in one discipline, they usually acquire proficiency in the other by apprenticeship. They feel that this latter method seldom gives them that mastery of the fundamentals of the science which is obtained from sitting at the feet of the professor.

In "Fundamentals of Radiobiology", Prof. Z. M. Bacq, a pharmacologist representing the biological sciences, and Dr. P. Alexander, a physical chemist, have combined to produce a book which will be best appreciated by the harassed radiobiologist or aspiring radiobiologist with the psychological complex.

From both the physical and biological aspects the book is written in a clear, convincing manner. Generally accepted facts are lucidly stated, which gives the student a feeling of confidence. Theories are expounded, due weight being given to the p and cons. The authors, having done this, usu sum up and set forth their own conclusions. T will please those who search for dogma, but n antagonize the esoteric who regard the theories still *sub judice*.

Broadly speaking, there are four large chapter on basic physics and physical chemistry—ei smaller chapters on various fundamental biolog aspects, morphological, physiological and biochemi and finally five small chapters on what may be ca applied radiobiology, including "Observations Human Beings". Each chapter has an extensive of references, "The 960 original papers quoted in bibliography represent a year's solid reading", there are author and subject indexes. The tex freely interspersed with tables and line diagra These admirable qualities are marred by a num of misprints.

J. F. Lou

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# A SURVEY OF CURRENT PSYCHOLOGY

## l'Année Psychologique

Cinquante-Quatrième année, 1954. Fascicule 1; viii + 306; 1,000 francs. Fascicule 2; pp. vii 309–618; 1,200 francs. Directeurs: Henri Piér Alfred Fessard et Paul Fraisse. (Paris: Pres Universitaires de France, 1954–55.)

THE 1954 volumes of "l'Année Psychologiqu contain several substantial experimental pape notably the ones on chromatic sensibility of the fov (Galifret and Piéron), the structure of rhyt (Fraisse and Oléron) and the interpretation of t meaning of ambiguous sounds (Bresson). A p ticularly thorough investigation is one report by Scherrer, Barbizet and Oudot-le Hénaff on t organization of somesthetic sensibility, in which t authors establish the minimum intervals which perr successive cutaneous stimuli to be discriminated a discuss the various allied problems that arise determining differential thresholds.

Most of the papers deal with problems in psyc physiology, but some are concerned with 'pu psychological topics such as the relation betwe powers of abstraction and mental flexibility. The is also a paper on personality and æsthetic preferenc and a shorter one on applications to the fine arts. T briefer reports cover a wide range of subjects, inclu ing leadership, psychiatric tests, studies of defen mechanisms and the statistics of measurement scal

The critical reviews of current periodicals ensu that French readers are kept in touch with develo ments elsewhere—a valuable feature. Among t many reviews there is one by Henri Piéron, t senior editor of the volumes, of a recently publish American work in which he remarks that the auth "appears systematically to avoid all citation authors in the French language . . . and, even European authors in general". Piéron adds: ' seems that one seeks nowadays to give to Americ students the impression that America alone co tributes to the development of science, an attitu symmetrical to that of the U.S.S.R.". All in "l'Année Psychologique" easily ranks among the b publications of its kind, both in quality and ran in contemporary psychological literature.

JOHN COHEN

# NEW HIGH-SPEED ELECTRONIC TACHISTOSCOPE

By Prof. GEORGE HUMPHREY, P. G. M. DAWE and BERNARD MANDELL
Institute of Experimental Psychology, University of Oxford

AN apparatus has been devised by us for exposing two visual fields for very short time-intervals ith control of the interval between them. This ticle is concerned not only with the description of is apparatus but also with the visual problems volved in this kind of work and with an outline of he preliminary experimental results.

## Apparatus

The apparatus makes use of two banks of short-ecay phosphor fluorescent tubes. There are four W. tubes in a bank, and each bank illuminates a isual field which is 6 in. square. These two fields re viewed from the same window by using the onventional half-silvered mirror technique for the irect transmission of one field, and the reflexion of he other, into the observer's eyes. Fig. 1 shows a lan of the instrument.

The fluorescent tubes are operated by d.c., with he current through each tube regulated by a hard alve. This is switched on and off by applying negative bias to the control grid which is derived om an Eccles–Jordan type of electronic switch. his switch is operated by short pulses, of less than ne microsecond in width, and is d.c. coupled to the ontrol valves so that the transition from on to off vice versa is accomplished in less than a micro-cond. The pulses for operating the electronic witches (for there are two, that is, one for each bank f tubes) are derived from electronic timing circuits perating on the flip-flop principle and embodying sistance capacitance combinations to give the ecessary time-delays. The timing circuits are upled together to give the desired sequence of witching on the closing of a trigger button, which initiates the first timing circuit. The coupling is arranged to cause lamps 1 to come on first, followed by a dark-interval, and then lamps 2. The exposure time of both sets of fluorescent tubes may be continuously varied between 200 μsec. and 0·625 sec. by a stepped switch and potentiometer. The limiting factor at the short exposures is most probably the resonance radiation decay-time of the mercury atom. At these very short exposures the light output is not particularly rectangular; but at an exposure of 1 msec. upwards fairly rectangular light pulses can be obtained. This is shown in Fig. 2a, which is an oscillogram of two 1-msec. light pulses separated by an interval of 1¼ msec. The dark-interval between the pulses is variable over the range 0–0·625 sec., although, as shown in Fig. 2b (for 200-μsec. light pulses with zero dark-interval), the light pulses will overlap at zero dark-interval due to the decay and build-up times of the radiation. The light pulses were observed by using caesium–antimony vacuum photocells connected by short low-capacity leads to the cathode-ray oscilloscope. Millisecond timing-pulses derived from a 1,000 c./s. square wave are shown superimposed on the Y1 beam of the oscilloscope for the purposes of measurement.

The light spectrum of the fluorescent tube is continuous, being that of the magnesium tungstate phosphor, together with the addition of the principal visual lines at 4047 and 5461 A. from the excitation

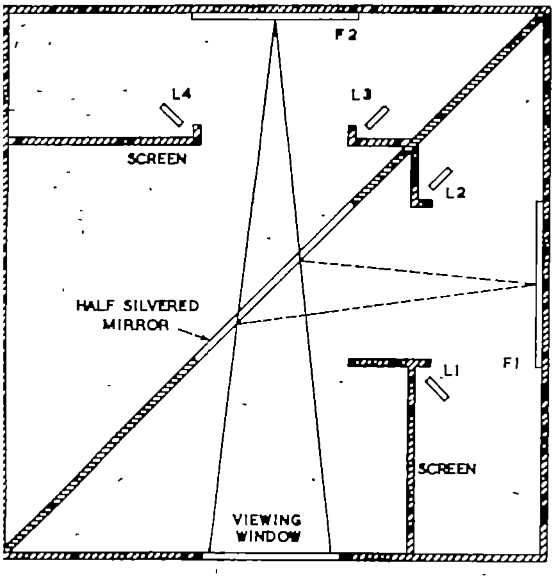


Fig. 1. Layout of the tachistoscope. Lamps *L*1, *L*2 illuminate field *F*1; *L*3, *L*4, field *F*2

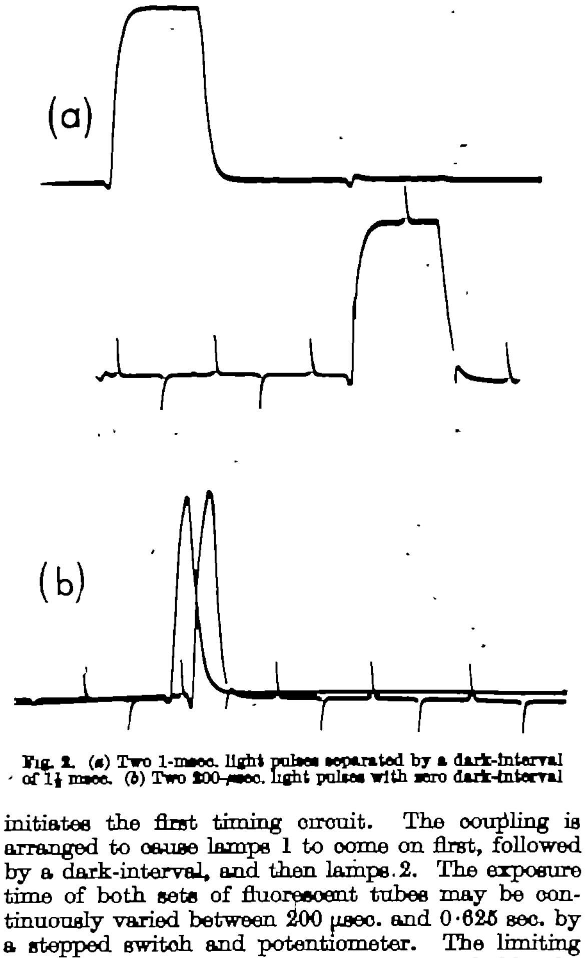


Fig. 2. (*a*) Two 1-msec. light pulses separated by a dark-interval of 1¼ msec. (*b*) Two 200-μsec. light pulses with zero dark-interval

of the mercury atom. Compared with daylight, the spectrum from the tube is somewhat deficient in red light. However, it is still possible to distinguish adequately between colours even at the shortest exposure times. The actual chromaticity co-ordinates of the lamp are given as $x = 0{\cdot}230$ and $y = 0{\cdot}290$.

The intensity of light from each bank of tubes is controlled by means of a variable resistor connected in the cathode circuits of the group of power valves feeding each bank of tubes. In this way the maximum current, and therefore the brightness, of the tubes can be varied over a range of approximately 2/1. The tachistoscope may, of course, be operated repetitively from an external pulse generator, and for the purpose of visual monitoring of the light pulses it proved convenient to do this at a repetition-rate of 10 per sec., the light outputs being displayed as an oscillogram.

## Visual Problems

In designing the apparatus, completely simultaneous exposure of all parts of the field was felt to be important, for modern neurophysiological considerations seem to leave open the possibility that sequential exposure may affect the manner in which an object is perceived[1-3]. The point was apparently first raised by Erdmann, more than sixty years ago, with reference to the tachistoscopes of the time, which, with the exception of those using an electric spark where the duration could not feasibly be varied, were either of the rotating wheel or other kind of moving-shutter type. In these the 'scanning' effect was said to be clearly visible, for longer exposures at least. Erdmann stated in a seminar that simultaneous exposure of the whole field with a variable exposure time was desirable but impossible. Dodge (personal communication, 1924) thought he had solved the problem with his mirror tachistoscope, the optical part of which has now become standard; but since he used a swinging pendulum as a shutter, he had really not done so.

It will be realized that in rapid exposures the phenomenal effect may be, and often is, one of complete simultaneity, when in fact the field has been scanned, either by part of a sector of a circle (Schumann) or by excursion of a rectangular slot in a moving shutter. On looking, for example, at a landscape, painted on a card, through an instrument of the circular, rotary, type in our laboratory, with an exposure of 1 msec., one sees the whole landscape appear as a single view, with no suggestion of the piecemeal and successive presentation which is actually occurring. Since the aperture was here smaller than the card, the total picture was never projected at one time on the retina. The effect is almost certainly due to some form of organic integration as the result of which a single picture is perceived when different retinal areas have been successively stimulated. This kind of process is, of course, not uncommon, the ordinary cinematographic picture being an obvious example. All this has been the subject of controversy, one side maintaining that, so long as the whole object appears simultaneously, the method of exposure is irrelevant. This conclusion is not justified *a priori* since, however clear and unitary the perceived object may be, the serial exposure and other features of this method of presentation may introduce phenomenal distortions ordinarily not noticeable, and which may prove important in accurate work. Whether this is so can only be discovered by experimental comparison of identical
objects as seen by the two types of apparatus, a
this is now being done. Similar considerations app
to the light pulse, which should ideally be of re
angular form. Herein lies the chief objection to t
ingenious instrument of Grindley, which focuses t
shutter on the lens of the eye and the object on t
retina, giving indeed a view of the whole obje
without 'scanning' but with a light pulse far fro
rectangular for its time base[4]. An adaptation of t
principle might, however, give good results at tim
shorter than are possible with Grindley's model.

It is further noteworthy that our problem is mu
more difficult than that of producing a short flash
an area of the retina, as for example in the expe
ments of Brindley and Crozier using a revolvi
mirror and a polarizable crystal, respectively[5,6].
any tachistoscope a total field must be illuminat
so that the effect of short exposure on complex pe
ceptual patterns can be observed.

Apart from the manner of field-illumination of o
instrument, which to our knowledge is superior
any yet built in its combination of simultaneit
very short and continuously variable exposur
together with practically rectangular light puls
from 1 msec. to 0·625 sec., an important new featu
is the timed dark-interval, between the two exposur
This enables closely timed work to be done on t
effect of a second exposure occurring after a variab
period; it is hoped, for example, that it will thro
light on what has been called 'metacontrast' (n
hibitory effect of post exposure[3]), Dodge's 'clearing-u
process'[7] and the possible effect of eye movement
subsequent vision.

## Preliminary Experimental Results

Taking as a starting-point the 'clearing-up proces
experiments of Dodge[7], an investigation was unde
taken into the conditions for clear vision of a patter
with very short exposures of consecutive fields. Th
experimental situation involved dark pre-exposu
and post-exposure fields, two illuminated fiel
(called here 'first field' and 'second field') and a dar
interval between them.

The luminance of both fields, the areas of whic
were 6 in. × 6 in., was equal and constant (70 mill
lamberts). The first white field, on which a 2-i
black cross was inscribed in two circles 1 in. and 2 i
diameter, with the line 0·1 in. thick, was followed
a second clear field of varying duration. It w
established that the perception of the pattern f
exposures from 0·2 to approximately 6 msec. coul
be totally prevented by a second field of somewh
longer duration, and that for exposures from appro
imately 6 to 30–35 msec. this period was of short
duration than the first field. (These are results for o
subject—forty years old—over the whole range
experiments. The individual differences betwee
subjects are considerable.) A pattern exposed f
more than 40 msec. was always, at least in par
perceptible, although with long second fields t
subjects saw it as a luminous cross, often followe
by a positive after-image. A disturbance in visibilit
of the pattern over all the range of exposure w
experienced when using second fields of short
duration than those producing total inhibition.

Taking into consideration that the pattern fie
was easily perceptible when exposed without t
second field, that the luminance of both fields w
equal, and the time relations, it is not convenient
describe the disturbance in terms of glare.

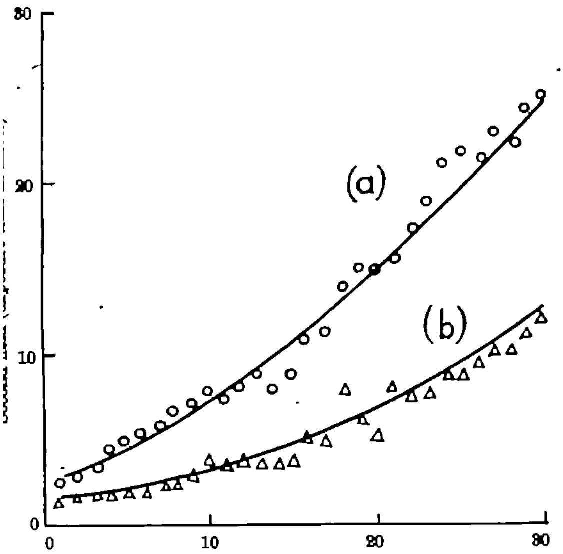


Fig. 3. Duration of a second field preventing or disturbing the visibility of the pattern in the first field: (*a*) no visibility; (*b*) bad visibility

The inhibitory or disturbing influence of the second eld could be prevented by interposing a short dark-nterval between the two fields. An interval of 5 msec. and more was necessary when a field of uration of 0·2 msec. was followed by a second field f duration more than 20 msec. For first fields of onger duration the dark-interval necessary for pereption of the pattern was considerably shorter; for xposures more than 15 msec. a dark-interval of 0 msec. was usually adequate. The experimental esults were cross-checked by eeping the exposure time of the rst field and the dark-interval onstant and increasing the durtion of the second field until he pattern was no longer visible.

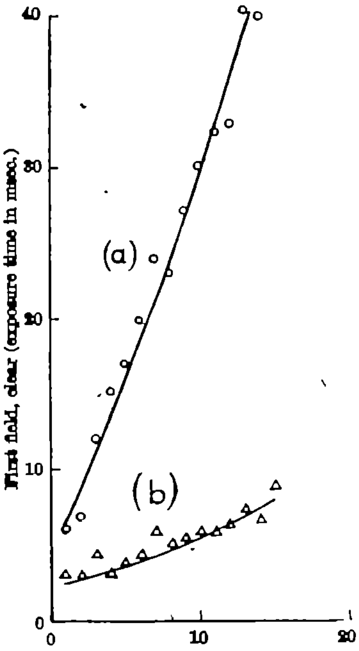
The reverse situation occurred hen a clear first field was folowed by a second field with a attern. A clear first field of -4½ msec. duration produced a isturbance in perception of a attern exposed for 1–5 msec., nd one of 4½–7 msec. prevented lear vision in pattern exposures p to 14–15 msec. A pattern xposed for 15 msec. and more ould not be rendered totally nvisible to the subject by a first lear field of the same luminance, hatever its duration.

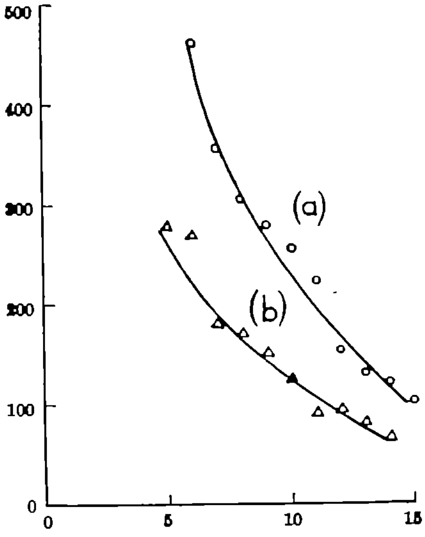
When the second field with he pattern was exposed for nore than 6 msec. (but less han 15 msec.) and the duraion of the first field was coniderably increased (permitting ome degree of adaptation), the ubject reported a reappearnce of the pattern. For exmple, with a pattern second ield of 6 msec. he reported t 4 msec. duration of the rst field a disturbance of vision, at 21 msec. a total disappearance of the pattern, at 240 msec. an appearance of a white cross on grey background, at 270 msec. the cross became blackish, and at 460 msec. the whole pattern was well cleared up. A pattern second field of 15 msec. duration was partly invisible with a 5 msec. clear first field. The biggest disturbance of vision was at 55 msec., but there was no total inhibition. At 73 msec. the subject reported improvement in vision, and at 103 msec. he reported a sharp, clear pattern. During the reappearance range he reported the arms of the cross 'coming back' earlier than the circles, and seeming very long and protruding beyond the circles.

As in the first experiment, a short dark-interval facilitated the perception of the pattern otherwise invisible. With very short first fields the subject reported the pattern as 'being there from the very beginning'. With long exposure of the first fields the pattern 'jumps' into the clear field.

The dark-interval was not always perceptible as an interval, and only in very few cases as 'dark'. There was a range of complete fusion of the first field and second field, a range of flicker and impression of doubleness with some apparent movement of the pattern, and a range of definite separation. The most important factor seems to be the duration of the first field in relation to the duration of the interval. The problem was investigated by Dunlap[8]; but his investigation technique was orientated towards 'singleness–doubleness' impression and towards perception of a dark field between moving illuminated ones, and not towards perception of interval, so that the problem is still with us.

Another problem arising from these experiments is that of the persistence of vision after stimulation has ceased. This can be expressed in terms of a dark-





Second field, with pattern (exposure time in msec.)

Fig. 4

Fig. 5

Fig. 4. Duration of a clear first field preventing or disturbing the visibility of a pattern in the second field: (*a*) no visibility; (*b*) bad visibility

Fig. 5. Visibility of the pattern in the second field with long exposures of the first field (50–500 msec.): (*a*) all pattern clear; (*b*) part pattern discernible

interval which it survives to fuse with the second field (a cross on the first field inscribed in the circle on the second field). This is not claimed to be a time measurement, as the second field is itself an experimental variable influencing the first field.

Experiments upon metacontrast indicate that an explanation in terms of contour building process (similar to Werner's interpretation of his 1935 contour experiments[9]) cannot account for all the phenomena, since inhibition occurs with irregular and incongruent contours. Both tachistoscopic experiments and experiments with intermittent stimulation point to the importance of retinal distances, although Alpern's[10] statements are not fully acceptable.

The building of the apparatus and the conduct of the experiments were under the general supervision of Prof. G. Humphrey; the tachistoscope was designed and built by P. G. M. Dawe, and the great majority of the experiments performed by B. Mandell. The apparatus and research were carried out by the aid of grants from the Medical Research Council and the Watts Bequest. Acknowledgment is also made to the British Thomson-Houston Co., Ltd., Rugby, which manufactured the fluorescent tubes for this apparatus.

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# MAGNETO-HYDRODYNAMICS

A DISCUSSION on magneto-hydrodynamics, organized by Sir Edward Bullard, was held in the rooms of the Royal Society on May 5. The proceedings were opened by Sir David Brunt, who took the chair for part of the discussion; he welcomed particularly the visitors from overseas, some of whom came from far afield. In his introduction Sir Edward Bullard said that the subject, which is concerned with the motion of a conducting fluid in a magnetic field, is not entirely new; but it was Prof. H. Alfvén, of Stockholm, who had rescued it from obscurity. The electromagnetic effects associated with such a motion are more conspicuous on a large scale, and the principal applications so far made are to astrophysical problems such as the theory of the sunspot field, the general solar magnetic field and stellar magnetic fields. There are also some applications in engineering, especially to pumps and flowmeters.

The subject is one which is understood in principle in so far as the relevant equations are known, being in fact the union of Maxwell's equations and the equations of motion and continuity of hydrodynamics. Sir Edward discussed at some length the terms in these equations which can be neglected in astrophysical problems. The solution of the equations is, however, a matter of real difficulty. Most of the solutions so far obtained have been derived from linearized equations, and he mentioned some examples of such solutions.

The next speaker, Prof. Alfvén, said that mathematical methods have been largely used for exploring the subject of magneto-hydrodynamics since it inception; but he pointed out that it is essential t explore the subject by means of experiments also i so far as certain aspects of the subject, as in the cas of turbulence, cannot be ascertained by mathematica methods alone. He considered such experimenta methods to be essential for a proper understanding o magneto-hydrodynamics. For excitation of mag neto-hydrodynamic waves in the laboratory, it i essential that the field-strength $B$, the linear dimen sion of the apparatus $l$, the conductivity and th density of the liquid $\sigma$ and $\rho$, respectively, shoul satisfy the inequality

$$Bl\sigma/\sqrt{\rho} \gg 1.$$

In the laboratory, we can attain fields of strength o the order of 10,000 gauss, and with such field magneto-hydrodynamic waves can be excited i mercury and sodium. On the cosmical scale, $l$ is ver large, and the above condition is amply satisfied.

Prof. Alfvén then went on to discuss the nature o currents occurring in magneto-hydrodynamic effect in the ionosphere and solar atmosphere, and he wa of the opinion that we have little evidence of current extending over a large volume; these, he thought tend rather to occur as filaments, and in support o this conclusion he quoted the auroral zone and the equatorial electrojects as examples. This effect i thought to be important in so far as it suggests the possibility that currents extending over large volume are unstable.

Dr. B. Lehnert next described some beautifu experiments on magneto-hydrodynamics which he has lately carried out in Stockholm. In this, a shallow cylindrical bath contains mercury in which a brass ring is inserted, capable of rotating about the vertical axis of the cylinder. There is a fixed horizontal circular disk within the ring, and a fixed annular disk outside it, both concentric with the disk resting half-way up the vessel. Dr. Lehnert showed that when the ring is rotated in a strong magnetic field the mercury over the ring is carried round as a rigid body, the outside fluid remaining at rest. Sir Edward Bullard interpreted this as an example of the theorem that, in a highly conducting liquid moving in a magnetic field, the magnetic lines of force are frozen in the fluid and tend to be carried by the fluid.

In the discussion that followed, Prof. S. Chandrasekhar showed some slides of some experiments made in the University of Chicago illustrating the inhibition of convection in mercury in the presence of a magnetic field. Prof. T. G. Cowling, referring to Alfvén's statement that cosmical currents tend to occur as filaments, said that he doubted the validity of this statement and that a filament current is more characteristic of an electrical discharge in gases.

Dr. D. Layzer next gave an account of a paper by himself, Dr. D. Menzel and Dr. M. Krook on torsional oscillations and solar magnetic fields. Dr. Layzer began by recalling the suggestion made by Cowling and Bullard that sunspot magnetic fields may be the result of a subsolar toroidal field which is convected to the surface. He suggested that, if the law of isorotation were violated at some initial instant, an alternating toroidal field would be produced by torsional oscillations of shells of magnetic lines of force, the sign of the field changing every half-cycle. Because of the low values of the kinematic and electromagnetic viscosities, such an oscillation could have existed throughout the past lifetime of the sun.

Dr. Layzer next considered how the submerged roidal field is brought to the surface. The growth a toroidal field at the base of the hydrogen convec- on zone gives rise to a hydrodynamic instability alogous to the instability of superposed fluids in a avitational field when the upper fluid is heavier an the lower fluid. The tension of the magnetic les of force plays a part analogous to that of surface nsion, so that if one supposes that there is a sharp terface between the region containing a magnetic ld and the overlying region in which no magnetic ld is present, ripples of small amplitudes will tend grow. Dr. Layzer suggested that this instability, ther than convection, is effective in convecting the bsolar toroidal field to the surface. The formation d subsequent dissipation of sunspot fields would aw energy mainly from the convection zone rather an from the primary oscillation. The equations verning the oscillations turn out to be linear in a st approximation, even if the amplitude of the cillation is large. Hence, for a given magnetic ell the period is nearly independent of the ampli- de. This point is a vital one in the theory which ntemplates large-amplitude oscillations rather than all vibrations about an equilibrium state.

In the discussion that followed, Prof. Cowling ointed out that Walén has shown that a reasonable rface field would be produced by a variation in me of 1–2 per cent in mean angular velocity. ichardson's measurements at the surface do not ow this. Hence, a substantially higher surface eld-strength would be required.

Prof. V. C. A. Ferraro next discussed the generation f magneto-hydrodynamic waves in rare ionized ases and its bearing on galactic magnetic fields. oubts have been expressed by several workers as to hether a rare ionized gas could behave as a perfect onductor on account of the very long free paths volved. Prof. Ferraro said that, if one neglects ollision altogether, magneto-hydrodynamic waves ay be excited in such a gas in the presence of a seed') magnetic field provided that the frequency f the waves is small compared with the gyro- agnetic frequencies of the charges. The phase elocity of the waves is the same as that found by lfvén; but the waves differ from magneto-hydro- ynamic waves in liquids in that they are circularly olarized. In order to excite the waves, the linear imensions of the gas must exceed the 'skin depth', hat is, the depth to which an external alternating eld would penetrate into the gas. As in the case f Alfvén waves, there is equipartition of mechanical nd magnetic energy independently of the magnitude f the 'seed' magnetic field. Thus, provided a eneral magnetic field exists in the galaxy, however mall, much larger fields may be generated, by mag- ification, as magneto-hydrodynamic waves through onvection or turbulence. But it is essential that he 'seed' field should have an 'external' origin, and his assumption is difficult to substantiate.

Prof. Cowling considered the problem of magneto- ydrodynamic oscillations of a rotating fluid globe nd, in particular, torsional oscillations. Steady otation can only hold for isorotation. Torsional scillations in the absence of rotation has been onsidered by Plumpton and Ferraro, who found a ontinuous spectrum for the normal modes of vibra- ions. This degeneracy might be removed by otation; but in this case, Prof. Cowling pointed out, he variable magnetic field associated with the field annot be purely azimuthal. On a rotating globe there must be, in addition to this field, a poloidal field also. Prof. Cowling referred to the equations of the problem and the boundary condition to be satisfied, and stated that these are sufficient to determine the solution. In the absence of rotation, the period of the oscillations is $2\pi/\sigma_0$, where

$$\sigma_0 = \frac{H}{a\sqrt{(4\pi\rho)}}$$

$H$ being the magnetic field, $\rho$ the density of the liquid and $a$ the radius of the star. If the angular velocity of the globe $\Omega$ is greater than $\sigma_0$, the Coriolis forces will greatly affect the period: in this case the magnetic forces are balanced by the Coriolis forces, and we get

$$2\Omega\sigma \sim \sigma_0^2$$

where $2\pi/\sigma$ is the period of the oscillation; this would therefore exceed $2\pi/\sigma_0$. In the case of the sun, one finds that the differential angular velocity is destroyed in a time of the order of $10^7$ years or more instead of 100 years. These results, however, do not apply to real stars, since the calculation is vitiated by the neglect of gravity. For, gravitational terms arise which largely prevent motion in meridian planes, and this means that the azimuthal Coriolis forces are no longer larger than the magnetic forces; thus, in spite of the fact that Coriolis forces are large, one can ignore them in considering torsional oscillation in actual stars. One may probably approximate to the periods of torsional oscillations using a form of Rayleigh's principle. In the discussion that followed, Prof. H. C. van de Hulst said that the solar cycle might well be a phenomenon too irregular to be classed as an oscillation.

Prof. Chandrasekhar opened the afternoon session with an account of an elementary theory of hydromagnetic turbulence which he has developed recently. He said that he has also developed a deductive theory along the lines of his recent theory of hydrodynamic turbulence; but there was no time to discuss it that afternoon. (It is understood that this will be published elsewhere.) The elementary part of the theory follows along the lines of Heisenberg's theory of ordinary isotropic turbulence. Prof. Chandrasekhar described in some detail the exchange of energy between the velocity field and the magnetic field; this, he showed, can be described in terms of an eddy resistivity and the spectrum of the random magnetic field, in a manner analogous to that of the inertial exchange of energy between the different Fourier components of the velocity field in terms of an eddy viscosity and the spectrum of the kinetic energy in Heisenberg's theory. The equations of stationary turbulence in this case lead to two essentially distinct solutions of the problem. Both solutions predict equipartition of kinetic and magnetic energy among the largest eddies present. For the smaller eddies, the ratio of the magnetic to the kinetic energy either tends to zero or to 2·6. Prof. Chandrasekhar then referred to the bearing of this theory on interstellar magnetic fields and especially the possibilities of distinguishing between Fermi's two pictures of galactic magnetic fields.

In the discussion that followed, Prof. van de Hulst asked whether, in Fermi's theory of the galactic magnetic field using gravitational arguments, the gravitational potential of the whole galaxy rather than that of a spiral arm should be considered. Furthermore, if the field is turbulent, can this be adopted as an explanation of starlight polarization? Dr. Layzer asked whether differential velocities are not likely to be more effective in getting higher magnetic fields; and finally Prof. H. Bondi asked whether the method adopted by Prof. Chandrasekhar is sensitive to deviations from isotropy. Sir Edward Bullard commented that equipartition of energy for large eddies does not exist in the earth's core; there the force driving the material has to be taken into account.

Dr. A. Banos began by recalling the fundamental notions in the theory of magneto-hydrodynamic waves originally given by Alfvén. He referred to the work of Walén and to the laboratory experiments of Lundquist and Lehnert, but he said that no complete account of fundamental equations has yet been given without making simplifying assumptions. A start has been made by Dr. Banos in a recent paper (*Phys. Rev.*, **97**, 1435; 1955), and his contribution amounted to an account of this paper, which is a systematic study of the problem. He showed how the equations of the problem, namely the Eulerian equation of hydrodynamics and the Maxwellian equations, can be reduced to one fundamental equation in the fluid velocity. Dr. Banos then considered the linearized form of this equation and its solution for the case of incompressible fluids, and compressible fluids (which gives rise to magneto-acoustics) for the case of plane and cylindrical waves.

The next speaker, Dr. W. Marshall, discussed the structure of magneto-hydrodynamic shocks. He first recalled the structure of an ordinary shock-wave, and then considered theoretically the detailed structure of an infinite plane shock moving with uniform velocity into a region of stationary ionized gas in the presence of a magnetic field perpendicular to the line of flow. When the 'penetration depth' is smaller than a mean free path (as in the case of high electrical conductivity), the field is very nearly proportional to the density, and the shock point has a width of the order of a few free paths. In the case of a conducting gas of low conductivity, if the permanent magnetic field is less than a certain critical value, depending on the strength of the shock, we have a sharp shock in which only the velocity and temperature change is preceded by a wider region in which the velocity, temperature and field change slowly. In this case, we have the surprising result that the field changes take place ahead of the shock. When the permanent magnetic field exceeds the critical value, it prevents the rapid changes in velocity and temperature, and no sharp shock occurs. All quantities change slowly in a wide region.

Dr. R. Hide spoke on the generation of waves in a heavy electrically conducting fluid of variable density in the presence of a magnetic field. Considering the stable case in which the density decreases vertically with height, Dr. Hide said that the fluid always tends to return periodically to its equilibrium state when viscosity is zero. In this case the motion gives rise to 'gravity' waves propagated horizontally. In the case of a viscous fluid, only modes of disturbance characterized by an infinite range of wave-lengths generate damped gravity waves, other modes decaying aperiodically. If the fluid is conducting and there is a magnetic field present, the gravity waves are modified by electromagnetic waves. The linearized equations for any variation of density and kinematic viscosity are solved by a variational principle for the case when the electrical conductivity is constant and the impressed magnetic field uniform.

In the case of a continuously stratified fluid of finite depth, Dr. Hide was only able to examine in detail the case of infinite conductivity. The properties the motions depended on two parameters $G$ and defined by

$$G = \frac{g\beta d^4}{\pi^4 \gamma^2}, \quad Q = \frac{\mu H_0^2 d^2}{\pi^2 \rho \nu^2}$$

where the density $\rho(z)$ is given by $\rho = \rho_1 \exp(-\beta z$ $H_0$ is the uniform magnetic field, $\nu$ the kinema viscosity, $d$ the depth of the liquid, $g$ the accelerati of gravity, and $\mu$ the magnetic permeability. If is the horizontal wave number of the motion, D Hide finds that waves can be generated within finite range of $k$ if $G > 27/16$ and $Q < 1$, whereas wh $Q < 1/2$ and $G < 27/6$ all modes are aperiodical damped, so that no waves are generated.

Dr. J. A. Shercliff spoke on some engineerin applications of magneto-hydrodynamics. He sa that engineers are interested in magneto-hydrodyn mics chiefly on account of its use in electromagnet pumps and flowmeters for liquid metals in nucle power plants and elsewhere. The fluid motion pumps is complex and difficult to analyse; th flowmeter problem is simpler, however, especially turbulence is suppressed by the transverse magnet field. The sensitivity of a flowmeter depends on th form of the velocity profile, and this may be disturb by electromagnetic forces or upstream disturbance As the fluid moves across the transverse magnet field, currents are induced which affect the velocit profile and sensitivity.

Dr. Shercliff then considered the equations of th problem; these involve two parameters, th Reynolds number and a number depending on th magnetic field. If the transverse magnetic field is sufficient extent in the direction of flow, there is further distortion of the profile, and in a circul non-conducting tube the sensitivity falls by som 7 per cent if the velocity profile is fully distorted fro axial symmetry by electromagnetic forces. Th theoretical results obtained have been verified exper mentally. Dr. Shercliff also considered the effect orifices in the surface of the tube, and said that th sensitivity can be large or low or even negative various points of the surface of the tube.

The last speaker, Dr. W. B. Thompson, considere the acceleration of cosmic-ray particles by magnet hydrodynamic waves. Dr. Thompson first reviewe Fermi's theory of the origin of cosmic rays pu forward in 1949 and recalled that Fermi had derive the exponent in the energy law as the ratio of tw times—an acceleration time $t_1$ and a mean life energetic particles $t_2$. In this theory the particle gain energy through elastic collisions with a movin magnetized cloud of gas. In a form of the theor due to Morrison, Olbert and Rossi, $t_2$ represents th time needed for an energetic particle to diffuse out the galaxy, and the theory seems able to provide a explanation of most of the observed features of th part of the cosmic-ray flux of greatest energy However, on this theory $t_1$ is of the order of $10^8$ year which is at least an order of magnitude too larg This led Fermi to attempt a more efficient acceleratin mechanism.

Dr. Thompson then directed attention to a mech anism, so far overlooked, indicated by recent view on the galactic magnetic field. If one supposes, wit Chandrasekhar and Fermi, that there is a genera field of the order of $10^{-6}$ gauss in a spiral arm and Fermi's magnetized clouds are also present, thes might act as scattering centres enabling cosmic-ra particles to be accelerated to high energies by th lectric fields associated with the magneto-hydro-ynamic wave. On the basis of this mode, an pproximate calculation of the rate at which relativistic particles acquire energy leads to a time $t_1$ such that

$$\frac{1}{t_1} \sim \frac{1}{x}\frac{v}{c}\left(\frac{\delta H}{H}\right)^2$$

where $v$ is the velocity of the magneto-hydrodynamic wave of wave-length $\lambda$, and $\delta H$ is the amplitude of he wave. By taking $v$ to be of the order of 30 km./sec. the value adopted by Fermi), $\lambda$ of the order of 0 light-years, $\delta H/H \sim \frac{1}{4}$, one finds $t_1$ to be of the rder of $10^6$ years, a value small enough to give greement between astrophysical and cosmic-ray data.

V. C. A. FERRARO

# OBITUARIES

## Dr. C. S. Orwin

DEEP regret will be widely felt for the death of Charles Stuart Orwin at his home at Blewbury, Berkshire, which occurred on June 30. He was born at Warnham in Sussex in 1876 and was educated first at Dulwich College, then at Wye College, which he entered in 1895, its second year of establishment as an agricultural institution. He was fortunate both n his fellow students and in his teachers: the subject was new and the principal, A. D. Hall, had the gift of attracting an able body of enthusiastic pioneers. Orwin thoroughly absorbed the spirit of the place and throughout his life held it in great affection; in particular, he had great admiration for Hall, who in turn thought very highly of him.

Orwin early became interested in the organization and development of agriculture, and on leaving Wye n 1897 he worked with an estate agent in Tonbridge and then for a short time in the City of London; he returned to Wye in 1903 as lecturer in estate management. He did not, however, remain long. Mr. Christopher Turnor, who had inherited the family estates in Lincolnshire, wished to develop them on sound lines, and in 1906 he invited Orwin to take over the management; this he did with satisfaction to all concerned.

Meanwhile, A. D. Hall was insisting that agriculture as a technical subject could not be taught apart from quantitative knowledge about the various operations; he was surprised at the vague ideas on the subject of costs and times required that were held by the ordinary college lecturers. Orwin took up the subject with enthusiasm, developed systems of bookkeeping which farmers could use, and built up a body of carefully ascertained knowledge on farming operations and their results, on which a new subject, agricultural economics, could be built up. Hall by this time was the Permanent Development Commissioner and had established an Institute for Agricultural Economics at Oxford: Orwin was put n charge and, with the aid of a succession of able young colleagues, was able to produce a series of valuable reports, first on a county basis, afterwards on more general lines. He was appointed assessor to the Agricultural Tribunal set up in 1922 to study the agricultural crisis of those days, and its report, issued n 1924, for the drawing up of which he was largely responsible, is justly regarded as one of the best on the state of British agriculture.

He was much interested in the history of agriculture, and was fortunate in having an able helper in the gifted wife of his second marriage. Together they produced in 1939 "The Open Fields", based on a study of the system still surviving at Laxton; this is now the standard treatise on the subject. His other works included an account of John Knight's reclamations at Exmoor in the early nineteenth century, a subject in which interest has been renewed by Earl Fortescue's recent reclamations, and a very readable short "History of English Farming" (1949). He adopted Hall's revolutionary view that the Government should acquire all the agricultural land of the country and redistribute it in larger units; he dealt with this in "Speed the Plough". His method of investigation is well seen in "Country Planning, a Study of Rural Problems" (1944), the work of a team under his direction.

Orwin's wide knowledge, sound judgment and deep sympathy with the small farmer and the worker made him a very acceptable member of the Agricultural Wages Board and of numerous other committees of inquiry, while Balliol College very shrewdly secured his help by making him estates bursar. He had his share of honours: Oxford conferred upon him the degree of D.Litt., Balliol made him an honorary Fellow and Wye College also elected him to a fellowship; but he lives in the memory of those who knew him as a friend ever ready to help and who steadfastly maintained the best traditions of the English country gentleman.

E. JOHN RUSSELL

## Prof. F. J. Lewis

THE death of Francis John Lewis on May 24 at the age of eighty marks the passing of one of the very few links left with the grand old tradition of British botany led by Bower, Oliver, Gwynne-Vaughan and others. Unlike most of his contemporaries, however, Prof. Lewis spent most of his botanical career overseas.

He was born in London in 1875 and received his early training at the Imperial College of Science and Technology, London, and at the University of Liverpool, from which he received the degrees of M.Sc. in 1908 and D.Sc. in 1912. He was appointed demonstrator in the University of Liverpool and held this post until 1905 and then became lecturer in geographical botany until 1912. During that time he did a great deal towards establishing the branch of geographical botany in undergraduate courses. In 1912 he was appointed professor of botany in the University of Alberta, Edmonton, Canada. There he worked and developed that department for twenty-three years until he resigned in 1935.

Lewis was an exceptionally active man both physically and mentally, and this meant that he could scarcely be expected to live in retirement. So in 1935 he exchanged to a very different environment—that of Egypt, where he was appointed professor of botany in the Fouad I University of Cairo in succession to F. W. Oliver. His headquarters were for some years in the old Zafaraan Palace at Abassia. In spite of the hampering episodes of wartime in the Middle East, he developed a small laboratory on the Suez Road where he investigated the phenomena of dew formation in the desert and studied the permeability of leaf tissues. He also took a leading part in the transferring of the Botany Department to the fine new building at Giza. There he organized the spacious laboratories and built up an excellent staff of Egyptian botanists. From the new laboratories, the botanical staff were able to work in much closer co-operation with the Egyptian Ministry of Agriculture Laboratories, the Cotton Research Laboratories and others which were nearby.

Although Prof. Lewis retired from Cairo in 1946 when he was seventy-one years of age and returned to Great Britain, he was still as active as a man half his age. He therefore accepted for one year the appointment of visiting lecturer in plant physiology in the Royal Holloway College (University of London). His knowledge of physiology and ecology stood him in good stead, not only there, but also in other activities such as that of an advisory editor to the new edition of "Chambers's Encyclopædia".

In 1905 Lewis was awarded the Cuthbert Peel Fund of the Royal Geographical Society and in 191 he was awarded the Neill Gold Medal of the Roya Society of Edinburgh, of which he was a Fellow. H was also Fellow of the Royal Society of Canada an of the Linnean Society. His work in connexion wit "Chambers's Encyclopædia" instilled in him a enthusiasm for publications, with the result tha right up to the time of his death he took an activ part in forming a liaison between the publishing fir of Macmillan and Co., and British universitie visiting them all in turn.

W. Lawrence Balls
L. J. F. Brimble

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# NEWS and VIEWS

## The Indian Botanic Garden : Dr. K. P. Biswas

Dr. K. P. Biswas retired on August 1 from his post as superintendent of the Indian Botanic Garden. He was appointed curator of the Herbarium of the Botanic Garden in 1927, and superintendent in 1938 when Mr. C. C. Calder retired. Dr. Biswas specialized in Algæ and systematic botany. He was granted study leave in Europe during 1937–38 and worked at Dr. F. E. Fritsch's laboratory at Queen Mary College, the Edinburgh Botanic Gardens and at the Herbarium of the Royal Botanic Gardens, Kew. During this time he was awarded the D.Sc. degree of the University of Edinburgh. He has published a number of papers in the *Records of the Botanical Survey of India*, of which he was the editor, and in several local and foreign journals—*Kew Bulletin*, *Hooker's Icones Plantarum*, etc. He has also published some important botanical treatises, among which is "Bharatiya Banaushadhi" in Bengali (3 vols.)—a joint publication for which he was awarded the Rabindra Memorial Prize in Science in 1951–52. A book on "Medicinal Plants of Sikkim Himalaya" is now passing through the press as a result of his detailed study of the Flora of Sikkim Himalaya. Improvements of the Garden and its amenities were effected during the past twenty-eight years of his service by introducing and acclimatizing many plants both in the Lloyd Botanic Garden, Darjeeling, and the Indian Botanic Garden, Calcutta. The Lloyd Botanic Garden, Darjeeling, was reorganized into a Phyto-Geographical Garden by arranging the plants according to their proper classified order. Dr. Biswas takes keen interest in the cultivation of medicinal plants in India. It was at his initiative that the Government of West Bengal started the cultivation of plants yielding some important drugs in the Eastern Himalaya (Rungo) under the joint auspices of the Medicinal Plants Committee of the West Bengal and of the Medicinal Plants Scheme of the Indian Council of Agricultural Research. During his regime extensive collections were added to the Botanic Garden Herbarium from South Burma, Naga Hills, Manipur (Assam), Sikkim, Orissa, Bihar (Santhal Parganas), etc. In India he has received many honours, such as the Elliot Medal and Bruhl Medal of the Asiatic Society of Bengal. He was president of the Botany Section of the Indian Science Congress in 1943, president of the Botanical Society of India in 1952 and president of the Botanical Society of Bengal during 1948–50. He is honorary lecturer in botany in the University of Calcutta.

## Dr. D. Chatterje

Dr. D. Chatterjee, systematic botanist at th Indian Agricultural Research Institute, New Delhi has been appointed to succeed Dr. Biswas. Dr Chatterjee was born at Chinsurah, near Calcutta on April 2, 1911. He studied botany at th Presidency College, Calcutta, where he specialized in systematic botany. Later, he went to the Universit of Edinburgh and was awarded the Ph.D. degree o that University in 1939. His work in Edinburg consisted of a critical study of the distribution of th Himalayan and Indian flora. On his return to Indi in 1939, Dr. Chatterjee worked for some time at th Indian Botanic Garden, Calcutta, and in 1940 wen to Burma as a lecturer in botany in the Agricultura College, Mandalay. The War in Burma, however did not allow him to stay there long and he returne to India in April 1942. He worked again at th Indian Botanic Garden, Calcutta, for nearly a year and later, in July 1943, he was appointed a lecture in botany at the Cotton College, Gauhati, Assam He again went to Britain early in 1946 and joine the Royal Botanic Gardens, Kew, London, as botanis for India, from which he published some valuabl papers dealing with new discoveries of several plant and on nomenclature of plants. In 1948, whil working at Kew, he was deputed by the Governmen of India to attend the Symposium on Botanica Nomenclature held at Utrecht, Holland. Dr. Chatterjee returned to India from Kew in April 1949 an was appointed systematic botanist in the India Agricultural Research Institute, New Delhi, in Jun 1949. While there he published papers dealing wit the origin of cultivated rice and other cultivate plants. He has also taken up the classification o cultivated wheats of India. In appreciation of hi work on Indian flora, Dr. Chatterjee was mad a vice-president of the International Botanica Congress held in Paris in 1954, and was awarde a Special Centenary Medal of the Société Botaniqu de France. He was also awarded the Bruhl Memoria Medal of the Asiatic Society of Bengal this year (1955) for meritorious work done in the field of botanica research during the past five years. Dr. Chatterjee ha travelled widely and has worked in several Europea herbaria and botanical gardens. In view of his lon experience in taxonomy and nomenclature, we fee confident that Dr. Chatterjee will prove a very abl superintendent of the famous Botanic Garden a Sibpur, Calcutta.

## conomic Factors in World Peace

In his Alex Wood Memorial Lecture, "The Recon-iling Spirit and the Economic Order", delivered in Glasgow on February 19, and which has now been ublished (pp. 17. London: Fellowship of Recon-iliation, 1955; 1*s*. 6*d*.), Prof. C. F. Carter analyses rst the several arguments that the causes of war re primarily economic. He believes that economic actors have played only a subsidiary part in the reat conflicts of this century, that we are justified n thinking that we are achieving more, and not less, willingness to consider the interests of others and hat pacifists have drawn too sharp a distinction etween police action and war. Economic wrong, waste and injustice still have to find their remedy; ut, as Prof. Carter points out, we cannot afford to do without the great efficiency of large-scale factory production and, while the capitalist system can show examples of ruthless or dishonest profit-making, it can also show many of disinterested public service. Any other way of running our economic affairs would equally depend on much the same human beings, nor is there a simple choice between a system based n competition and one based on co-operation; both xist in any economic system. Inequality and competition between individuals result from our need for a discipline to help us give of our best in production, and such a discipline is not necessarily a bad thing. The conflict between management and labour is not necessarily to be removed by a change to public ownership but by better techniques of management —a more imaginative understanding of the other man's work and aspirations. While, therefore, we should not ascribe to a particular economic system difficulties which would be inherent in any economic system and should distrust the simple solution, Prof. Carter pleads for greater efforts to understand the position of the other man, to see the good in that and the evil in our own, and to be solid and sensible n our proposals for change. Anything we can do to increase personal knowledge about those with whom we are in an economic relationship can be a way of lessening conflict.

## Mount Everest Foundation

A Mount Everest Foundation for the support of scientific work in mountain regions has recently been set up by the Royal Geographical Society and the Alpine Club with funds acquired from the proceeds of the books, film, lectures and other activities which followed the successful Everest Expedition of 1953, sponsored by the two bodies. Within the broad object of supporting the exploration of mountain regions, the Foundation will particularly aid moun-aineering expeditions exploring, to some extent at east, little-known or unknown territory, but not necessarily engaged in a particular branch of scientific research; but provision is also made, more specifically, for the support of scientific investigations in mountain country, not necessarily involving special mountaineering technique, or new exploration in a geographical sense. In this scientific field, grants may be made for research into geography, topography, geology, ethnology, meteorology, botany, zoology, entomology, glaciology, and allied studies, either in, or concerned with, mountain regions; physiological studies dealing with the effects of altitude upon the human organism, and the means of countering such effects, are also among the objects of the Foundation. Those seeking grants should write for application forms to the Honorary Secretary, Mount Everest Foundation, c/o Alpine Club, 74 South Audley Street, London, W.1. The forms should reach the Foundation not later than February 1, April 1 and October 1 each year, for consideration in April, June and December, respectively.

## New Nature Reserves in Britain

The Nature Conservancy on July 28 announced the establishment of three new nature reserves. The first of these, the Wychwood Forest Nature Reserve, covers about 647 acres of mixed woodland, about seven miles west of Woodstock. The mixed fauna and ground flora are rich, and it is intended that the reserve shall be a permanent forest, regenerating naturally and consisting of indigenous species of hardwoods on a long rotation. The reserve will be used for scientific research and will not be open to the public. The Tring Reservoirs Nature Reserve covers an area of 50 acres of the banks only of the four reservoirs, Wilstone, Marsworth, Little Tring and Startopsend, which when full have a combined water area of more than 200 acres. The marshy ground provides a habitat for plants such as the round-fruited rush (*Juncus compressus*), the orange foxtail (*Alopecurus aequalis*) and the broad-leaved ragwort (*Senecio fluviatilis*), which are rare in Britain; but the reservoirs are best known to naturalists as a bird sanctuary, and in 1938 were the first recorded site in Britain for the nesting of the little ringed plover. The nesting species include shoveller, teal, pochard and tufted duck, little and great crested grebe, reed warbler and sedge warbler. Permits will be necessary for those wishing to undertake research, collect specimens, or to visit parts of the reserve away from the footpaths. The Hales Wood Nature Reserve covers only twenty acres about two and a half miles from Saffron Walden, and is one of the best known examples in Britain of oak–ash woodland on chalky boulder clay where the true oxlip (*Primula elatior*) has replaced the primrose in the herb layer. The shrub layer consists mainly of hazel, with occasional maple, blackthorn, dogwood and the large guelder rose; as the wood must be kept undisturbed, access permits can be granted only in very limited numbers and for special reasons.

## Department of Scientific and Industrial Research

In a written answer in the House of Commons on July 21, Mr. J. R. Bevins, Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the Council, gave the names of the members of the committee which is investigating the work of the Department of Scientific and Industrial Research as follows: Sir Harry Jephcott (chairman), chairman and managing director, Glaxo Laboratories, Ltd.; Mr. C. H. Andrew, deputy secretary, Board of Trade; Sir Hugh Beaver, managing director, Arthur Guinness, Son and Co., Ltd.; Mr. E. W. Playfair, third secretary, H.M. Treasury; Sir Alexander Todd, professor of chemistry, University of Cambridge.

## Recent Lunar Research

A paper by Dr. H. Percy Wilkins which appears in the *Journal of the British Interplanetary Society* (13, No. 6; November 1954) is the first of a series of papers which are to appear dealing mainly with changes in lunar topography. Dr. Wilkins returned recently from a tour of the United States where, as he describes it, "with traditional courtesy and hospitality the giant American telescopes were freely placed at my disposal . . .". The instruments that he used were the 60-in. reflector at Mt. Wilson Observatory and the 26-in. refractor at the Naval Observatory, Washington. An account is given of his observations on cracks and clefts, the first object dealt with being the crater of Vendelinus. In 1891, T. Gwyn Elger, the first director of the Lunar Section, British Astronomical Association, observing this crater with his 8½-in. Calver reflector, saw a cleft or crack running north from a small crater on the northern part of the interior, and Elger recorded this cleft later, additional confirmation being obtained by Dr. W. H. Maw's observations with his 6-in. refractor. Wilkins and other experienced observers failed to find a trace of it, and the remarkable thing is that not only did the 60-in. telescope reveal no cleft, but where it once appeared Wilkins saw elevations. Perhaps more remarkable still is the fact that though the cleft had vanished, two new ones had opened up, one on each side of its former position. An examination of Mare Humorum with the Washington 26-in. refractor showed that the border of this plain, which had been known to be extensively cracked, was much more cracked than had been previously suspected. Five clefts seem to be new and one marking shown by the older observers as a ridge is now a cleft. These are only two instances, supported by a considerable body of evidence, and suggest that cracks are still being formed.

## Excavations at Kirkstall Abbey, near Leeds

The Thoresby Society has been excavating for a number of years at Kirkstall Abbey, near Leeds, and the fifth report of the Society, covering 1954 (pp. 16+2 plates; from the Society, Leeds; 1955; 1*s*.), describes an interesting find of a large earthenware crucible. The crucible is 17¼ in. high and 17¼ in. in diameter at the top, decreasing to 11¼ in. at the base, and was used for refining copper or bronze. Metallurgical methods and processes, whether used in the Bronze Age or in later medieval times, are always of interest, and the new find adds considerably to our knowledge of how the folk of this latter period worked. A general account of metallurgical processes is also given, and this will be welcomed by students of many different periods who have not had any training in chemical studies.

## A Museums Calendar for British Museums and Art Galleries

For many years the museums, art galleries and cognate institutions in Great Britain have suffered from a lack of current and reliable information concerning themselves and allied institutions. At one time and another directories have been issued, but these are costly compendiums and are soon out of date. The Museums Association has recently issued an excellent "Museums Calendar" which contains an almanac for 1955, various details of the Association, including notes on its past history, regulations for both its diploma and technical certificate, a complete list of institutional and personal members, and a list of all the museum and art galleries in Great Britain. Details of the present policy of the United Kingdom Carnegie Trustees towards museums are given, as well as particulars, with a useful map, of the regional federations. For the present issue it was only possible to collect information regarding certain overseas museums and art galleries, but in subsequent annual editions, to be issued in January, this feature will be greatly extended. Such a publication is indispensable for those working in, or associated in any way with, British museums and art galleries. In stiff paper covers, it is published at the reasonable price of 5*s*. and can be obtained from the Museums Association, 33 Fitzroy Street, London, W.1.

## Distribution Maps of Scandinavian Species of *Hieracium*

During the last few years of his life, Prof. Gunnar Samuelsson was engaged on a compilation of some of the main features of the plant geography of the Scandinavian *Hieracium* flora. To this end he had prepared distribution maps of more than a hundred species. At the time of his death in 1944 these maps were in a more-or-less complete state; but they had not been worked up or commented on in any way. This has now been done by Erik Almquist, the work being available as a publication of the *Kungl. Svenska Vetenskapsakad. Handl.* (Fjärde Serien, 5, No. 3 1954). This monograph includes 123 maps and a short foreword and index. According to the editor, "Samuelsson's main intention seems to have been to bring to light a number of different distributive types, and to show, at the same time, how far we have come in our knowledge of the occurrence of the more important species". The commentary in the foreword on the distribution of different species and groups is brief; but a number of interesting points are made. In particular, the view is expressed that, although most species of *Hieracium* are in various ways favoured by cultivation, the maps nevertheless afford a fair indication of their natural distribution, certainly of the species of at least some sections of the genus. It is held that spreading of a synanthropic kind over large distances is unusual. Species of other sections, on the other hand, are more-or-less entirely associated with localities under cultivation; but the bulk of the area's species "undoubtedly consists of endemic small species of varying age, having mostly emerged in post-glacial time".

## Speciation and Variation in Asexual Fungi

In a monograph under this title, published under the editorship of R. W. Miner, as Vol. 60, pp. 1–182 (1954), of the *Annals of the New York Academy of Sciences*, readers will find a rich collection of well-illustrated information on this important botanical topic. As Dr. K. B. Raper says in the introduction: "I do not believe that we are dealing with problems basically different from those faced by an investigator concerned with the taxonomy of micro-organisms. In the so-called asexual fungi, however, these problems become particularly acute. The very fact that these organisms reproduce themselves so successfully without the intervention of sexuality at once precludes from consideration a developmental phase with attendant characteristics and structures which, if present, would normally provide the most stable features possible. In the absence of such features, we must somehow get along with what is left". The individual contributions cover a wide range of mycological themes, such as interrelationships of speciation, type preservation, and nomenclature in bacteria; variation and speciation in the genus *Fusarium*; the evolution of species concepts in *Aspergillus* and *Penicillium*; spontaneous and induced variation in selected stocks of the *Penicillium chrysogenum* series; experimental control of morphogenesis in micro-organisms; natural and cultural variation in entomogenous Fungi Imperfecti; types of variation in Actinomycetes; variation and criteria of speciation in the genus *Streptomyces*; 'Ektachrome' transparencies as aids in Actinomycete classification; induced mutation and strain selection in some industrially important micro-organisms; morphological studies in the genus *Nocardia*.

## Statistics of Petroleum Products in Britain

STATISTICS recently issued by the Petroleum Information Bureau on behalf of the Petroleum Industry Advisory Committee reveal that in 1954, for the first time, the United Kingdom used more than twenty million tons of petroleum products (excluding bunkers for ships engaged in foreign trade). Actual total inland consumption was 21,038,511 tons—more than two million tons increase on the corresponding figure for 1953. Of this total, nearly six million tons represents motor spirit (including motor benzole); 1·3 million tons burning and vaporizing oils; 1·4 million tons derv fuel; 6·3 million tons gas, diesel and fuel oils. Consumption of all other petroleum products showed substantial increases over corresponding figures for 1953. Of indigenous materials made available for distribution in the United Kingdom by the industry, motor spirit by low-temperature carbonization and also refined benzole showed increases compared with 1953.

## Library of the University of Leeds: Report for 1953–54

THE annual report of the Librarian of the University of Leeds for the session 1953–54 (pp. 11; Leeds, 1954) records holdings of books and pamphlets totalling 540,770 on June 30, 1954, accessions during the year totalling 13,347 volumes, 2,421 pamphlets and 25,086 periodical parts. Of these, 6,503 volumes and 1,684 pamphlets were presented, while many books and periodicals were obtained by systematic exchange, particularly with the Biblioteca Apostolica Vaticana, the British Museum, the Library of Congress, Societas Entomologica Fennica and the Universities of Berne, Helsinki, Marburg, Münster and Zurich. The second instalment of the new stack and mezzanine floor has given complete satisfaction both on practical and aesthetic grounds, and it is hoped that the scheme will be completed in the near future by the addition of the two surrounding portions which will bring the new floor to the outer perimeter and make provision for research readers. There was an increase of 5 per cent in cataloguing done during the year; but the position of the Medical Library further deteriorated, and there is now insufficient space for text-books and monographs and the commonly used periodicals. Plans have been made for a small extension of the building which it is hoped will have been undertaken early this year.

## Chemistry and Biology of Phospholipids: Symposium in London, Ontario

THE Biochemistry Division of the Chemical Institute of Canada is sponsoring a symposium on phospholipids, to be held in the University of Western Ontario, London, during October 12–13, immediately preceding the meeting of the Canadian Physiological Society. The symposium will consist of two sessions on the following topics: chemistry of phospholipids (chairman, A. M. Wynne, University of Toronto), at which phosphoglycerides, inositol phospholipids and sphingolipids will be discussed; and metabolism and function of phospholipids (chairman, W. R. Bloor, University of Rochester, New York), at which their biological synthesis, metabolism *in vitro*, and function will be discussed. Members of the Canadian Physiological Society and others interested may attend the symposium. There will be a registration fee of one dollar. Further information can be obtained from Dr. R. J. Rossiter, Department of Biochemistry, University of Western Ontario, London, Ontario.

## Announcements

SIR ARNOLD HALL, director of the Royal Aircraft Establishment, Farnborough, since 1951 (see *Nature*, 168, 19; 1951), is retiring and will join the Hawker Siddeley Group as technical director. He will be succeeded at Farnborough by Mr. G. W. H. Gardner, director-general of technical development (air) at the Ministry of Supply.

THE Council of the Physical Society has made the following special awards for 1956: *Guthrie Lecture*, Sir Francis Simon; *Rutherford Lecture*, Prof. P. I. Dee; *Duddell Medallist*, Prof. J. G. Gaunt; *Charles Vernon Boys Prize*, Dr. G. D. Rochester and Dr. C. C. Butler.

THE Executive Council of the Commonwealth Agricultural Bureaux has elected Mr. J. E. C. Coventry, representing the Federation of Rhodesia and Nyasaland, as its chairman, in succession to Mr. W. F. C. Morton, who represented the Union of South Africa. Mr. A. L. Perera, representing Ceylon, has succeeded Mr. Coventry as vice-chairman.

DR. HELEN MARGUERITE MUIR-WOOD, principal scientific officer in the Department of Geology, British Museum (Natural History), has been appointed deputy keeper in that Department. Dr. Muir-Wood is a graduate of the University of London (Bedford College and University College) and went to the British Museum (Natural History) in 1922. She was given charge of the Brachiopoda, on which group she has published a number of monographs and papers.

DR. T. A. M. NASH, deputy director of the West African Institute for Trypanosomiasis Research, Kaduna, Northern Nigeria, has been appointed director of the Institute, the appointment dating from October 17, 1954, when Colonel H. W. Mulligan retired. Dr. Nash, who is well known for his work on the ecology and control of tsetse flies, has been connected with the Institute as chief entomologist and deputy director since its inception in 1948; he has been engaged in tsetse work since his first appointment to Tanganyika Territory in 1927.

IT has been decided to change the name of the Royal Sanitary Institute; it will be known in future as the Royal Society for the Promotion of Health.

THE Chemical Research Laboratory (Department of Scientific and Industrial Research), Teddington, Middlesex, is having open days during September 27–29. Applications for invitations should be sent to the Director not later than August 31; those already on the mailing list need not re-apply.

THE Institution of Chemical Engineers and the Society of Instrument Technology have arranged a joint conference on "Automatic Control in the Process Industries", to be held at the Caxton Hall, London, S.W.1, on October 4. Further particulars can be obtained from the General Secretary, Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1.

# PROBLEMS OF INTERNATIONAL CONCERN IN THE BIOLOGICAL SCIENCES

DURING the Twelfth General Assembly of the International Union of Biological Sciences, held in Rome in the rooms of the Consiglio Nazionale delle Ricerche during April 12–16, a symposium was held on "Problems of International Concern in the Biological Sciences" with the aim of discussing some possible lines for the future work of the Union. The symposium was centred around seven major topics, and the discussion of each was introduced by a panel of three. In each panel one of the three acted as the chairman of the discussion.

For the first topic, "Standards, Units, Symbols and Terms", A. Frey-Wyssling (Botanisches Institut, Zurich) was chairman, and J. H. Burn (Department of Pharmacology, Oxford) and E. Hadorn (Zoologisches Institut, Zurich) were the main speakers. It was recommended that the Union should urge the universal adoption of the decimal system for international scientific publications: editors of international periodicals should be requested to convert all units into the decimal system if the authors had not already done so. A more general resolution aiming at promoting the unification of standards, units, symbols and terms in the field of biology was adopted by the General Assembly. Dr. Burn discussed the successive steps in the co-ordination of international standards for substances demanding biological assay. The matter is now regulated by an organization established under the auspices of the United Nations World Health Organization, which is working well. Dr. Hadorn's speech was especially concerned with the work of the Committee on Genetical Nomenclature and Symbols. It is planned to have a conference on this topic immediately before the next International Congress of Genetics, which is to be held in Montreal during 1958.

The second topic dealt with the "Organization and Support of Research", with R. E. Cleland (Botanical Institute, Bloomington, Ind.) as chairman, and C. F. A. Pantin (Zoological Laboratory, Cambridge) and B. Rajewsky (Max-Planck-Institut, Frankfurt-am-Main) as main speakers. The matter was thoroughly discussed, and finally it was suggested that the International Union of Biological Sciences should attempt four things: to persuade countries to undertake co-operative solutions of problems which transcend national boundaries; to make pronouncements on matters of world-wide scientific concern where the welfare of science is threatened by considerations involving the interests of individual nations; to organize programmes of research which cannot be organized by individual nations; to devote some of its time to the consideration of future trends in biology, and of how certain major problems of biologists, such as publishing, can be solved in the future (to this end the Union might sponsor symposia from time to time on such topics, either at the time of the General Assembly, or independently).

The third topic, "Teaching and Training", was introduced by P. Weiss (Rockefeller Institute, New York). The invited speakers were Chr. P. Raven (Zoologisches Laboratorium, Utrecht) and W. Ankel (Zoologisches Institut, Giessen). The discussion centred around the dilemma, clearly pointed out by Weiss, that, on one hand, biology has developed from many independent branches which are gradually discovering their common principles, thus calling for a deliberate integration; and, on the other, that the increasing volume of biological research and the spectacular advances in certain lines are fostering a dispersive tendency toward further fragmentation. The rate of progress in the biological sciences will depend to a great extent on the rate at which biological teaching can be made to cope with these conflicting trends and adapt itself to the changing situation. Students should be prepared for the biology of the future rather than educated in that of the past.

The subject of the fourth topic was "Publications", and for this M. J. Sirks (Genetisch Instituut, Haren) was chairman, with B. Glass (Department of Biology, Baltimore, Md.) and P. Rosbaud (Pergamon Press, Ltd., London) as panel members. The international support of periodicals should go first to the abstracting and indexing periodicals; second, to review periodicals and book series; third, to handbooks of data, indexes, lists of materials and workers, dictionaries of symbols, etc.; and lastly, to monographs of a costly and truly international scope.

In view of the magnitude of the literature to be surveyed, the abstracting and indexing journals must begin to co-operate and co-ordinate their efforts. It was recommended that they apply for admission to the Abstracting Board of the International Council of Scientific Unions and that they work out a co-operative plan. Since both general and specialized abstracting periodicals are for the present necessary, the latter should provide the former with a selected coverage of special fields, and each of the former should undertake to cover completely a nucleus of journals not dealt with by the other general abstracting services. Review periodicals and book series should be subsidized so far as possible in order to reduce their present high cost to users throughout the world. Co-ordination should be developed to prevent simultaneous reviews of the same subject in different places.

The recommendations to the Executive Committee of the International Union of Biological Sciences with regard to the fifth topic of the symposium, "Supplies and Depositories" (Dr. L. Harrison Matthews (Zoological Society, London) chairman, with A. van Straelen (Museum of Natural History, Brussels) and J. Westerdijk (Centraalbureau voor Schimmelcultures, Baarn) as panel members), were threefold. *Living materials.* The appointment of a small international committee to study the problems of the supply of laboratory animals, the cataloguing of users and of sources of supplies, the definition of standards and related matters on an international scale; representatives of the Division of Botany and of the Sections of Microbiology and Genetics should be included in the committee to advise upon the matters relating to their subjects. *Museum collections.* While the documentation of botanical type specimens ppears to be satisfactorily in progress, the same annot be said for zoological type specimens. It ight be useful to ask a small panel of zoologists to raw up recommendations for the preservation, ollection and cataloguing of zoological type specimens, the distribution of co-types and para-types, nd the safeguarding of the type specimens in times f international emergency. *International expeditions.* Unesco should be advised when international expeditions are under consideration, both for the selection f personnel and for the distribution of specimens ollected.

The chairman for the sixth topic, "International Congresses and Conferences", was J. Runnström (Wenner Grens Institutet, Stockholm), and the invited speakers were Sir Gavin de Beer (British Museum (Natural History), London) and P. Chouard (Conservatoire National des Arts et Métiers, Paris). The main conclusions of the discussion of this very important topic were as follows. The large international congresses should not be suppressed; their need is still very great in the biological sciences to avoid the danger of over-specialization. Their rhythm should be one of four or five years. The congresses should include a number of symposia introduced by at least two invited speakers with divergent views or with a divergent approach to the subject. Discussion from the floor should be allowed after the introductory papers. Uninvited short papers should be submitted to previous scrutiny, as is customary for the acceptance of a paper in a scientific journal. It was also decided that specialized conferences (symposia) with no more than twenty to twenty-five participants should be held between the general congresses. The Executive Committee of the Union should study the question of publication of the proceedings of the symposia in order to reach a certain degree of uniformity.

The last topic of the symposium, which dealt with "International Co-operative Projects", should have been introduced by B. Rensch (Zoologisches Institut, Münster), but he was unfortunately not able to attend, and J. Runnström took the chair in his place; Dr. Rensch's paper was read by Dr. L. Harrison Matthews (London). R. Hiatt (Hawaii Marine Laboratory, Honolulu) and E. Aichinger (Landesinstitut für Pflanzensociologie, St. Georgen am Sandhof, Austria) were the two invited speakers; but the latter was absent. Rensch expressed the opinion that the barriers raised by differences in language are greater than they should be, and that more personal contact would help to remove these hindrances to the more complete utilization of scientific experience. In some fields of biological research, international co-operation is imperative: such are the biological problems presented, for example, by the oceans and the polar regions. International co-operation is also essential within certain borderline fields between biology and other sciences, as, for example, biometry, biophysics and biological philosophy. Hiatt's special concern was international co-operative projects in marine biology; this matter was more exhaustively discussed in a symposium on marine biological laboratories held under the auspices of the Union a week later (see *Nature*, June 18, p. 1062).

In conclusion, it may be said that many of the resolutions or suggestions which came out of the discussion at the symposium were adopted by the General Assembly of the International Union of Biological Sciences, or will guide the future policy of the Executive Committee of the Union.

# BREEDING LABORATORY ANIMALS

THE use of laboratory animals in nearly all branches of biological research has been steadily increasing for several decades and, as was to be expected, it has kept in step with the general increase in work of this kind. Moreover, the usefulness of animals, and in particular of the smaller mammals such as the common laboratory rodents, in investigating and assaying drugs and other therapeutic substances not susceptible to chemical standardization accounts to-day for a very large proportion of all laboratory animals used in Britain and in most other countries[1]. Concomitant with this increased use has developed the demand for quality, so that to-day laboratory animals tend to be regarded more or less as reagents. Among the essential qualities of any reagent are some indication of its purity, or at least its degree of contamination, and also the requirement that it should be perennially reproducible. This implies that attention must be given to the methods of producing these biological reagents[2].

In the past much reliance has been placed upon animals supplied by breeders or dealers whose main interest is to offer suitable animals for sale upon such terms as will afford them reasonable business profits. There is much to be said for this system in that it relieves laboratory workers of the burden of manufacturing their own reagents, and, provided the quality of the animals supplied in this way is of a high enough standard, there is every reason to suppose that the commercial breeder or supplier will remain in the field indefinitely.

This proviso, however, is an important one, because to-day the laboratory worker's demands for animals of a given specification are more exacting than ever before. For certain types of animal, commercial sources cannot hope to provide suitable material, and the laboratory worker is driven, often rather reluctantly, to breed his own animals. Such instances as inbred strains of mice for cancer research, and the production of litter-mate groups, may be cited. It has now become quite evident that, in order to obtain animals of the quality required, it is often necessary to breed them under laboratory conditions and in considerable numbers—numbers such as will satisfy the greater part of the demands of, say, all the laboratories of a single university.

It was therefore timely that a symposium on the breeding of laboratory animals should have been arranged by the Laboratory Animals Bureau, and was held at the Royal Society of Medicine on May 9, with Prof. E. C. Amoroso, of the Royal Veterinary College, London, in the chair. The papers read at the symposium will be published in the "Collected Papers", Vol. 3, of the Laboratory Animals Bureau (obtainable from the M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3).

Mr. A. L. Bacharach (Glaxo Laboratories, Ltd.) opened the symposium with a paper entitled "Some Aspects of Animal Production for Routine Biological Assay". He treated his subject mainly from the point of view of the user, and he drew largely from his experience of the colonies of rats and mice which have been maintained for many years by the Glaxo Laboratories at Greenford. These colonies were set up in order to fulfil the exacting demands of the bio-assayists, and Mr. Bacharach played a prominent part in their establishment. Experience at Greenford has shown that ample reward in the way of more uniform animals, and therefore better reagents, has been obtained, not only by closely regulating the environment in which the animals are bred but also by achieving further uniformity through inbreeding. The combination of genetic uniformity and an optimum uniform environment has added little to the cost of animal production.

Dr. H. Grüneberg (University College, London) spoke about "The Genetical Aspects of the Breeding of Laboratory Animals". In considering whether uniformity might be best achieved by the use of strictly inbred animals, by their first- or second-generation crosses, or by randomly mated members of a comparatively large population, he directed attention to the fallacy of *a priori* reasoning. In respect of some thirty-one morphological characteristics in mice, he showed that the variance in inbred strains and in their *F*1 and *F*2 crosses is quite unpredictable. The inbred strains may have a high or low variance for any particular characteristic; so also may crosses between strains, and it may be greater or less than that of either parent strain, so that in any single instance the degree of variance can only be discovered by investigation. What is true for morphological features is likely to be equally true for physiological responses. It follows that for every test where maximum uniformity is of value the merits of each case must be examined individually[3].

The third paper was given by Dr. D. Michie (Department of Zoology, University College, London) and was entitled "Towards Uniformity in Experimental Animals". Dr. Michie pointed out that, whereas inbred strains possess the maximum genetical uniformity, the phenomenon of inbreeding decline may render them particularly sensitive to small changes in the environment. In this way the phenotypic variance may be, and frequently is, greater than is to be expected on the assumption that variance from genetical and environmental causes is merely additive. If, however, two inbred but comparatively unrelated strains are crossed, the resulting progeny will possess a full measure of hybrid vigour because they will be to a large extent heterozygous; but, because their parents are homozygous, the genetical pattern of the first generation progeny will be as uniform as that of the parents. In such an instance, therefore, it is possible to obtain genetically uniform animals with all the vigour conferred by the heterozygous state and thus far less susceptible than their parents to small changes in the environment[4,5].

Dr. Anita M. Mandl (Department of Anatomy, University of Birmingham) spoke about "The Value of Litter-mate Controls in Endocrinological Research". For this type of work her own experience leaves no doubt that in problems involving a limited number of treatments the use of litter-mate controls gives far greater accuracy, or conversely requires far fewer animals, for a given degree of accuracy. This does not necessarily follow, she continued, in the field of bio-assay. Indeed, for much work of this kind it may be difficult to provide litter-mate controls.

The points arising from the morning session of the symposium emphasized once again the importance of choosing the right animal for the purpose. No rules, are generally applicable to every case, but time spent on making a proper choice will be more than counterbalanced by increased accuracy or by economy in the use of animals. As Dr. Mandl pointed out, the recording necessary to produce animals of known family history is a burden so small as to be almost negligible.

The afternoon session was opened by Prof. J. E. Nichols (Department of Animal Husbandry, University College of Wales, Aberystwyth), who discussed "The Principles of Animal Production". He referred to the production of farm animals for particular purposes, and it was implicit in his remarks that breeding, for example sheep, for special characteristics involved the same principles as breeding laboratory animals. There was much to be learnt about the breeding of laboratory animals from a study of modern farm-stock breeding practice.

Dr. J. S. Perry (formerly of the Agricultural Research Council Field Station, Compton, and now at the Agricultural Research Council Institute of Animal Physiology, Babraham) gave a paper on prenatal loss as a cause of reproductive wastage. By no means every ovum shed may be fertilized, and there is an inevitable and variable loss from among those fertilized which never survive to be born. Whether or not this almost universal prenatal wastage has a value under natural conditions, there can be no doubt that in the less rigorous environment of the laboratory it is worth attempting to reduce it so that the maximum reproductive potential may be more nearly approached.

Dr. I. W. Rowlands (Institute of Animal Physiology, Babraham) spoke on postnatal causes of reproductive wastage. There is little advantage, he said, in an embryo surviving the hazards of uterine life only to succumb to the further hazards of the period between birth and weaning. Some of these latter hazards are inherent in the dam or the offspring. Others, however, are largely influenced by the circumstances of the breeding colony. In either case losses should not be accepted with complacency.

The last paper was given by Dr. C. S. Grunsell (Royal (Dick) School of Veterinary Studies, Edinburgh); Dr. Grunsell is curator veterinarian of the small-animal breeding station at the University of Edinburgh, and he spoke from his own experience of the problems besetting anyone in such a position. One of these problems is the old one of fluctuating demand which too seldom keeps in phase with supply. A university breeding station serving a single university, he said, is probably the right sort of size to aim at and has the advantage of administrative convenience. It should be capable of supplying most of the requirements of different university departments for most species of laboratory animal. At least in its early stages it cannot be expected to produce animals down to an economic figure, and perhaps it may never compete successfully in terms of hard cash with the commercial market, although it is impossible to say that this must necessarily be so. It should, however, provide a much better service to university departments than they can generally obtain either from the commercial market or from setting up departmental, and usually thoroughly uneconomic, units of their own.

As Prof. Amoroso pointed out in his summary, we are not far removed from the beginning of our knowledge in this important field, and it would be premature at this stage to pay too much attention to the economic aspect. Indeed, comparatively little is known even about the actual cost of breeding laboratory animals. Those laboratories that do possess figures show as great variations in their costs of breeding as they do in their methods, and too many laboratories appear to have little or no idea of ust how much their animals are costing them. But he cost of breeding is only one item. The cost of asted time and frustrated research resulting from he use of unsuitable or inferior animals can never e properly calculated. One point, however, is clear eyond doubt: the breeding of laboratory animals no longer a matter for the amateur, if indeed it ver was. It has become a special subject in its own ght.

The general conclusion arising from points dis-ussed at this symposium is that there is an urgent eed for far more information about the characteris-cs and responses of different types and strains of boratory animals, and that this information should e handled much more than it is on an international asis. For example, it is not sufficient in referring o work in which animals are used to describe them s just 'mice', or even as 'CBA mice', for even a amed inbred strain may not be the same in two ifferent laboratories. Mouse geneticists and cancer orkers have shown what can be done with defining nbred strains of a single species[6], and the "Catalogue f Uniform Strains" of the Laboratory Animals ureau represents a step in a rather different and erhaps more widely applicable direction. More ecently, the "Handbook of Laboratory Animals" f the American Institute of Animal Resources[7] has ade a further contribution. But these lists are nly a beginning. They are in themselves incomplete nd only serve to emphasize the need for a world-ist of laboratory animals, fully annotated and eriodically kept up to date. The preparation of uch a list would be a considerable labour, but the eans of compiling it should not be difficult to find; here can be no doubt of its ultimate great value to ll who use laboratory animals.

W. Lane-Petter

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# FOURTH COMMONWEALTH HEALTH AND TUBERCULOSIS CONFERENCE

THE fourth Commonwealth Health and Tuberculosis Conference, organized by the National ssociation for the Prevention of Tuberculosis, was eld in the Royal Festival Hall, London, during une 21–24 and was attended by more than thirteen undred delegates from the United Kingdom and the ominions and Colonies, from the United States, and rom various parts of Europe, Asia and Africa. ifty-eight different countries were represented. The cientific programme had been skilfully planned to ppeal to the wide variety of interests represented y chest physicians, radiologists, medical and lay dministrators, industrial medical officers, matrons, urses, social workers and physiotherapists, and con-isted of discussions on the following topics: pre-entive outlook; child hygiene and infection; choice f drugs in medical and surgical treatment of tuber-ulosis; death-rates; X-ray and tuberculin surveys; uberculosis as a problem of different races; psychology of the patient and relatives as a factor in successful treatment; tuberculosis in industry; tuberculosis and leprosy; and rehabilitation.

In the session on the preventive outlook to-day, Dr. P. V. Benjamin, technical adviser in tuberculosis to the Government of India and the first recipient of the Sir Robert Philip Medal of the National Association for the Prevention of Tuberculosis for his outstanding contribution to the control of tuberculosis in India, stressed the many difficulties besetting the introduction of preventive measures on an extensive scale in his country. There are few doctors with a real aptitude for this type of work, and the majority of those specially trained are more interested in the clinical aspects. One of the steps under consideration by the Government of India is a re-orientation of medical education to lay increasing emphasis on prevention and social medicine. A BCG vaccination campaign was launched in 1948, and it is intended that all the susceptible population, numbering nearly 170 million, should be tuberculin-tested and BCG-vaccinated by 1960. So far, more than 57 million people have been tuberculin-tested, and 18 million vaccinated, with an average monthly turnover of 2½–3 million.

In the discussion on the choice of drugs in the treatment of tuberculosis, Dr. Walsh McDermott, editor of the *American Review of Tuberculosis*, described isoniazid as a revolutionary drug which has made possible the domiciliary treatment of the disease in outlying places. There is also a strong possibility that it may be used for prevention. In his experience, isoniazid given alone has proved as effective as, and even better than, combined therapy with streptomycin and *p*-aminosalicylic acid, for example. Dr. O. F. Thomas, of Aintree Hospital, Liverpool, emphasized that, in the absence of reliable laboratory methods for establishing drug sensitivity of the tubercle bacillus, it is all the more important to be familiar with the previous history of drug treatment in any given case. Dr. Brendan O'Brien, of Dublin, presented a preliminary report on the clinical use of a new molecular combination of isoniazid, thiosemicarbazone and starch ('Hinconstarch') in nine patients with varying degrees of tuberculosis, seven of whom became sputum-negative. The drug was well tolerated, and there were no toxic effects on any system. Dr. Frank Retief, chief medical officer to the Witwatersrand Native Labour Association, Johannesburg, communicated an interesting paper on the results of isoniazid therapy in African miners with open pulmonary tuberculosis. The most striking effects were euphoria and increase in appetite. Of the forty-five patients treated, 68 per cent gave a sputum reversal to negative after three months, and 80–90 per cent showed improvement radiologically, particularly during the first four to six weeks after beginning treatment.

In the session on tuberculosis as a problem of different races, Dr. T. F. Anderson, director of medical services, Kenya, stated that, in the absence of specific treatment, pulmonary tuberculosis in the African patient runs a rapidly fatal course; but that the response to modern chemotherapy is extremely good, even in cases showing widespread disease. According to Dr. Riaz Ali Shah, associate professor of tuberculosis at King Edward Medical College, Lahore, many complex and variable factors are concerned in influencing the speed of decline of morbidity and mortality from tuberculosis in various ethnic groups, such as economic factors, genetic elimination of susceptible persons and educational campaigns, so that tuberculosis is inherently not a racial problem.

In the discussion on tuberculosis and leprosy, the late Dr. John Lowe, in a paper read for him by Dr. E. Muir, honorary medical adviser, British Empire Leprosy Relief Association, suggested that the varying susceptibility of different persons to leprosy might be related to the presence or absence of acquired immunity to tuberculosis. Compulsory isolation in his opinion is unscientific, impracticable, ineffective and inhuman. He concluded by saying that leprosy is not a disease apart, but that it is a general public health problem; that public health, and not public fears and prejudices, should determine the policy of leprosy control.

An attractive and informative exhibition, spaciously housed, was organized in conjunction with the conference and included a mass-radiography unit at work; technical apparatus; drugs; books and periodicals; occupational and art therapy; scientific exhibits from various hospitals; examples of work done by administrators, doctors and patients in the British Colonies; and an exhibit of the Ministry of Agriculture, Fisheries and Food illustrating the rapid progress made since the end of the Second World War in the eradication of bovine tuberculosis in cattle. Some very interesting short films were shown, and the conference ended with a number of visits to hospitals, sanitoria and other institutes specially connected with problems of tuberculosis.

W. R. BETT

# MUSEUMS ASSOCIATION

## CONFERENCE IN BIRMINGHAM

FOR its sixty-first annual conference, held during July 4–9, the Museums Association returned to Birmingham, which was last visited in 1932. The 1955 Birmingham conference was, however, about twice as large as its predecessor, being attended by about three hundred and fifty delegates, including fourteen from overseas. The Barber Institute of Fine Arts in the University of Birmingham provided ideal headquarters, with lecture theatres. In the absence through illness of the president of the Association, Sir Leigh Ashton, the chair was taken by the vice-president, Dr. F. J. North. In a presidential message, Sir Leigh paid a sincere tribute to those in industry who are aware of the value of the vital part played by design in the manufacture of consumer goods; he recalled that in the Victoria and Albert Museum, London, are many objects from Birmingham, especially those illustrating the craft of the silversmith. Dr. North then gave a much-appreciated survey of the main activities of the Association during the past year, specially stressing the important acquisition of new headquarters, the increasing value of the diploma, and the initiation of the technical certificate.

Mr. John Summerson (Sir John Soane's Museum, London) gave the first paper, which was on museum buildings as architecture, and said that Smirke's design for the British Museum was in essence the English collegiate conception. In the Oxford University Museum of 1855 progressive ideas came forward, and it may be considered as a conscious attempt to go one better than the great new railway stations of the period. During the afternoon of July the archæological section of the conference had thr papers. Mr. R. L. S. Bruce-Mitford (British Museur discussed the functions of national and local museum as regards the acquisition of material, and he state that the British Museum can now carry out excav tions of its own, and one is now in progress Hodhill in Dorset. Prof. C. F. C. Hawkes (Oxfor outlined the great advantages of "Inventar Archæologica", a handy compendium of selecte material, printed not in volumes but on uniform ar inexpensive cards. These are planned to cover th widest possible range of types, periods and culture and about two hundred British cards should b ready by 1960. Dr. D. B. Harden (Ashmolea Museum, Oxford) concluded the afternoon sessior he maintained that the primary object of the publ in visiting museums is recreational.

On July 6, Mrs. Lydia Bond-Powel described th American Wing of the Metropolitan Museum of Ar New York; this is devoted to the chronologic development of the interior architecture and deco ative arts in the American Colonies and the earl Federal period of the United States. Mr. Io Williams strongly advocated the formation of museum of oil paintings. He stated that there is n museum which collects paintings not primarily a works of art but as paintings. This constitutes serious deficiency in the study of painting, and should be possible for museums to rectify the positio by the formation of reference collections for the a historian. Prof. Ellis K. Waterhouse (Barbe Institute) pleaded for a closer co-operation betwee art teachers and museum officials and the widenin of the fellowship of the Association to include thos who are chiefly concerned with the teaching of ar history. Prof. W. G. Constable (Boston Museum c Fine Arts, Mass.) made a number of suggestion regarding the place of museums in this changin world, some of which were of a rather revolutionar character. Mr. Norman Bertenshaw, describing th organization of the new Museum of Science an Industry in Birmingham and the way in which th Elkington electro-plate factory has been adapted fo the purpose, stated that the policy of the Museum i to stimulate the interest of the visitor rather tha attempt the portrayal of a complete developmenta sequence, since it is felt that the latter is mor properly the function of the national museums. Dr F. Sherwood Taylor (Science Museum, London) abl outlined the functions of museums in relation t children and science, and maintained that it i essential for instruction to be provided throug pleasure; it is desirable that the exhibits should tel their own story and not rely upon written labels Finally, Prof. H. Graham Cannon (University o Manchester) gave an instructive and practical pape on aquaria in museums.

A session, open to the public, was held on July 9 when Sir Mortimer Wheeler gave an admirabl summary of past negotiations regarding State ai to museums in Great Britain and advocated th formation of a museum grants committee comparabl to the University Grants Committee. Sir Georg Dyson, chairman of the Carnegie Trust, felt that th position of museums is illogical in that the Government has accepted responsibility for the nationa museums but defines national as London. Th provinces pay taxes for the national museum grant and are also expected to support their ow museum.

During the week, tours were arranged to the museums of Birmingham and Warwick, an archæoogical site at Weoley Castle, Althorp, the seat of Earl Spencer, and a tour of the canals to Wolverhampton. At the meeting, Dr. F. S. Wallis (Bristol) was elected president for 1955–56, and it was decided o hold the next conference in Amsterdam, probably at the end of June 1956.

# THE NATIONAL OCEANOGRAPHIC COUNCIL

## ANNUAL REPORT FOR 1953–54

THE National Institute of Oceanography is now firmly established at its new premises at Wormey, near Godalming, Surrey, and the Discovery Committee collections and staff are comfortably housed there, apart from a small group still accommodated at the British Museum (Natural History).

In the Institute's report on research during the year April 1, 1953–March 31, 1954*, two topics of particular interest on the physical side are the relationship between waves, wind and swell, and the transfer of nergy between air and sea; these studies have nvolved not only the co-operation of the Liverpool Tidal Institute but also that of the Department of Meteorology of the Imperial College of Science and Technology, London. An expedition, made possible by a grant from the Royal Society, was run jointly with the latter to investigate energy exchange between air and sea at the flat Island of Anegada in the West Indies. Much important data were gathered and will be reported in detail by Prof. P. A. Sheppard, Mr. H. Charnock and others. Several pieces of new apparatus have been developed or improved. These nclude improvements to the electro-mechanical filter of the wave analyser, further developments to the electromagnetic flowmeter and a new type of recording camera which takes 175 ft. of photographic paper. In collaboration with Kelvin Hughes, Ltd., Dr. J. N. Carruthers has developed a 'streamed cone' current meter allowing for instantaneous measurements of current speed and direction.

On the biological side, advances have been made n the study of krill (*Euphausia superba*), which is the main food of the larger animals in the Antarctic. Mr. J. W. S. Marr has been able to establish that this organism is confined to Antarctic waters and lies mainly in the drift from the Weddell Sea and in the East Wind Drift close to the continent. A comparable study of the chætognath, *Sagitta gazellae*, has nearly been completed by Mr. P. M. David. Mr. A. de C. Baker has shown that common species of phyto- and zoo-plankton have a circumpolar range and leaves little doubt that populations are continuous around the antarctic circle. Further work is being carried out on the material brought back from the expedition on the Royal Research Ship *William Scoresby* to investigate the Benguela Current.

There is still much study to be done on the large collections built up under the Discovery Committee, and a number of specialists are engaged on this. The most recent work to be published on these collections was Captain A. C. Totton's monograph on the Siphonophora of the Indian Ocean. Considerable work has been carried out through international collaboration on whale-marking, thanks largely to a number of whaling companies for lending a modern diesel-driven whale-catcher, the *Enern*. In addition, a number of papers by members of the staff have been published which are important to the study of the life-history and migration of whales.

The Royal Research Ship *Discovery II* has been refitted with a number of new items, including an up-to-date radar set and position-finding equipment. The 1954–55 programme includes a study of deep-water movements in respect of density distribution and other factors. The biological work includes new methods of sampling and observing deep-sea organisms. Investigations will also be carried out using the carbon-isotope method for studying photosynthetic activity. In addition, the ship will also provide facilities for the Admiralty, Sir Edward Bullard and the University of the West Indies for various research purposes. After twenty-eight years of service, the *William Scoresby* has sadly been put in the hands of the shipbreakers. She operated largely as a whale-marker, but during the Second World War served as a minesweeper and patrol vessel in the Falkland Islands area; in 1949 she returned to her work of whale-marking, but only managed one cruise in this capacity under the National Oceanographic Council.

This account of the work of the Council is only a brief summary, and of necessity much of interest has had to be omitted; but much credit is due to the Council and to the energies of Dr. G. E. R. Deacon, director of the National Institute of Oceanography, and his staff for the rapid development of research after the major upheaval of changing premises and equipping new laboratories. C. D. OVEY

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* Annual Report of the National Oceanographic Council, 1 April 953–31 March 1954. Pp. v+28. (Cambridge: At the University Press, 1955.) 5s. net.

# THE GOLDEN EAGLE IN AMERICA

THE golden eagle (*Aquila chrysaetos canadensis*) is widely distributed in mountains and adjacent plains throughout much of the northern hemisphere. Its principal breeding-range in North America extends from the Arctic Ocean south into Mexico, westward from the 99th meridian. As it nests from near sea-level to the timber-line, it may be found in a wide variety of habitats and in winter it occurs practically throughout this country. Its food habits are as varied as the diversified habitats in which it lives. These, and the economic status of the eagle, have been described by Lee W. Arnold in a publication of the Fish and Wildlife Service of the United States Department of the Interior (Circular 27).

The golden eagle has been known to kill and eat more than sixty different kinds of animals, ranging from full-grown deer and antelope to mice, birds, frogs and insects. Both living creatures and dead are included in its diet, and at times it accepts carrion even though living prey is available.

Rabbits and rodents form the staple diet of the golden eagle, the proportion taken varying with local conditions. During the nesting season on a Colorado antelope range, rabbits supplied most of the golden eagle's food; under winter conditions on a North Dakota pheasant refuge, they comprised approximately 19 per cent.

On occasion, the bird will kill adult and young antelope, although in northern Colorado, where four pairs of eagles nested in close proximity to antelope at fawning time, such predation was negligible.

Although the golden eagle will kill either the adult or the young of deer, no evidence was found to indicate that the bird is more than a minor influence when compared to other factors controlling deer populations.

Depending on local conditions, the golden eagle exerts a varying pressure on upland game birds, and at times this pressure may be sufficient to warrant eagle control. The harassing of upland game, thus keeping them from feeding properly in severe weather, may be more serious than the actual killing activities of the eagle. When nesting in the vicinity of waterfowl areas, the golden eagle may feed its young largely on these birds.

Golden eagles at times kill domestic lambs. The extent of this damage varies with local conditions. On occasion, they kill calves or may even contribute to the death of full-grown cattle. All evidence indicates that this is an exceptional activity.

Golden eagles occur in varying numbers on more than sixty-five Federal wild-life refuges where, in general, they serve a beneficial purpose in consuming wounded, sick or dead ducks and forage-consuming jack-rabbits and rodents.

## RESEARCH ON FOREST PRODUCTS

THE strength properties of plywood have already been considered in Bulletin No. 29 of the Forest Products Research Laboratory, Princes Risborough, entitled "Comparison of 3-Plywoods of a Standard Thickness, Part 1" (see *Nature*, **174**, 383; 1954). In Bulletin No. 33 on "The Strength Properties of Plywood, Part 2: Effect of the Geometry of Construction"*, the author states that an increasing demand for data on the mechanical properties of plywoods exists; but owing to the wide variety of constructions and thicknesses now available, it is not possible to obtain these data by testing procedures alone. To cover the whole field, some simple methods for estimating strength from limited basic data are required, and this the author sets out to do. This investigation has become necessary because plywoods have become a structural material and can now be produced in forms practically indestructible by delamination. It is stated that increasing quantities are being used, for box and web types of girder, panel floors and walls, ship's planking and concrete shuttering. The trouble is the large variety of thicknesses and different forms of construction, all of which cannot be tested. The coming of plywood in this extensive form of utilization will be very beneficial to the tropical and subtropical forester in charge of forests containing large mixtures of species of trees of which until comparatively recently only a few luxury timbers were marketable. A number of others are now being used, and sylviculturally the management of the forests should become more intensive with the improvement of working plans.

The Bulletin contains the results of an investigation to provide suitable equations for calculating the bending, tension, compression and shear strengths of any plywood construction. All the tests are carried out on African gaboon. From the results, equations
have been formulated which can be used in practi
for calculations or constructions of any other speci
of wood. An appendix to the Bulletin shows ho
they can be applied.

Bulletin No. 32 of the Forest Products Laborato
entitled "Field Tests on Wood Preservatives used f
Pressure Treatment"* describes experimental wo
carried out during 1929–53. The lengthening of t
life of wood for the various purposes for which it h
for so long been used by man has always been a fact
for some consideration, especially in tropical cou
tries where perhaps the matter has been more
the forefront of both forester and wood user.
long ago as the 1860's, when railway construction w
being carried out on an intensive scale in northe
India, the supplies of the valuable Himalayan deod
threatened to give out, and sleepers were cut fro
the *Pinus longifolia* which was abundant in t
lower hills. Creosote was brought out from Brita
and applied cold without any protective effect.
was more than half a century before the ra
way authorities tried this timber again for t
purpose.

In temperate climates, in Europe at least, so
form of preservative for wood structures has f
long been under experiment. So far the hig
temperature creosotes have proved to be the mo
effective preservative under test. The metho
employed is to set out a small 'graveyard' of sm
blocks of a perishable wood (the agar wood is chief
used) and these are treated with graded concentr
tions of the preservative under test, untreated wo
blocks being side by side with the treated ones. Th
treated blocks are kept for a few months with
specific fungus growing on a nutrient agar medium
Periodical examination of the blocks is undertake
one of the tests being done at Princes Risborough,
second at Thetford and the third at Dolgelly. No
is as yet complete.

The results already obtained, however, do give so
indication of how effective most of the treatments a
likely to be. So far, the high-temperature creosot
have proved to be the best preservative under test
all are highly effective, and after twenty years the
is no sign of any difference between them. The lo
temperature creosotes, however, do not appear to
quite so effective. At present there is not much
choose between the various modern water-solub
preservatives under test, although 'Ascu' appears
be the most promising.

E. P. STEBBING

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* Forest Products Research. Bulletin No. 33: The Strength Properties of Plywood. Part 2: Effect of the Geometry of Construction. Pp. iv+28+4 plates. By W. T. Curry. (London: H.M.S.O., 1954.) 2s. net.

* Forest Products Research. Bulletin No. 32: Field Tests
Wood Preservatives used for Pressure Treatment. By D. N. Smit
Pp. iv+52+1 plate. (London: H.M.S.O., 1954.) 2s. 6d. net.

## SPITSBERGEN TERTIARY COAL FOSSILS

SVEIN MANUM has reported on the pollen-grai
and spores to be observed in coal deposits
Tertiary age in west Spitsbergen (Norsk Polarinstitut
Med. 79, pp. 1–9; 1954; English summary).

The Tertiary formation, of Palaeocene–Eocene ag
comprises several coal seams of which a preliminar
analysis of the contents of pollen and spores h
now been made. The numbers of microfossils,
well as their state of preservation, are highly variabl
All grains and spores are completely flattened in t
coal and do not regain their round shape after macer
tion. The pollen and spores thus far observed hav

n referred to fifty-two sporomorphs, most of them mbling species already described, in particular n the German lignites. Some twenty sporo- rphs, however, are considered to be new. De- ptions and names have not been attempted in the sent paper; but some of the most characteristic romorphs have been illustrated, and indications their affinities given. A comparison has also n made with the genera that are known as crofossils.

Nathorst mentions six such species of pterido- ytes, while twelve sporomorphs indicate that this up was represented by a considerably larger nber of species. Most of the spores are referable the Polypodiaceae and Osmundaceae. The copodiaceae are not known as macrofossils; but of the spore types seems to belong there.

The gymnosperms are abundantly represented as crofossils (twenty-seven species, among them enty-four conifers) as well as pollen. Among the nged pollen grains some have a strong resemblance *Abies*—a genus not so far found as a macrofossil. nong gymnosperm pollen grains without wings ere are two which somewhat resemble *Sciadopitys* another genus not observed as a macrofossil.

The Betulaceae, Fagaceae and Salicaceae are resented by more than twenty species of macro- sils, and correspondingly a large number of pollen ins belong to this group. Some grains also recall Myricaceae, which, however, are not among the crofossils. Another type resembles the pollen of *er*, of which three macrofossil species have been orded; and so on, materials indicative of affinities th *Alisma, Nymphaea, Potamogeton* and Ericaceae ing recorded. Lastly, some pollen grains have aracters recalling those of certain palms (*Sabal*), ich are known from the Tertiary of Central Europe, t of which no macrofossils have been found in itsbergen.

## GROWTH-SUBSTANCES SEPARATED BY CHROMATOGRAPHY

METHODS for the chromatographic separation on paper of indole compounds, and for the rect biological assay of the chromatograms using e *Avena* coleoptile straight-growth method, have en described by N. P. Kefford (*J. Exp. Bot.*, 6, 16, 9; 1955). Reagents for the detection of the dole-3-carboxylic acids, indole-3-acetonitrile, and amine as coloured spots on chromatograms are mpared, and the areas of such spots are shown to proportional to the logarithms of the quantities substance present.

The procedure of chromatography described is own not to involve a loss of indole-3-acetic acid tivity if chromatography is done in darkness and romatograms are not stored in light and air.

Methods are described for the extraction of growth- bstances from plant materials, the purification and romatography, on paper, of the extracts and the oassay of the chromatograms using *Avena* coleoptile ctions. The ether extracts, containing acidic bstances, of etiolated broad bean and pea shoots d roots, etiolated sunflower shoots, maize roots, d potato etiolated shoots and tuber have been romatographed and the chromatograms bio- sayed.

On all chromatograms three areas active in *Avena* coleoptile section growth are found. One area of growth promotion is shown to be due to indole-3-acetic acid. Another area of growth-promotion and one of growth-inhibition are due to unknown substances, which are named accelerator α (α) and inhibitor β (β) respectively. On chromatograms of potato tuber a fourth growth-promoting area, in addition to those described above, is detected and is shown to be probably due to indole-3-acetonitrile. This or indole-3-pyruvic acid may occur together with indole-3-acetic acid on chromatograms of extracts of immature maize kernels and cauliflower head respectively. On cabbage extract chromatograms the growth-promoting activity corresponding in position with indole-3-acetic acid is shown to be due to this acid alone.

## CONTROL OF FERTILITY BY ANTIMITOTIC AGENTS

By Dr. B. P. WIESNER and Prof. JOHN YUDKIN

Department of Nutrition, Queen Elizabeth College, University of London

WHILE continuing our studies on naturally occurring substances which might be used in the control of human fertility[1], we have also adopted a new line of investigation into this problem. This has been a study of some of the numerous substances which are alleged to have antimitotic activity, in the hope that one or more might prove effective in controlling fertility. These are the reasons which led us to this approach.

First, some types of human infertility, such as disturbances of spermatogenesis and very early miscarriage, are often associated with disturbances of mitosis and cytokinesis. These effects may be limited to the seminiferous epithelium or to the ovum, and the sterility which they produce is usually not accompanied by detectable signs of ill-health in the man or woman. Secondly, mitotic poisons frequently prevent the development of the fertilized ovum of various aquatic animals. In fact, many such poisons have been discovered by exposing echinoderm eggs to them. Again, it has been found that concentrations of a mitotic poison which readily suppress cleavage of the fertilized ovum need not affect the adult organism.

We have therefore studied the effect on pregnancy in female inbred Swiss mice of a number of antimitotic substances, administered in solution or suspension by stomach tube or subcutaneous injection. In all experiments, control animals receiving the dispersing medium in similar manner remained unaffected. Two examples of active substances so far discovered are given here.

*Example* 1. *D-usnic acid*. The antimitotic effect of this compound was described by Marshak and Harting[2]. We administered it daily by stomach tube in the form of freshly made solutions in $N/100$ sodium hydroxide at a dosage-level of 1·5 mgm. Administration begun before pairing had no effect on mating, as shown by the occurrence of a vaginal plug. Administration either before pairing or immediately after copulation was usually not followed by pregnancy but by a recurrence of oestrus and of mating. However, notwithstanding continued administration of usnic acid, there eventually resulted a state of resistance in which copulation was followed by pregnancy. These pregnancies went to term, though the litter-size and growth-rate of the pups suggested somewhat lowered fertility. Some litters were retained and a second generation reared with the view of detecting possible effects upon the progeny; no such effects were observed.

*Example 2. Podophyllotoxin.* The antimitotic effect of this substance was demonstrated by Cornman[3]. We administered podophyllotoxin by subcutaneous injection, either as a solution in aqueous alcohol or as a suspension of microcrystals in water. A single dose of 0·25 mgm. was given to each animal either immediately after detection of vaginal plug or 3, 6, 12 or 14 days thereafter. Pregnancy did not continue in animals treated three days or more after copulation. Administered within twenty-four hours after copulation, podophyllotoxin was only occasionally effective. After interruption of pregnancy, mating again occurred. Podophyllotoxin was again administered, and pregnancy again did not continue. This has been repeated for three successive pregnancies; thus, unlike usnic acid, there is no evidence of a rapidly acquired resistance.

The subsequent fourth pregnancies were not treated and they proceeded to term quite normally. No side effects such as excessive defæcation or vaginal hæmorrhage were detected even in animals allowed to go to the fourteenth day of pregnancy before podophyllotoxin was administered. In each pregnancy, the increase of maternal body-weight corresponded to that of normal gestation. The only systemic effect noted after administration was the rapid loss of gestational gain of weight.

It is possible that the suppression of fertility accidentally observed by Jackson and Bock[4] after the administration of triethylene melamine may not be related to the carcinostatic activity of this substance as such but rather to its more general antimitotic action. As regards podophyllotoxin, Didcock, Picard and Robson[5] have also shown that it interrupts pregnancy at an advanced stage, although their reason for undertaking the experiment was the hypothetical resemblance of tumours to pregnancy. It has been supposed that podophyllotoxin acts by interfering with the blood supply[6]. Since, however, we have found that it prevents the continuation of gestation even before the implantation of the ovum, its activity is more likely to relate to direct action upon the ovum.

Our results encourage us to continue the search for antimitotic substances the ovicidal activity of which may be employed for the screening of agents of possible use in the control of human fertility.

We acknowledge with thanks the gift of D-usnic acid from Mr. H. A. Berens of Messrs. Biddle, Sawyer and Co., of podophyllotoxin from Dr. W. Mitchell of Messrs. Stafford Allen and Co., and of various other compounds from Mr. S. G. Long of Messrs. R. F. Reed, Ltd. We are also indebted to Messrs. Kylon, Ltd., and Messrs. Stafford Allen for financial assistance, and to Mrs. E. M. Blacker and Miss Margaret Rule for technical assistance.

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# A METHOD FOR THE LOCALIZATION OF SITES FOR OXIDATIVE PHOSPHORYLATION

By Dr. BRITTON CHANCE and Dr. G. R. WILLIAMS

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ISOLATION of portions of the respiratory cha involved in oxidative phosphorylation either b inhibitors that block a portion of the chain or b specific substrates that activate only a portion of th chain show that phosphorylation occurs betwe reduced diphosphopyridine nucleotide and oxygen and cytochrome *c* and oxygen[1,2]. A more exa localization of sites is limited by the availability specific substrates and inhibitors for all parts of th respiratory chain. Our approach is based upon dire spectroscopic observations of the effect of th initiation of oxidative phosphorylation upon th steady state of the components of the respirator chain of intact mitochondria[4]. When respiratio abruptly increases upon addition of adenosi diphosphate to mitochondria supplied with substra and phosphate, we observe a consistent gradation the changes in the steady state along the respirator chain from an oxidation at the dehydrogena portion to a reduction of the oxidase portion[5]. C the basis of these observations, we can identify sit for oxidative phosphorylation in the intact mit chondrial system.

The mitochondria were prepared according to th method of Schneider[6] as modified by Lardy an Wellman[7]. The reactions were studied in the usu 'isotonic' medium. The preparations had values phosphorus/oxygen of about 3 with β-hydrox butyrate as a substrate[8].

For recording the kinetics of spectroscopic chang we use a double-beam differential spectrophotomet with the two monochromators set at wave-lengt differing by the half-width of the absorption band t be measured. Since only the difference of absorptio is measured, the recording is relatively insensitive non-specific changes of light transmission that occ in the mitochondria[9]. The phosphorylative activi and the respiration are monitored simultaneously b a technique based upon the vibrating platinu microelectrode[4,9]. The pairs of wave-lengths th were used in the recording of the components of th

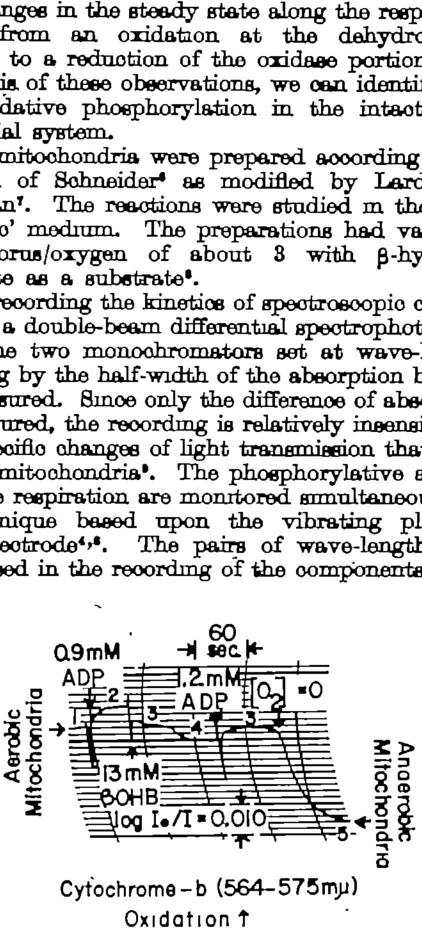
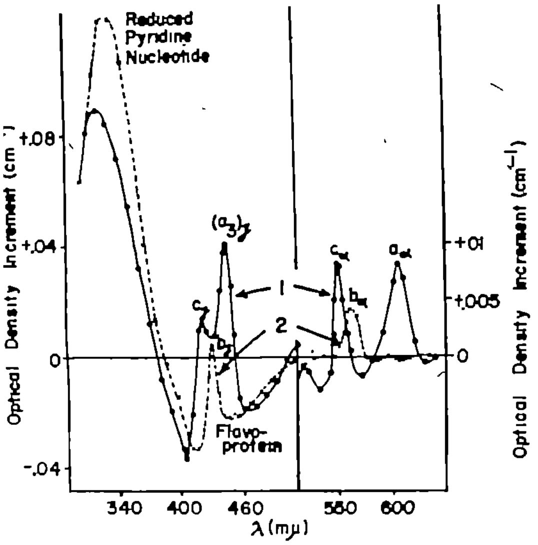


Fig. 1. The various steady states of intramitochondrial cytochrome *b*. Rat liver preparation diluted in complete reaction medium except for substrate and phosphate acceptor. Spectroscopic changes recorded at the wave-lengths indicated with a double-beam spectrophotometer. An upward deflexion indicates a decrease of optical density at 564 mμ (Exp. 348 *b*, *c*)



ig. 2. Difference spectra representing the transitions from erobic mitochondria (state 1) to anaerobic mitochondria (state 5) nd from the fully oxidized state 2 to the antimycin-A inhibited tate. The peaks of the various cytochrome bands are identified n the figure. Rat liver mitochondria, β-hydroxybutyrate as substrate (Exp. 432 d)

spiratory chain are given in Table 1. The observaons reported in this paper are limited to the six mponents that can be separately recorded at these ave-lengths. Other components, not resolved ectroscopically, are omitted from the present distssion because their function in the phosphorylating spiratory chain cannot be incisively evaluated. xamples of such omissions are Slater's factor[10], tochrome $e$[11], mitochrome[12] and vitamin K [13].

*States of the mitochondrial respiratory chain.* The spiratory enzymes exist in a wide variety of states reduction, as illustrated by Fig. 1 for intramitoondrial cytochrome $b$. The mitochondria as diluted the isotonic reaction medium (containing phoshate, but no substrate) are in state 1. Addition of lenosine diphosphate causes a rapid initiation of spiration (see ref. 8, Figs. 1 and 2) and oxidative hosphorylation. Spectroscopically, the double-beam strument records a decrease of optical density at 34 mμ with respect to 575 mμ (note upward deflexion the trace after addition of adenosine diphosphate). his change corresponds to an oxidation of cytorome $b$ (see Table 1). Since only endogenous subrate is present (usually equivalent to 30 μ$M$ oxygen) and excess adenosine diphosphate (900 μ$M$) was added, state 2 is soon reached in which excess adenosine diphosphate is present and negligible respiration occurs (see Table 2). Independent controls show that all the components of the chain are completely oxidized in state 2. Now addition of substrate rapidly reduces cytochrome $b$ (and all the other components to varying degrees) and initiates rapid respiration and phosphorylation (ref. 8, Fig. 1). This is state 3, characterized by high activity. It is terminated when the added adenosine diphosphate is used up and the respiration abruptly decelerates (ref. 8, Fig. 1). Then state 4 is reached, a quiescent condition. A second addition of adenosine diphosphate causes a transition back to state 3. This time state 3 is terminated by exhaustion of the oxygen dissolved in the medium and the anaerobic state (state 5) is soon obtained.

*Difference spectra.* The difference spectrum representing the transition from state 1 to the anaerobic state 5 is given in Fig. 2 (trace 1) and shows absorption bands of cytochromes $a_3$, $a$, $c$ and $b$ as well as flavoprotein and reduced diphosphopyridine nucleotide. Cytochrome $b$, flavoprotein and reduced diphosphopyridine nucleotide absorption bands are more clearly shown when a transition from the fully oxidized state 1 to reduction of these components is obtained by addition of excess antimycin A (Fig. 2, trace 2). By applying to these optical density changes their actual or assumed molecular extinction coefficients (compare ref. 14), we can calculate the concentration of the members of the respiratory chain relative to cytochrome $a$ (Table 3). Observations are included for two types of phosphorylating systems from liver and flight muscle, and for two types of non-phosphorylating systems from liver and heart muscle. The liver mitochondria are distinguished by their large content of diphosphopyridine nucleotide (up to forty times that of cytochrome $a$), which is negligible in the flight muscle sarcosomes and in the non-phosphorylating systems obtained by disruption of mitochondria. The latter systems are relatively deficient in cytochrome $c$, and, in the case of the heart muscle preparation, flavoprotein as well.

The turn-over number of cytochrome $a$ is also computed and ascites tumour cells have the lowest value.

*Positions of cytochromes b and flavoprotein in the respiratory chain.* The function and location of cytochrome $b$ in the mitochondrial respiratory chain

Table 1. PAIRS OF WAVE-LENGTHS USED IN DOUBLE-BEAM RECORDINGS

| | $O_2$ ←—— | $a_3'$ ←—— | $a'$ ←—— | $c'$ ←—— | $b''$ ←—— | reduced flavoprotein ←—— | DPNH ←—— | β-Hydroxybutyrate |
|---|---|---|---|---|---|---|---|---|
| ave-lengths used (mμ) | | 445<br>455 | 605<br>630 (590) | 550<br>540 | 564<br>575 | 465<br>510 | 340<br>374 | |

Table 2. DEFINITIONS AND VALUES OF STEADY STATES IN RAT LIVER MITOCHONDRIA
SUBSTRATE: β-HYDROXYBUTYRATE; PHOSPHATE ACCEPTOR: ADENOSINE DIPHOSPHATE 25°

| Characteristics | | | | | | Steady state percentage reduction Components | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| State | $[O_2]$ | ADP level | Substrate level | Respiration-rate | Rate-limiting substance | $a$ | $c$ | $b$ | Flavo-protein* | DPNH |
| 1 | > 0 | low | low | slow | ADP | 0 | 7 | 17 | 21 | ~90 |
| 2 | > 0 | high | ~ 0 | slow | substrate | 0 | 0 | 0 | 0 | 0 |
| 3 | > 0 | high | high | fast | respiratory chain | < 4 | 6 | 16 | 20 | 53 |
| 4 | > 0 | low | high | slow | ADP | 0 | 14 | 35 | 40 | > 99 |
| 5 | 0 | high | high | 0 | oxygen | 100 | 100 | 100 | 150 | 100 |

* These values are based upon the amount of flavoprotein that is reduced upon addition of antimycin-A to the mitochondria in state 2 hich is ⅔ the state-5 value.

Table 3. Relative Contents and Turn-over Numbers of the Components of the Respiratory Chain of Intact Cells, Phosphorylat Mitochondrial Systems and Non-phosphorylating Succinic or Reduced Diphosphopyridine Nucleotide Oxidase Systems

| Material | Source | Experiment | Substrate | Turn-over number of *a* (sec.$^{-1}$) | Relative contents of components *a* | *c* | *b* | Flavoprotein | DPNH |
|---|---|---|---|---|---|---|---|---|---|
| Mitochondria | rat liver | average of 4 | β-hydroxybutyrate | 8 | 1 | 1·7 | 0·9 | 3·6 | 19 (40 max |
| Mitochondria | guinea pig liver | average of 4 | glutamate<br>succinate | 11<br>27* | 1 | 1 4 | 0 6 | 4 4 | 43 |
| Mitochondria (water and saline washed) | rat liver | 432 *d* | succinate | ∼ 120† | 1 | very small | 0 5 | 4 | very sm |
| Sarcosomes | flight muscle | 421 *f* | α-glycerol phosphate | 65 | 1 | 1 7 | 0 55 | 2·2 | < 1 |
| Small particles | pig heart | 937 | succinate | 22 | 1 | 0·6 | 0·4 | ∼ 0 | ∼0 |
| Intact cells | bakers' yeast | 172 | ethanol | 120 | 1 | 3 | 2 4 | 3 | 16 |
| Intact cells | ascites tumour (Ehrlich hyperdiploid) | 225 | glucose | 3 | 1 | 2·7 | 0·33 | 3 | 6 |

* This value approaches 100 sec.$^{-1}$ in special media. † With added cytochrome-*c*, extrapolated to infinite [cytochrome-*c*]

Table 4. Kinetics of Reduction and Oxidation of the Components of the Mitochondrial Respiratory Chain

| Component | $a_3$ | *a* | *c* | *b* | Flavoprotein | DPN |
|---|---|---|---|---|---|---|
| Percentage oxidation as respiration ceases (25°) | — | — | 68 | 71 | 79 | 84 |
| Rate of reduction at 4° on substrate addition to aerobic system (μM Fe/sec.) | — | — | 0·015 | 0·019 | 0 07 | 0 064 |
| Rate of oxidation at 25° as 3 μM oxygen is added to anaerobic system (sec.$^{-1}$) | 158 | 120 | 39 | 20 | 13 | — |

has been considered in detail, and a fully developed discussion is beyond the scope of this article. In order to justify the sequence of action of the respiratory enzymes presented in equations 7 and 8, we include in Table 4 a summary of kinetic studies of the oxidation and reduction of the components of the chain as measured by rapid spectrophotometric methods under various conditions: (1) the kinetics of reduction of the components as the oxygen concentration falls to zero due to respiration (given as percentage pigment remaining oxidized); (2) the rate of reduction upon the addition of substrate to state 2; and (3) the rate of oxidation upon adding oxygen to anaerobic mitochondria (states 5–3) as measured in the regenerative flow apparatus[15]. All these kinetic results are consistent with the conclusion that the components react in the sequence in which they are written in equations 7 and 8 below.

*Changes in the steady state caused by the initiation of oxidative phosphorylation.* By comparing the levels of states 1, 3 and 4 with that of state 2 (the fully oxidized state) and by using state 5 as a reference level (see Fig. 1), we have computed the percentage reduction of cytochrome *b* in these three states (see Table 2). By repeating the experiment at pairs of wave-lengths appropriate to the other components (Table 1) we obtain the results shown in Table 2.

The characteristic change in the steady-state levels caused by the initiation of oxidative phosphorylation in a rat liver preparation (state 4–3 transition) is an increase in the reduction of cytochrome *a*, and a decrease in the reduction, or an oxidation, of cytochromes *c* and *b*, flavoprotein and reduced diphosphopyridine nucleotide. These oxidations of components below cytochrome *a* occur in spite of the four- to ten-fold increased respiration when phosphorylation is initiated. The point along the respiratory chain at which the reduction changes to an oxidation is called the cross-over point, and this lies between cytochromes *a* and *c* as illustrated by Table 2. The position of this cross-over point in the respiratory chain depends upon the balance of oxidase and dehydrogenase activities. Either by choosing a liver (from guinea pig) with a different balance of these activities or by adding azide (∼ 100 μM) to the rat liver material, the cross-over poi is moved down the chain to between cytochrom *b* and *c*. At higher azide concentrations, the cros over point lies between reduced diphosphopyridi nucleotide and flavoprotein, no cross-over poi between cytochrome *b* and flavoprotein having be identified.

Specific uncoupling agents such as dinitrophen dibromophenol, and butyl 3 : 5-di-iodo, 4-hydro benzoate, when added to the mitochondria in state cause oxidations and reductions along the respirato chain similar to those caused by adenosine diphc phate.

*Note added in proof.* The same state 4–3 transitio is observed in intact yeast cells when the intr cellular hexokinase activity is used to raise momen arily the intracellular adenosine diphosphate leve The crossover point lies between cytochrom *a* and *c*.

***Action spectrum for adenosine diphosphate.*** So fa we have afforded no proof that the spectroscop changes illustrated by Fig. 1 and measured at oth pairs of wave-lengths given in Table 1 are actually du to the respiratory enzymes named. We have therefo repeated the experiments indicated in Fig. 1 at variety of wave-lengths and have plotted the resultin optical density changes for the state 2–4 and 3- transitions in Fig. 3. Two technical points need t be noted: (1) the spectroscopic data are not co tinuous, but spot checks in the regions omitte indicate that no large absorption bands have be missed; and (2) the optical density changes in t region 580–620 mμ are for a guinea pig and not rat liver preparation; but the curve is plotted accordance with the magnitude of the change for rat liver preparation as given in Table 2.

Remembering that the difference spectra represe the transition from states 3 to 4, the cessation phosphorylation, we observe in support of the resul in Table 2 that there is the appearance of a reduc diphosphopyridine nucleotide band at 340 mμ, reduced cytochrome *b* at 430 mμ and at 564 mμ, an of reduced cytochrome *c* at 550 mμ. The α-band reduced cytochrome *a* at 604 mμ disappears, sin this component is oxidized. The small change oprotein absorption at 465 mμ is caused by uction of the absorbing oxidized form. On iation of oxidative phosphorylation (state 4–3 isition) the converse series of spectroscopic nges is observed.

he absorption bands observed in this transition ely resemble those of the known members of the piratory chain, and do not yet indicate that any ctroscopically distinct forms of the respiratory ymes are required to participate in oxidative sphorylation. Such direct experiments render ikely hypotheses that a special abbreviated piratory chain is required[13] or, in view of the fact t the steady state of many components is affected addition of adenosine diphosphate, that phosrylation occurs at only one point in the respiratory in[16].

*A reaction mechanism.* A mechanism for oxidative sphorylation must satisfy two seemingly incomible requirements of the reactions that occur upon transition from state 4 to 3: an oxidation of the mponents of the respiratory chain below cytoome *a*, together with a four- to ten-fold increase the respiration-rate[8]. The converse effect, the nsition from states 3 to 4 caused by the exhaustion adenosine diphosphate, in many ways resembles effects of an inhibitor of the respiratory chain; example, the effect of antimycin-*A* upon respiran and steady-state levels[14]. In the latter case, ochromes $a_3$, $a$ and $c$ become more oxidized, ereas cytochrome *b* becomes more reduced, the ss-over point for the effect being between cytoromes *c* and *b*. In the presence of azide (see above), same cross-over point is observed when adenosine hosphate is exhausted in the state 3–4 transition, cross-over point identifying the site of action of unknown inhibitory compound. With antimycinthe cross-over point is invariant and the extent of luction of cytochrome *b* as well as the inhibition electron transport are practically complete. With state 3–4 transition, cross-over points are identid at three places along the respiratory chain, and, the case of diphosphopyridine nucleotide, the exnt of reduction is more than 99 per cent and, for a htly coupled preparation, the inition of electron transport exeds 95 per cent[8]. Addition of enosine diphosphate to the inited electron transport chain idly increases respiration[8] by reving such inhibitory compounds m these cross-over points, as idenced by the fact that comnents below cytochrome *a* can come more oxidized in the transin from states 4 to 3. This view at the withdrawal of adenosine phosphate involves an inhibitory ect along the respiratory chain, d that addition of adenosine diosphate reverses this effect, is, of urse, in agreement with hypoeses of those who have approached is problem along rather different es[17,18], but now we are able to dicate the three pairs of respiratory catalysts that are involved in is effect.

Such a current formulation for e reversal-of-inhibition theory is at the oxidation-reduction reaction causes the formation of a high-energy compound with the oxidation product; an example for a particular site of oxidative phosphorylation is:

$$I + c''' + b'' \xrightarrow{k_1} c'' + b''' \sim I \qquad (1)$$

The formation of adenosine triphosphate takes place by the following reactions:

$$b''' \sim I + X \longrightarrow X \sim I + b''' \qquad (2)$$

$$X \sim I + P_i + \text{ADP} \longleftrightarrow X + I + \text{ATP} \qquad (3)$$

In state 4 in the absence of adenosine diphosphate (the amount of *X* or *I* being limited) the $b''' \sim I$ compound, an oxidized, inhibited form of the respiratory enzyme, will accumulate and stop the respiration. There are several experimental data which indicate that the current formulation is inconsistent with our experimental results. First, our results show that the reduced, and not the oxidized, forms of the respiratory enzymes accumulate in the inhibited state 4; for example, diphosphopyridine nucleotide is more than 99 per cent reduced in state 4 (see Table 2). Secondly, mitochondria rendered permeable by hypotonic treatment are found still to contain considerable intramitochondrial reduced pyridine nucleotide which does not elicit rapid respiration unless adenosine diphosphate is added. Nevertheless, addition of a solution of diphosphopyridine nucleotide in the absence of added adenosine diphosphate gives nearly as rapid respiration. Thirdly, mitochondria in state 4 appear to contain an amount of high-energy compound roughly equal to their reduced diphosphopyridine nucleotide content. This compound may react with adenosine diphosphate even in the presence of respiratory inhibitors[19]. These results suggest that reduced diphosphopyridine nucleotide is present in an inhibited form in mitochondria in state 4. While similar experiments have not been carried out with cytochromes *b* and *c*, the analogue computer studies (see below) indicate that the reduced forms of these components are also bound by an inhibitor.

A revised hypothesis that is consistent with our experiments is that the reduced, and not the oxidized,

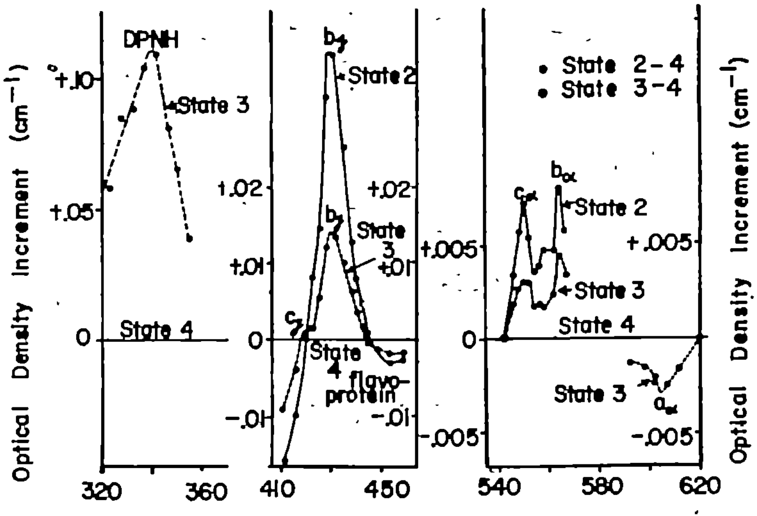


Fig. 3. Action spectrum for adenosine diphosphate, a difference spectrum representing the transition from the active oxidative phosphorylation state (state 3) to the quiescent state 4. The difference spectrum corresponding to the state 2–4 transition is also included. The base-line for both spectra is state 4. (Exp. 359)

Table 5. OXIDATION, REDUCTION AND PHOSPHORYLATION REACTION SEQUENCE IN THE RESPIRATORY CHAIN OF LIVER MITOCHONDI

$$O_2 \xrightarrow{k_1} a_3''' \xrightarrow{k_3} a''' \xrightarrow{k_5} c''' \xrightarrow{k_7} b''' \xrightarrow{k_9} \text{fp} \xrightarrow{\quad k_{11} \quad} \text{DPN} \xrightarrow{k_{13}} \text{acetoacetate} \qquad (7)$$

$$\begin{array}{l} O_2^- \xleftarrow{k_1} a_3'' \xleftarrow{k_3} a'' \xleftarrow{k_5} c'' \xleftarrow{k_7} b'' \xleftarrow{k_9} \text{rfp} \xleftarrow{k_{11}} \text{DPNH} \xleftarrow{k_{13}} \beta\text{-hydroxybutyrate} \\ \qquad\qquad\qquad \begin{array}{ccc} \uparrow X,P_1 & \uparrow X,P_1 & \uparrow X,P_1 \\ \downarrow \text{ADP} & \downarrow \text{ADP} & \downarrow \text{ADP} \\ c'' \sim I & b'' \sim I & \text{DPNH} \sim I \end{array} \end{array} \qquad (8)$$

fp, rfp, DPN and DPNH represent respectively the oxidized and reduced forms of flavoprotein and diphosphopyridine nucleotide

forms of the respiratory enzymes react with the inhibitor $I$ so as to conserve a part of the free-energy change of the oxidation-reduction reaction.

$$I + c''' + b'' \xrightarrow{k_7} b''' + c'' \sim I \qquad (4)$$

the transfer to $X$ being similar,

$$c'' \sim I + X \rightarrow X \sim I + c'' \qquad (5)$$

(As is described fully elsewhere, the portion of the free energy charge used to form the $\sim I$ compound could have been conserved when cytochrome $c$ was oxidized in the previous reaction cycle by cytochrome $a$, and held over until the reduction of cytochrome $c$ by $b$ as in equation 4, at which time the $\sim I$ compound would be formed.)

Equation 4 is ambiguous and has two interpretations. (1) A non-competitive inhibition of respiration in which the formation of $c' \sim I$ is obligatory and in which $c' \sim I$ cannot be oxidized by cytochrome $a'''$. In this case respiration can proceed only if reaction 5 occurs. (2) A competitive inhibition in which the formation of $c' \sim I$ is not obligatory, and oxidation by cytochrome $a$ can proceed with or without the intermediary reactions leading to phosphorylation. The phosphorus/oxygen (atoms) value of case 1 is fixed; that of case 2 depends upon the relative speeds of formation of the $\sim I$ compound and the competitive oxidation reaction. When the former reaction is rapid compared to the latter, the phosphorus/oxygen (atoms) value for the competitive case rises to that of the non-competitive case.

A transfer reaction initiated by addition of adenosine diphosphate, the state 4–3 transition (cf. equation 5), would cause a definite spectroscopic shift if the spectra of the $\sim I$ compounds differed from those of the uninhibited reduced forms. But our experiments show only absorption bands for the state 4–3 transition (Fig. 3) that can be attributed to known respiratory enzymes. We conclude that no detectable spectral shift occurs in reactions similar to that of equation 5.

Thus the state 4–3 transition releases cytochrome $c'$ with no spectral shift. The observed spectral shift is caused by the rapid oxidation of $c'$ by $a'''$:

$$a''' + c'' \xrightarrow{k_5} c''' + a'' \qquad (6)$$

A similar reasoning applies to the observed oxidations of other components of the chain (cf. Fig. 1 and Table 2).

*Analogue computer studies.* In order to comprehend the effects of the state 4–3 transition more fully, we have represented by means of an analogue computer a reaction sequence involving four of the enzymes and two of the sites for phosphorylation (see Table 5). (The assistance of William Holmes and Joseph Higgins in these computer studies is gratefully acknowledged.) From these and other studies it is possible to make two generalizations concerning steady-state changes following this transition.

(1) For a single phosphorylation site, the co ponent involved will become more oxidized Fig. 1); the components on the oxygen side become more reduced, and those on the substr side more oxidized.

(2) For two adjacent phosphorylations example, at $c$ and $a$), the component nearer oxy may or may not show an oxidation, whereas the nearer the substrate will show an oxidation.

From these two generalizations we obtain very useful cross-over theorem: in the state transition, the component on the oxidation s of the cross-over point from reduction to oxi tion is identified as a site of oxidation ph phorylation. Depending upon the conditions, cy chromes $b$ and $c$ and reduced diphosphopyrid nucleotide have shown this cross-over behavi and are identified as phosphorylation sites. Acco ing to (2), a component on the reduction side the cross-over is not ruled out as a possible s Thus our results do not conflict with those of Lar or Lehninger[2] on phosphorylation between cy chrome $c$ and oxygen.

The series of reactions of Table 5 summari (1) the sequence of spectroscopically detectable co ponents of the oxidative phosphorylation cha (2) the three locations of the reactions which lead the formation of inhibitory high-energy compoun and (3) the transfer reactions by which the inhibit compounds are decomposed by interaction w adenosine diphosphate (these reactions are abb viated forms of equations 3, 4 and 5). The advant of writing the reaction sequence as in Table 5 is th the oxidation and reduction pathways are clea indicated, and that participants in the individ oxidation-reduction reactions are placed over another. Such a sequence includes only those co ponents detectable by these methods and represe only single electron reactions.

This work was supported by a grant from t National Science Foundation and from the Office Naval Research.

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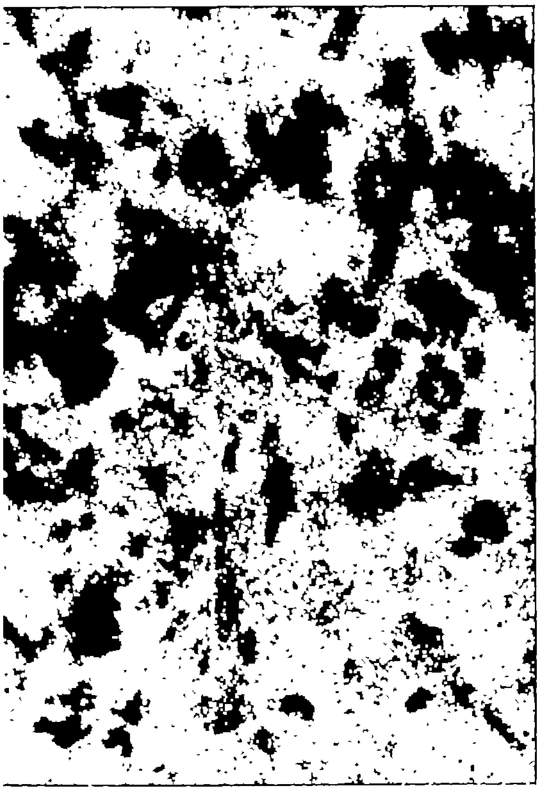
# LETTERS TO THE EDITORS

*he Editors do not hold themselves responsible or opinions expressed by their correspondents. Vo notice is taken of anonymous communications*

## ntranuclear Changes in the Polyhedrosis of *Tipula paludosa* (Diptera)

HE technique of cutting ultra-thin sections for
tron microscopy has made it possible to follow
behaviour of certain viruses in the cell, and this
particularly true of the nuclear virus diseases of
ects. The present note describes the remarkable
haviour in the nucleus of the polyhedral virus
ich causes a blood disease in the larva of the fly,
*pula paludosa*[1]. Sections through blood cells in
early stages of infection show an apparent con-
sation of the chromatic material in the centre
the nucleus in which the virus rods can be seen
veloping (Fig. 1). Most of the virus rods at this
ge are concentrated in the centre though some
ur scattered throughout the nucleus. The virus
ls are never observed on the outer side of the
clear membrane.

As the disease progresses, what is apparently a
ge thin-walled vesicle develops around individual
us rods which collect in masses on the inner edge
the nuclear membrane. These vesicular masses
apparently held together, probably by a thin
mbrane (Fig. 2). The vesicles are much less dense
n the surrounding medium, and the virus rod in
h vesicle is thinner and more sharply defined than
rods remaining outside. The appearance of the
sicle and the fact that each rod is suspended away
from the sides suggest that there may be a fluid, possibly a protein solution, inside the vesicles. Next, the edge of the mass nearest the nuclear membrane becomes denser, and the vesicles at this point are apparently compressed and much smaller. As crystallization proceeds all the vesicles become greatly reduced in size, possibly because of the osmotic effect of the medium surrounding them, until each vesicle, empty now of fluid and closely pressed around the virus rod, eventually forms the capsule in which each virus rod in the polyhedral crystal is enclosed. It may be that fluid forced out of the vesicles is used in the crystal formation.



ig. 1. Thin section through part of the centre of a diseased nucleus, showing the developing virus rods. × 50,000

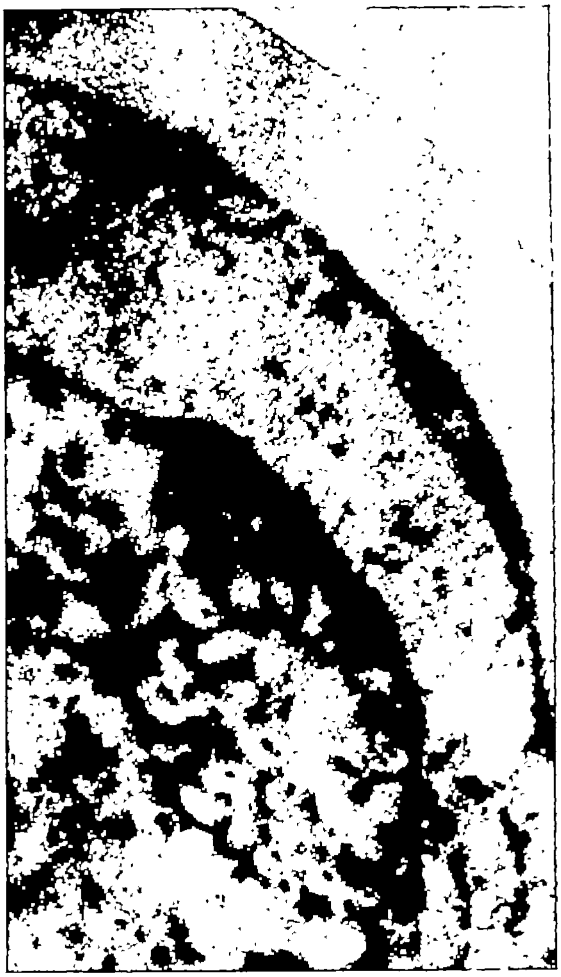


Fig. 2. Segment of a diseased blood cell, showing the mass of vesicles against the inner edge of the nuclear membrane. × 25,000

All these changes take place inside the nucleus; but the final position of the completed crystal is outside the nucleus with its inner edge along the nuclear membrane. Apparently as the crystal forms it is forced out of the nucleus until it reaches that position.

The accompanying electron micrographs were taken by S. Vernon-Smith.

KENNETH M. SMITH

Virus Research Unit
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Molteno Institute,
Cambridge.

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# Xanthomycin A

WHILE studying the antibacterial products of a species of *Streptomyces* (N.C.I.B. 8697) sent by Dr. R. Green from Malaya, we have isolated an orange-red coloured basic substance which is very active against a variety of bacteria and is highly toxic to mice. The antibiotic was extracted from the culture fluid into chloroform, at $p$H 6, and re-extracted into water at $p$H 2, or extracted into trichloroethylene, at $p$H 8·5, and re-extracted into water at $p$H 3·5. It was purified by counter-current distribution in a solvent system consisting of trichloroethylene and 0·1 $M$ sodium citrate buffer, $p$H 5·95. In this system its partition coefficient, $K$ (= concentration in trichloroethylene/concentration in water), was 0·98. The purified product yielded a crystalline hydrochloride, reineckate and picrate. The behaviour of this antibiotic suggests that it is identical with, or very closely related to, xanthomycin *A*—a substance which has been isolated from species of *Streptomyces*[1], and stated to have quinonoid properties[2]. We wish to record, however, that it is a stronger base than xanthomycin *A* has been reported to be and that it yields two simple bases on hydrolysis which have not been described as degradation products of xanthomycin *A*.

A number of properties of the antibiotic from the Malayan *Streptomyces* were similar to (and in some cases virtually indistinguishable from) those reported for xanthomycin *A*. The hydrochloride of the antibiotic ($[\alpha]^{20}_{D}$ + 100, in water) had an equivalent weight of approximately 540 and gave analytical data which were not inconsistent with the molecular formula $C_{23}H_{29-31}N_3O_7,2HCl$. It showed an ultra-violet absorption spectrum with a maximum at 265 mμ ($E$(1 per cent, 1 cm.) 180) and an infra-red spectrum that was almost identical with one published by Rao and Peterson[2]. The partition coefficient of the antibiotic in the system chloroform–0·1 $M$ sodium citrate buffer, $p$H 4·2, was close to unity. The free base, obtained from an aqueous solution at $p$H 6 by extraction with chloroform, yielded a product on evaporation of the solvent which showed absorption maxima at 288 and 455 mμ. On paper chromatograms run with $n$-butanol containing 1 per cent by volume of normal hydrochloric acid, the antibiotic behaved as though it could exist in two forms, with $R_F$ values of 0 and 1·0 respectively, which were interconvertible.

A concentration of 0·002 μgm./ml. of the antibiotic inhibited the growth of *Staph. aureus* (N.C.T.C. 6571) in meat broth, and a dose of 30 μgm., given intravenously, proved lethal to a 20-gm. mouse within three days (Florey, H. W., unpublished experiments). These values appear to be of the same order as the corresponding values reported for xanthomycin *A*.

Xanthomycin *A* has been reported to contain two weakly basic groups with $pK$ values of 2·0 and 4·5. Electrometric titration revealed that the antibiotic from the Malayan *Streptomyces* contains basic groups with $pK$ values of 3·0 and 7·3 respectively. Below $p$H 9 the titration is reversible. Above $p$H 11 the antibiotic undergoes a rapid irreversible change, resulting in loss of activity, the virtual disappearance of the group with $pK$ 7·3, and the appearance of groups with $pK$ values of about 9·7 and 4·7 respectively. The presence of a group with $pK$ 7·3 in the antibiotic is consistent with the fact that it migrates as a base during ionophoresis on paper in collidine acetate buffer at $p$H 7·0[3], and that its partition coefficient in a trichloroethylene–wa system increases rapidly as the $p$H of the aque phase is raised from 6 to 8. The fact that it is larg extracted by chloroform, like xanthomycin *A*, fr an aqueous solution at $p$H 6, can be attributed the very high partition coefficient of the free bas favour of the chloroform phase.

The antibiotic gives only a poor ninhydrin reacti but yields two ninhydrin-positive bases on treatm with 6 $N$ hydrochloric acid at 105° for twenty hou The first base is highly volatile and is indistingui able from methylamine when subjected to io phoresis on paper, at $p$H 7·0, or to chromatogra on paper in butanol–acetic acid[4]. The second b is less volatile and is oxidized by periodate to yi ammonia. It is easily recovered from hydrolysa together with the first, by azeotropic distillat with toluene[5]. When subjected to ionophoresis paper at $p$H 7, or to chromatography on pap developed with butanol–acetic acid or butan pyridine–water[6], it is indistinguishable from ethar amine. Quantitative studies[7] have shown that nea one mole of the first base and two moles of second are liberated from one mole of the antibio

Hydrogenation of the antibiotic in the presence palladium on charcoal resulted in the uptake of nea three moles of hydrogen. No ethanolamine v detected after hydrolysis of the product of hyd genation. This suggests that the ethanolamine not joined to the rest of the molecule by eithe normal amide or ester linkage alone, or by both ty of linkage. The infra-red spectrum of the antibic shows no band corresponding to the CO of a norr ester grouping, but bands at 6·03μ, 8·70μ, 8· and 9·13μ. It is of interest that bands in the reg of 8·70μ, 8·98μ and 9·13μ have been reported be shown by simple oxazolidines and a band in t region of 6·03μ by the corresponding Schiff's bas

We are indebted to the Medical Research Counc Antibiotics Research Station, Clevedon, for suppl of culture fluid and concentrates of the antibiotic.

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# Effects of Adenosine Triphosphate and Metals upon an Electron Transport System in Mitochondria

IN the course of studies on oxidative phosphoryl tion coupled with the succinoxidase system of r liver mitochondria, it was found that adenosi triphosphate, alone and with certain metals, si nificantly accelerated reduction of triphenyltet zolium chloride to triphenylformazan.

Mitochondria were isolated from rat livers homogenization in 8·5 per cent sucrose and coagul tion with 0·15 $M$ potassium chloride[1]. The reactio

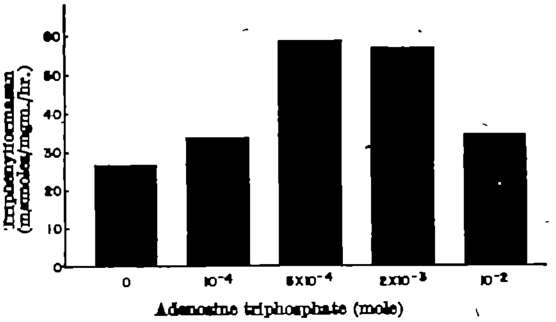

Fig. 1. Effect of varying amounts of adenosine triphosphate on production of triphenylformazan by mitochondria. The reaction mixture totalled 3·0 ml., containing 50 μmoles of potassium succinate, 400 μmoles tris (hydroxymethyl) amino-methane buffer pH 7·4, 1 μmole of triphenyltetrazolium chloride, 0·2 ml. of mitochondria in 0·15 *M* potassium chloride

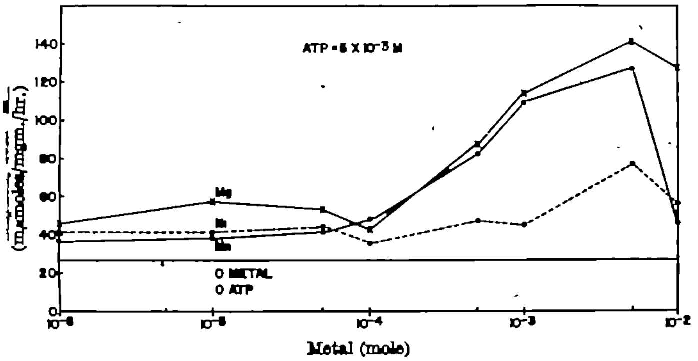

Fig. 2. Effect of varying amount of magnesium, manganese or nickel with a constant amount of adenosine triphosphate on the production of triphenylformazan by mitochondria

roceeded aerobically for sixty minutes at 25° C. ithout shaking. The protein was precipitated by he addition of 3 ml. of acetone to terminate the eaction and removed by centrifugation; simult-neously, the triphenylformazan was extracted and s concentration was determined at 480 mμ.

The addition of adenosine triphosphate in varying uantities to the reaction mixture produced a marked icrease in the reduction of triphenyltetrazolium hloride; similar concentrations of adenosine monohosphate or pyrophosphate had no effects (see Fig. 1). ts effect was maximal at concentrations between 0·5 and 2 × $10^{-3}$ *M* and statistically significant in a series of experiments. Since the effect of adenosine triphosphate in biochemical systems has been shown to be dependent upon the presence of magnesium or manganese[1], and since mitochondria contain significant amounts of these and other metallic elements (unpublished work with R. E. Thiers), the effect of the addition of a variety of metals with varying amounts of adenosine triphosphate was studied: aluminium, barium, beryllium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, strontium, vanadium and zinc. The effects of the addition of varying amounts of magnesium, manganese or nickel with a fixed amount of adenosine triphosphate is shown in Fig. 2. Fig. 3 shows similar results obtained when varying amounts of adenosine triphosphate were added together with fixed amounts of magnesium or manganese. Significantly, maximal activation of the production of triphenylformazan occurred when metal and adenosine triphosphate concentrations were equal.

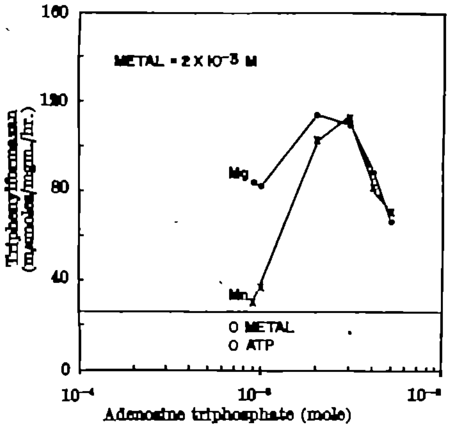

Fig. 3. Effect of varying amounts of adenosine triphosphate with a constant amount of magnesium or manganese on the production of triphenylformazan by mitochondria

Studies on the interaction with other elements showed that calcium, barium, strontium and chromium neither produced additional activation nor interfered with the action of adenosine triphosphate in activating this reduction mechanism. Beryllium, aluminium, zinc, copper, iron, vanadium and molybdenum not only had no stimulating effect but also abolished the stimulation due to adenosine triphosphate itself.

The enhancement of the stimulatory effect of adenosine triphosphate upon reduction of triphenyltetrazolium chloride when magnesium, manganese or nickel were added in equimolar quantities suggests as a working hypothesis that the adenosine triphosphate alone acts in conjunction with the metals of mitochondria. The levels of concentrations of magnesium and manganese in mitochondria support such a hypothesis. The relationship of metal–adenosine triphosphate complexes to electron transport is now under investigation for its implications in the mechanism of oxidative phosphorylation. A similar suggestion, based upon a different experimental approach, has been advanced recently[3]; our attempts to complement this hypothesis by the repetition of Lindberg and Ernster's experiments have failed so far. The substance of this communication will be published more fully elsewhere.

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## Distribution of Free Amino-Acids in Embryos of *Xenopus laevis*

RECENT investigations[1,2] have shown that some of the free amino-acids in amphibian embryos change in concentration during early development. These changes are of interest because they may be related to the synthesis of new, specific proteins[3]. It has been shown that halved embryos of *Rana pipiens* and *Hyla regilla* allowed to develop in a medium containing radioactive glycine or methionine will incorporate these amino-acids directly into protein, and that the rate of incorporation is particularly high in dorsal halves of gastrulæ and neurulæ, which are known to synthesize protein more rapidly than other parts of the embryo[4,5].

The most complete investigation so far published[2] on free amino-acids in amphibia was carried out on whole *Rana pipiens* embryos. These contain free aspartic acid, glutamic acid, glycine, histidine, threonine, arginine, tryptophan and valine. Aspartic acid, glycine, histidine and threonine are present in high concentration at the beginning of development, and their concentration falls sharply during cleavage, rising afterwards to a maximum at the neurula stage. Arginine, tryptophan and valine are present in very low concentration at first, and their concentration rises steadily during development, to reach a maximum in the neurula. No data were given for separate dorsal and ventral regions of the embryo.

Work which is now in progress on embryos of *Xenopus laevis* shows that the whole embryos, like those of *R. pipiens*, contain free aspartic acid, glutamic acid, glycine, arginine and valine; but that, in addition, free glutamine, α-alanine, β-alanine, leucine and cystine are present (Fig. 1). Histidine, threonine and tryptophan, on the other hand, cannot be detected. Aspartic acid and glutamic acid are present in highest concentration, and these show a significant decrease between morula and early gastrula stages. Glutamine, also present in fairly high concentration, shows a significant decrease between late neurula and early tailbud stages. The concentration of leucine increases significantly between early and late gastrula stages, with a further increase at the tailb stage.

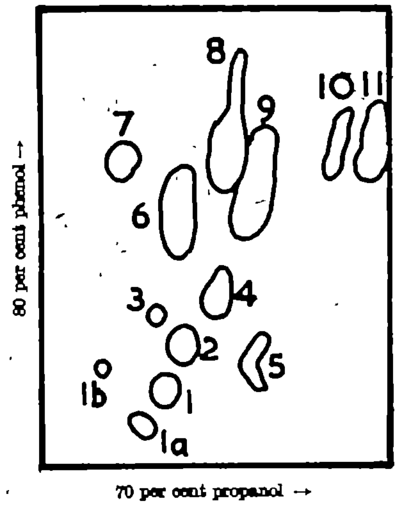

Fig. 1. Map showing the positions taken up on chromatograms by the eleven free amino-acids identified in *Xenopus laevis* embryos. (1) Aspartic acid; (1*a*, *b*) ? glutathione; (2) glutamic acid; (3) ? cysteine; (4) glycine; (5) cystine; (6) glutamine; (7) arginine; (8) β-alanine; (9) α-alanine; (10) valine; (11) leucine

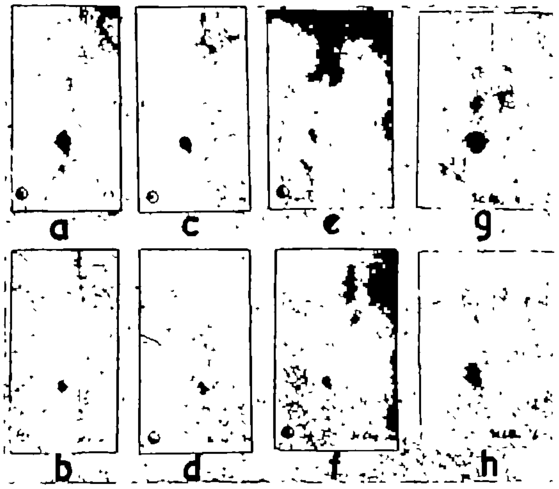

Fig. 2 Chromatograms of the free amino-acids extracted from 10-mgm. samples (frozen-dried weight) of tissue from different regions of the embryo. (*a*) Animal half of blastula; (*b*) vegetal half of blastula; (*c*) dorsal lip of early gastrula; (*d*) remainder of early gastrula after excision of dorsal lip; (*e*) dorsal half of late gastrula; (*f*) ventral half of late gastrula; (*g*) dorsal half of neurula; (*h*) ventral half of neurula (compare with Fig. 1)

In addition to the work on whole embryos, t free amino-acid content of dorsal and ventral regio of blastulæ, gastrulæ and neurulæ have been analys separately. In the blastula, there is a higher co centration of total free amino-acid (γ/mgm. froze dried tissue) in the animal half than in the veget half: this difference is particularly marked f aspartic acid. In the early gastrula, the concentrati of total free amino-acid is higher in the dorsal l than in the rest of the embryo. Dorsal and ventr halves of the late gastrula, on the other hand, ( not differ significantly in their free amino-acid co tent. By the late neurula stage the difference betwe dorsal and ventral halves has reappeared. In pa ticular, aspartic acid, glutamic acid and glutami are present in significantly higher concentration the dorsal half. Chromatographs of the free amin acids in these half-embryos are compared in Fig.

Special precautions were taken throughout obtain clear, consistent chromatographic results a to avoid all possibility of autolysis in the embryon tissue. The procedure was as follows: since sali caused streaking of the chromatograms, samples embryos were collected in distilled water. T embryos that were to be analysed whole were ke alive in this medium by not removing the jelly fro them. (Test chromatograms of jelly alone had show that it contained no detectable amino-acid.) Embry that were later to be halved had, however, to demembranated first. This was done as quickly possible, on groups of not more than twelve embry which were then frozen immediately on an ice/s bath at − 10° C. Batches of embryos prepared one of the above methods were stored in the de freeze and then frozen-dried. The frozen-dri demembranated embryos could then be dissected leisure, at room temperature, without any danger autolysis. The tissues were ground up in a morte and the free amino-acids obtained from them by fo successive extractions with 80 per cent ethanol, an ice-bath. (Previous trials had shown that a fif extraction with ethanol did not remove any furth ino-acid.) The combined extracts were evaporated dryness at 60° C. and the residue was redissolved the minimum 80 per cent ethanol for transfer to in. squares of Whatman No. 1 filter paper for omatography. Chromatograms were run two-nensionally, using as the first solvent 80 per cent v) phenol with 3 c.c. of 30 per cent aqueous monia added for every 500 gm. phenol. The ond solvent was 70 per cent propanol. The omatograms were sprayed with 0·5 per cent hydrin in absolute ethanol, and the colour de-oped at 65° C. for twenty minutes. The quantities individual amino-acids present were estimated by olorimetric method[6].

sing this technique, it is possible to carry out lyses of the free amino-acids not only in whole bryos but also in different regions representing ferent tissue primordia. Any regional differences free amino-acid content which might be related the early synthesis of tissue-specific proteins can this way be detected. The results already quoted icate that at least dorsoventral regional differences exist: further work on more precisely defined ts of neurulæ, tailbud stages and early larvæ is in progress.

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## Metabolism of Triaryl Phosphates in Rodents

ONSIDERABLE interest is attached to the meta-ism of the compound tri-*o*-cresyl phosphate, which been shown to inhibit various esterases *in vivo* which is capable of producing demyelination and alysis in certain species of animals[1]. Pure tri-*o*-syl phosphate exhibits little inhibitory activity inst esterases *in vitro*[2,3] and the compound pears to be converted into an active inhibitor in animal; this conversion can also be effected by ubation with liver slices *in vitro*[3].

t had been shown previously by Gross and sse[4] that, two hours after intravenous injection of -*o*-cresyl phosphate into rabbits, an amount of sol ester equivalent to 70 per cent of the ad-nistered compound can be recovered from the estinal tract and an amount equivalent to 50 per t from the liver of the animal. The amounts of sol ester present in other tissues were too small be determined, although a large proportion of the sol ester is later excreted in the urine[4]. In our eriments we had found an active esterase in-itor in the urine of rats and rabbits after intra-itoneal injection of tri-*o*-cresyl phosphate[5]. This ding suggested that the cresol esters measured by oss and Grosse might in fact be reactive derivatives tri-*o*-cresyl phosphate. We proceeded, therefore, examine the tissues of the rats for esterase inhibit-activity after intraperitoneal injection of tri-*o*-syl phosphate, this compound being readily orbed from the peritoneal cavity[4].

The tissues were homogenized with four volumes of water, the proteins precipitated by the addition of three volumes of ethanol to the homogenate, and various amounts of the supernatant fluid were incubated with a 1 per cent solution of human serum at 37·5° and pH 7·4 for 30 min. Under these conditions, extracts of tissues from normal animals fail to cause any significant inhibition of the pseudocholinesterase of human serum. However, the extracts obtained from the tissues sixteen hours after intraperitoneal injection of 1 ml. tri-*o*-cresyl phosphate per kgm. into adult male rats proved to be strongly inhibitory. The pseudocholinesterase of human serum was 50 per cent inhibited by the addition of the extract from 0·1 mgm. fresh weight of liver or 0·03 mgm. of intestine to 1 ml. of the incubation mixture. No significant inhibition was observed with extracts of brain, while the remaining tissues tested (blood, kidney, pancreas, spleen, lung, testis, salivary gland, Harderian gland and the remaining carcass) all contained small amounts of the inhibitor, 50 per cent inhibition of the pseudocholinesterase being obtained when the extract from 3–4 mgm. of fresh tissue was added to 1 ml. of the incubation mixture. The total inhibitory activity present in the tissue extracts was 3–6,000 times greater than the total inhibitory activity present in the tri-*o*-cresyl phosphate which had been injected; that is, the derivative formed in the animal must be at least six thousand times more active than the original compound as an inhibitor of pseudocholinesterase. Approximately 80 per cent of the total esterase inhibitor was located in the intestinal tract, while 12 per cent was recovered from the liver and 8 per cent from the remainder of the body. These values agree fairly well with the determinations of cresol ester in rabbits reported by Gross and Grosse[4].

The concentration of inhibitor in the liver appears to reach a maximum within 30 min. after the injection of tri-*o*-cresyl phosphate, while the concentration in the intestine increases slowly to reach a maximum after several hours. The hypothesis that tri-*o*-cresyl phosphate is converted into an active inhibitor in the liver, excreted in the bile and re-absorbed in the intestine was confirmed by the fact that the bile of rabbits and intestinal contents from rats and rabbits contain very high concentrations of the reactive inhibitor after injection of tri-*o*-cresyl phosphate. Appreciable amounts of the inhibitor can still be recovered from the liver and intestine 7–10 days after the tri-*o*-cresyl phosphate was administered.

The structure of the reactive derivative of tri-*o*-cresyl phosphate is not known. However, a similar inhibitor of serum pseudocholinesterase can be recovered from the liver and intestine after the administration of triphenyl phosphate. Moreover, Bloch has reported that the esterases of the rabbit can be inhibited *in vivo* by the administration of tri-*o*-chlorophenyl phosphate as well as by tri-*o*-cresyl phosphate[6]. Thus it seems probable that the primary alteration in the structure of the triaryl phosphates leading to the formation of reactive inhibitors *in vivo* is a substitution on one or more of the phenyl rings. By analogy with the results obtained with other aromatic derivatives[7], we would expect that a hydroxyl group is introduced into the *para* position and afterwards converted to a sulphate or glucuronide.

Further examination of the urine and liver preparations obtained in the above experiments has revealed the presence of more than one inhibitor.

The major portion of the inhibitory activity is due to a compound which is soluble in ether and other organic solvents, and unstable in aqueous solution. A small part of the total inhibitory activity is due to a compound which is poorly soluble in ether, and stable in aqueous solution at neutral and at acid pH. It is possible that other derivatives may be formed in small amounts[7]. Further experiments on the separation of these compounds are being carried out.

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## A New Difference between Live and Dead Spermatozoa

When semen is diluted with a solution of formaldehyde under certain standard conditions of pH, temperature and osmotic pressure, dead spermatozoa are agglutinated but living ones are not. This difference between live and dead spermatozoa has been investigated in 103 ejaculates from seven bulls at a commercial insemination centre. Samples from a hundred of these ejaculates were used for insemination, three ejaculates being unsuitable for insemination because of low sperm motility.

The percentage of dead spermatozoa in duplicate samples of each ejaculate was estimated in smears stained with nigrosin-eosin[1]. The staining solution (pH 7·2; Δ, − 0·54° C. ± 0·02° C.) was used at 37° C. Details of the composition of this new solution and of the buffered formal-saline used here will be published elsewhere. Duplicate samples of each ejaculate were fixed in a buffered isotonic solution of sodium chloride (pH 7·0; Δ, − 0·53° C.) with added formaldehyde (5 per cent formaldehyde), by adding one drop of semen at 37° C. to each of two tubes containing 3 ml. fixative also at 37° C. After fifteen minutes incubation at 37° C., the samples were allowed to cool to room temperature.

Measurements of the percentage of dead (eosinophil) spermatozoa and of the degree of agglutination were made after a variable period (up to two weeks), following treatment of the sample. The number of dead spermatozoa in a total of a hundred was counted on each of two slides. The degree of agglutination was scored on a unit scale of 1 (minimal agglutination) to 4 (maximal agglutination). The samples were shaken and scored by visual assessment of agglutination using transmitted light. The percentage dead and the agglutination score were estimated independently by different observers.

The relationship between percentage dead spermatozoa and agglutination score was examined by regression analysis. The mean percentage dead spermatozoa was used as one variable, and the co bined agglutination scores for each sample pair the second variable. The analysis was made Dr. R. C. Campbell, Agricultural Research Cou Unit of Reproductive Physiology and Biochemist Cambridge.

A highly significant relationship ($p < 0·001$) found between percentage dead spermatozoa agglutination score. The mean percentage of d spermatozoa for all samples was 16·7 (range 3·5–65· the mean agglutination score for all samples was (range 2–8). The mean percentages of dead spe atozoa in the three ejaculates discarded as unfit insemination were 65·0, 40·0 and 39·5; the co bined agglutination scores were 8, 6 and 6.

This difference between living and dead cells d not seem to have been noted before and it may th fore be of some fundamental interest; but, at moment, we are more concerned with the follow practical implications. In 103 samples of bull se which, with three exceptions, were judged to suitable for insemination, there was a pronoun relationship between the proportion of dead spe atozoa and the degree of agglutination after treatm of the semen with formaldehyde. A relationshi known to exist between the fertilizing capacity bull semen and its content of dead spermatozo the agglutinability of spermatozoa by formaldeh may therefore be a simple and useful criterion of fertilizing capacity of bull semen.

We wish to thank Dr. R. Aschaffenburg, Natio Institute for Research in Dairying, Reading, Lord Rothschild, Department of Zoology, Univer of Cambridge, for measurements of the freezing poi of some of the reagents used, and Mr. J. A. M Avoncroft Cattle Breeders, Ltd., for facilities.

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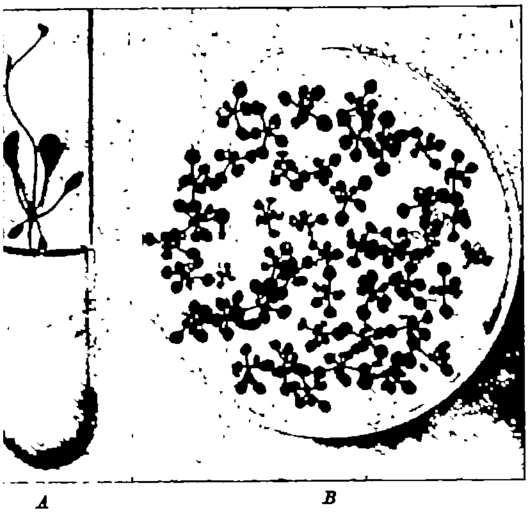
## Biochemical Mutations in the Crucifer *Arabidopsis thaliana* (L.) Heynh.

The photosynthetic flowering plants possess greater capacity for synthesis of crystalloids than other group of organisms. Their complete exogen requirements for growth consist of only fourt elements and the two compounds carbon dioxide water. No intact flowering plant, with the except of those lacking chlorophyll, has been shown require any organic compound apart, of course, fr carbon dioxide. I have now attempted to exam plant biosynthesis by the 'mutational block' meth which has been of great success in the analysis metabolism in haploid micro-organisms.

Selection of mutants deficient in essential synthe can only be carried out satisfactorily under ase conditions, so a necessary prerequisite is an adequ method for the sterile culture of higher plants. this respect the suitability of the experimental pl



1. *Arabidopsis thaliana.* *A*: normal plants, 14 days old, wing aseptically on 5 ml. mineral agar in a 16 mm. × 160 mm. t-tube; nearly full size. *B*: forty-five plants, 13 days old, wing aseptically on cellulose pulp in a Petri dish of 9-cm. diameter; about half-size

ritical, and a search was made for small rapidly wing plants with certain other necessary attributes. *rabidopsis thaliana* (L.) Heynh.[1], a small crucifer 1 a short life-cycle (28 days), a low chromosome iber ($n = 5$), and a high seed output, fitted the uirements reasonably well. In culture, the plants w well on 5 ml. of medium in ordinary test-tubes . flowered 13–14 days after germination. The lium, solidified with 0·6 per cent agar, contained y the minerals of Knop solution and chelated trace nents. Seeds were sterilized in hydrogen peroxide l ethanol (1 : 1), a method recommended to me by J. Harris, and transferred to the agar medium h a platinum loop. After a 24-hr. cold treatment ensure uniform germination, the cultures were ed in a growth chamber maintained at 25° C. and ut 800 ft.-candles light intensity.

'lants may be grown on a large scale in Petri dishes taining pure cellulose and mineral nutrients. itamination was avoided by packing the space ut the lid with cotton-wool pretreated with yl-pyridinium chloride. The inner surface of the may be treated with 'anti-dim' to prevent water densing in large drops and reducing the available t. When the plants entered the reproductive se, the Petri dish lid was removed to allow igation of the flower stalk, flowering and seed-ing. Fifty plants may be grown to maturity in h Petri dish.

'he required mutations were induced by X-irradia-1[2] (6,000 r., 130 kV.) of seeds, and isolated by wing the segregating ($X_2$) generations on sterile, mically defined medium. From 110 $X_2$ families, nty-seven mutants have been isolated, nine of se being lethals.

)ne mutation, inherited as a simple recessive, ders the plant incapable of synthesizing thiamine. tant plants have mottled cotyledons, and the sequent leaves are white or have chlorophyll only the tips. The block in synthesis, however, is not olute, for after a lag in growth, which increases duration as the temperature is raised, the plants ome green again and resume growth. All plants at temperatures above 27° C.; but at 20° C. only 10 per cent show any deficiency symptoms. Irrespective of the temperature, all grow normally with 1 μgm. of thiamine per plant. There is some evidence suggesting that the coupling of derivatives of pyrimidine and thiazole to form the thiamine molecule is blocked.

Another recessive lethal mutant, although green, has cotyledons which show early degeneration and the plant dies at the two-leaf stage. When supplied with coconut milk, this mutant will grow slowly and eventually flower. Its specific requirements have not yet been identified.

Three of the lethal mutations prevent the formation of plastids from proplastids. Their effects are apparently not expressed solely as an inactivation of the photosynthetic mechanism, for the plants show no growth response to added sucrose. The formation of chlorophyll is prevented in yet another mutant; but deficient plants will grow slowly and form flowers if sucrose is supplied in the medium. The three remaining lethal mutants have green cotyledons but produce only one pair of very small pale-green leaves. They resemble phenocopies obtained with specific amino-acid antagonists; but no supplement has been found that will improve their growth.

It is to be expected that many mutations blocking metabolism will be eliminated by the sieve of seed development. Thus mutations affecting respiratory processes and the formation of non-diffusible substances necessary for embryo growth will probably not be detected in the $X_2$ generation. Biochemical genetics in flowering plants is therefore likely to be a more restricted field than its counterpart in the micro-organisms.

A detailed description of these experiments will be published elsewhere. I thank Prof. D. G. Catcheside, in whose laboratory this work was carried out, for helpful criticism and advice; Prof. F. Laibach, of Frankfurt-am-Main, for seeds of *Arabidopsis thaliana* and for generous advice; and the Commonwealth Scientific and Industrial Research Organization for the award of a studentship.

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## A New Technique for the Study of Chromosomes of Palms

THE study of the chromosomes of palms has always been considered very difficult, as is clearly evidenced by the lack of data on a large number of genera[1]. Even where the number of chromosomes has been recorded, the details of the structure are unknown.

In recent years, the use of a number of pre-treatment chemicals[2,3] has solved to a great extent the problem of karyotype study. But all these are of limited application, appropriate only to certain groups of plant; none of these methods when tried on palms proved to be of any use.

In the study of the cytology of tropical palms which has been undertaken in this laboratory, a number of alkaloids were tested for the fixation of their chromosomes. With one of the alkaloids, namely, aesculine (a derivative of *Aesculus hippocastanum*), excellent results were obtained. Its application in chromosome analysis appears to have solved this long-standing difficulty.

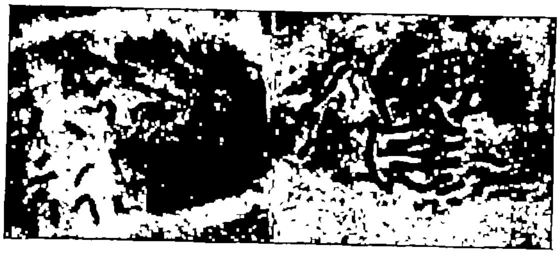

Fig. 1. Somatic metaphase plates of (1) *Oreodoxa regia* H.B. and K., and (2) *Rhapis flabelliformis*, L'Hérit., showing 36 and 34 chromosomes respectively following æsculine treatment

Freshly cut root-tips were treated for different intervals of time at various temperatures, prior to treatment for a few seconds in a mixture of 2 per cent aceto-orcein and *N* hydrochloric acid (9 : 1). Then the tips were smeared in 1 per cent aceto-orcein. Excellent results could be obtained if the tips were treated in a saturated solution of æsculine in water for twenty-four hours, the first two hours being at a temperature of 2°–4° C. and the remainder of the period at 12°–18° C. After treatment, the tips were heated in the dye-acid mixture mentioned above and stained in orcein in the usual way. Application of uniform and sufficient pressure during smearing was very necessary for good results.

The chromosomes come out well scattered with constriction regions distinctly clarified (Fig. 1). So far, about thirty species of palms known to be difficult of analysis have been tried, and the technique proves to be equally effective in all.

The effect of the treatment appears to be principally a change in the plasma viscosity, as suggested by Stalfelt in the case of oxyquinoline[3]. Further, we believe, from the results obtained with a number of chemicals[4], that æsculine to some extent brings about a coagulation of protein—a process which is finally completed by treatment in the dye-acid mixture. Fixation is thus to be attributed to both these steps.

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# Hypomagnesæmia in Dairy Cattle and its Possible Relationship to Ruminal Ammonia Production

THE highest incidence of hypomagnesæmia in dairy cattle occurs in the first few weeks of the spring grazing which follows the winter stall-feeding period. Some factors which influence its incidence at this time and methods for its control have been studied at this Institute for several years[1]. Recently, we have investigated the changes in blood composition, rumen fermentation and mineral metabolism caused by the transfer to grazing or the feeding of cut spring grass in the stall, and several observations have ar
which suggest a possible mechanism for the
duction of hypomagnesæmia.

The daily intake of magnesium by a grazing
receiving no other food or mineral supplemen
20–30 gm., which is comparable with the int
during the stall-feeding period, and it is gener
considered that hypomagnesæmia does not arise f
an inadequate intake of magnesium. We have fo
that the excretion of magnesium in the urine of
cow is markedly and rapidly reduced with the cha
to spring grass. To quote two examples, the d
urinary excretion of magnesium of one cow fell wit
the first twenty-four hours from 3–4 gm. to 1·5
and then gradually to 0·2 gm. at the end of ei
days; while in another, the initial daily excret
of 1·5 gm. fell to 0·1 gm. over the same per
There was a concomitant fall in blood serum m
nesium level in both animals from more than 2 mg
100 ml. to about 1 mgm./100 ml. If such a fal
the urinary excretion of magnesium reflects a redu
intestinal absorption, as observed by McCance
Widdowson[2] in humans, it would indicate that
ruminants the magnesium of spring grass has
unusually low availability. Garner[3] has shown th
*in vitro*, the action of rumen micro-organisms
gastric juice releases the magnesium of grass, so t
it would appear that during the early grazing per
there is some alimentary disturbance which modi
the availability or absorption of magnesium.

Among the observations made in our rumen stud
a highly significant one, we feel, has been a rise
the ammonia content of rumen liquor, on the trans
to grass feeding, to a continuously high level of
60 mgm./100 ml. In contrast, under winter st
feeding conditions, a general level of 10–20 mgm./
ml. was found, with peak values of 30 mgm./100
for short periods after feeding. That ammonia p
duction on grass was abnormally high was a
reflected by the presence of ammonia in jugu
blood, up to 0·3 mgm./100 ml. being observ
indicating that the capacity of the liver for the c
version of portal blood ammonia to urea had be
exceeded.

In view of these observations, an attempt was ma
to influence the absorption of magnesium in cat
receiving a hay and concentrate ration by the ad
tion to the rumen, via a fistula, of ammoni
acetate and ammonium carbonate. The da
addition of 1,250 gm. or more of these salts per c
for a period of four days produced ruminal ammo
levels comparable with those observed on grass, a
similarly reduced the urinary excretion of magnesiu
Smaller additions had no effect. This reduction
magnesium excretion was accompanied by a fall
the serum magnesium from 2·5 to 2·0 mgm./100

In view of these observations, we feel justified
suggesting that hypomagnesæmia of cows on gra
and particularly during the early spring, arises fr
an inadequate absorption of magnesium and is pr
ably associated with high ruminal ammonia p
duction. The mechanism is not understood;
it is feasible that ammonia may pass in quant
from the rumen to the small intestine, where an int
action between ammonia and magnesium absorpti
could take place.

The marked difference in swards in their abil
to produce hypomagnesæmia, and the spontane
recovery in serum magnesium levels of cattle as t
grass matures and the nitrogen content falls, mig
be explained, at least in part, by the critical nat

the ruminal ammonia-level. The severity of hypo-gnesaemia in dairy cattle grazing a given sward uld be determined by the animals' individual serves of magnesium at the end of the winter feeding riod, and by the level of their daily requirement. This series of studies, involving field-trials, balance periments and studies of rumen digestion, is being ntinued.

We gratefully acknowledge the collaboration of our lleagues at this Institute in this work.

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## ar Formation in Timothy Grass (*Phleum pratense*) following Vernalization and Short-day Treatments

In many perennial grasses of temperate regions, posure to low temperature has proved to be a cessary condition for the attainment of the reproctive phase. After vernalization, flowering may cur directly in response to long-day conditions in me grasses[1], or after initial treatment with short ys followed by transfer to long photoperiods in hers[2,3]. The precise requirements of timothy grass ve so far remained unknown, except that it flowers long days[4] and that spring sowings may lead to r formation in the same year[1]. In view of the ronomic importance of the plant, some clarification peared desirable.

Two similar experiments were conducted, one in 53, the other in 1954. In the first year, seed of *S*.48 nothy, after being vernalized according to the thod of Purvis and Gregory[5] for 8, 6, 4, 2 or weeks, was sown in soil on April 10. Immediately germination one-half of the seedlings in each atment was exposed to long-day conditions exnded to sixteen hours by artificial illumination, ile the other half passed through an initial phase four weeks in short days (eight hours). At the d of this period, both sets of plants were transnted into pots and placed in a latin square design t of doors under natural day-length conditions. In 54 the experiment was carried out in the same way, except that vernalization treatments of 16, 8, 4 or 0 weeks were given, after which the seed was sown on April 12.

Table 1. Days to Ear Emergence

| Weeks of ernalization | 1953* Long-day treatment from germination | 1953* Long-day treatment after 4 weeks of short days | |
|---|---|---|---|
| 0 | 93 5 | 97·9 | Approx. S.E. = ± 2 70 |
| 2 | 99·5 | 94 4 | |
| 4 | 96·1 | 90 0 | |
| 6 | 88·2 | 90·9 | |
| 8 | 91 8 | 93 5 | |
| | 1954 | | |
| 0 | 100·1 | 112 4 | Approx. S.E. = ± 4·12 |
| 4 | 99·8 | 90 6 | |
| 8 | 93·8 | 99·6 | |
| 16 | 97·8 | 99 4 | |

* Weeks converted to days

Table 2. Number of Ears produced per Plant

| Weeks of vernalization | 1953 Long-day treatment from germination | 1953 Long-day treatment after 4 weeks of short days | |
|---|---|---|---|
| 0 | 13·5 | 10·8 | Approx. S.E. = ± 1 49 |
| 2 | 13·5 | 10 3 | |
| 4 | 18·2 | 11 3 | |
| 6 | 15 2 | 12 9 | |
| 8 | 12·0 | 11·1 | |
| | 1954 | | |
| 0 | 13·9 | 14 1 | Approx. S.E. = ± 1 99 |
| 4 | 14 1 | 19 0 | |
| 8 | 11 9 | 10 9 | |
| 16 | 10 9 | 12 6 | |

Records of ear emergence on the main stem and the first three tillers were kept. The mean number of days to ear emergence on the main stem are given in Table 1.

In both years ears were produced under all treatments, including non-vernalization followed by long-day conditions from germination. Analyses of variance showed no significant differences with vernalization and day-length treatments in the time taken to ear emergence during 1953. In 1954, vernalization appeared to have had some influence, just significant at the 5 per cent level. The effect was, however, not consistent with increasing length of treatment and can scarcely be said to indicate a response to low temperature. No difference with day-length treatment was apparent. Similar relations held if leaf number was taken as a measure of time to ear emergence. Hanson and Sprague[6] have shown that the time taken to differentiation and ear emergence in timothy varies only slightly with temperature during an initial four weeks of short days, but depends mainly on temperature conditions during the long-day period.

During 1953 long-day treatment resulted in a significantly greater number of ears per plant being produced. This was an effect of increased tillering under these conditions, as shown by covariance of ears on number of tillers. Vernalization had no effect in 1953, but in the repeat experiment a significant difference ($p < 0{\cdot}05$) occurred, due apparently to an unusually high figure for one treatment. There was no indication that increasing exposure to low temperature or short-day conditions had led to greater ear production. Evidence that ear-bearing capacity of successive tillers is not entirely controlled by day-length will be presented elsewhere.

Since neither seed vernalization nor initial short-day treatments had any consistent effect, the conclusion seems warranted that timothy grass does not normally require low-temperature exposure or short-day induction for the production of inflorescences.

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## Charge acquired by Powdered Salts on moving over Metal Surfaces

One of the common principles of contact electrification is that considerable electrification accompanies the relative motion of two surfaces only if one or both of them has a low electrical conductivity. Dealing with the electrification which occurs when a powder or sand flows down an inclined earthed metal surface, Hudson[1] has shown, by an indirect method, that a typical insulator (zircon sand) acquires a much larger charge than a semiconductor (rutile sand). Hudson's findings were confirmed by measuring directly the charge acquired by these sands from various lengths of an earthed aluminium chute. Fig. 1 shows the results for sands of 114μ average particle size.

The attainment of a limiting charge by the rutile is attributed to the establishment of a balance between the charging action (the nature of which is still obscure[2]) and a recombination of the separated charge caused by leakage due to the conductivity of the rutile[3]. The absence of such leakage with insulator particles allows the extended accumulation of charge, as found with zircon sand. Similar behaviour was found when the electrification was tested of glass microspheres in various states of preparation with respect to adsorbed moisture. Dry microspheres (114μ average diameter) gave a pattern like curve *A*, normal ones a curve of intermediate shape, while microspheres having abnormal adsorbed moisture yielded a curve of the same shape as *B* (cf. Peterson[4] working with atmospheres of different humidities).

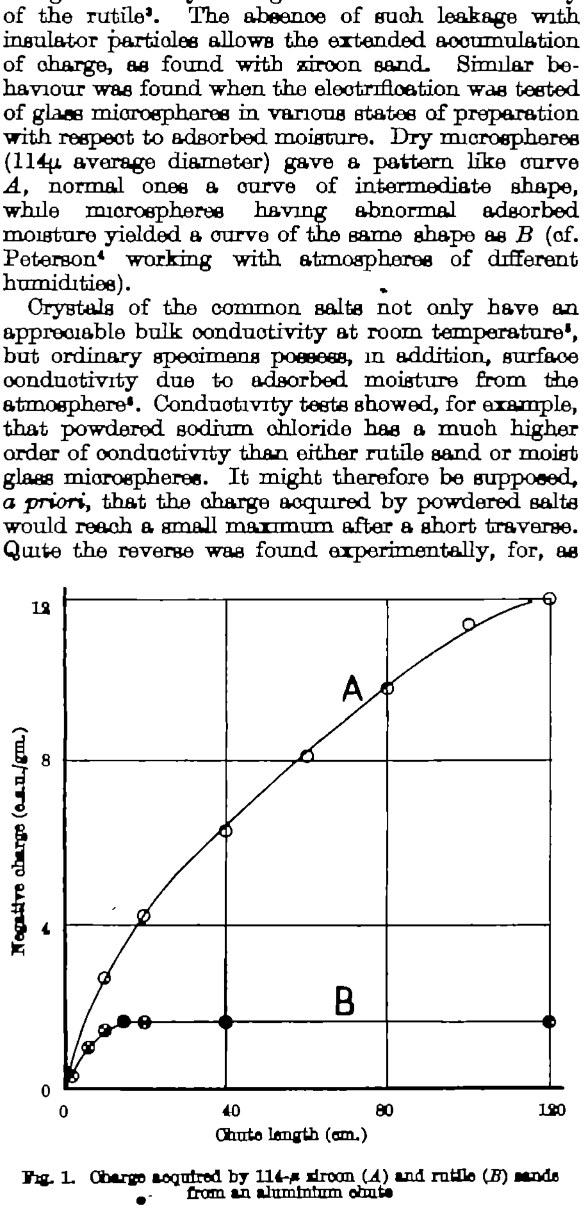

Fig. 1. Charge acquired by 114-μ zircon (*A*) and rutile (*B*) sands from an aluminium chute

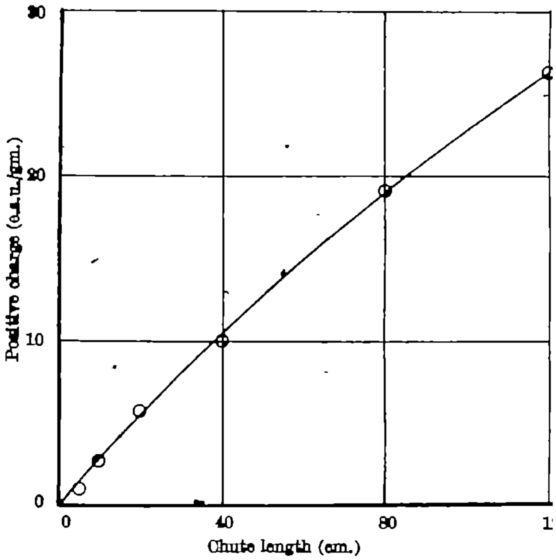

Fig. 2. Charge acquired by 211-μ sodium chloride particles from an aluminium chute

Crystals of the common salts not only have an appreciable bulk conductivity at room temperature[5], but ordinary specimens possess, in addition, surface conductivity due to adsorbed moisture from the atmosphere[6]. Conductivity tests showed, for example, that powdered sodium chloride has a much higher order of conductivity than either rutile sand or moist glass microspheres. It might therefore be supposed, *a priori*, that the charge acquired by powdered salts would reach a small maximum after a short traverse. Quite the reverse was found experimentally, for, as Fig. 2 shows, powdered sodium chloride (211μ ave age particle size) was electrified intensely by aluminium chute, and the accumulation of char with distance showed almost no sign of falling o despite the high conductivity of the salt. Other ion compounds gave similar results, both negative a positive electrification being found with differe compounds on various metal chutes. The effect removing the moisture film from powdered sodiu chloride (by evacuation for two hours) was to mal it acquire a much smaller charge from the aluminiu chute, namely, + 5·1 e.s.u. per gram from a 120-c traverse compared with + 26·4 acquired by the sa before evacuation.

The magnitude of the tribo-electric effect display by salts on metals shows it to be an importa electrokinetic phenomenon. The rule that hi conductivity leads to only slight electrification clearly disobeyed. Further experimental work, whi is being prepared for publication, suggests that th is due to ion transfer being the governing factor electrification, whereas the rule has been based o systems involving predominantly electron transfer.

I wish to thank Prof. M. B. Donald for his intere in, and encouragement of, this work, which w carried out at the Ramsay Laboratory, Universit College, London. The South African Council f Scientific and Industrial Research provided financi assistance, and Messrs. British Titan Products, Ltd gave the mineral sands used.

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## Thermal Expansion of Coal

HE physical properties of coal have not yet been uately studied. Consequently, proposed models oal structure cannot be tested nor apparently flicting experimental observations reconciled. We ocate that accurate measurement of such pro- ies of coal as the thermal expansion, electrical ductivity, and response to mechanical stress ld be made concurrently with chemical and sical researches which seek to elucidate the cture of the material in increasingly specific ns.

ccordingly, we have made preliminary measure- nts of the coefficient of thermal expansion of a ted range of British bright coals in a direction llel to the bedding plane and normal to the main t over the temperature range 77°–293° K.

hanges in the length of small coal lumps have n measured by a capacitance method which has n chosen as sufficiently accurate and convenient he first instance. The condenser assembly consists a fused quartz plate upon which rests a short nder of the same material bearing the upper con- ser plate, a circular copper disk 30 mm. in neter with three lugs. Resting upon the quartz e and within the cylinder is a disk of copper upon ch stand three like coal specimens supporting lower condenser plate. The whole assembly is tained within a vessel which can be evacuated chilled. The coal specimens are cut from bright ain in the form of tetrahedra 10 mm. high the es of which are parallel to the main cleat. We e not yet measured the coefficient of thermal ansion parallel to the main cleat or normal to bedding plane. The capacity change resulting n a change in the temperature of the coal specimens in these experiments been measured by a com- cial instrument in which the incremental capacity be caused to occupy the whole of the measuring le.

he measurements relate to dry coal, the specimens ing been exposed over magnesium perchlorate thirty-six hours before use and the vessel con- ing the complete electrode assembly maintained $0^{-1}$ mm. mercury for the twelve hours before the oduction of nitrogen (15 mm. mercury) in readi- s for initial measurement and chilling. The ervations made have included the change in linear ension on chilling from room temperature to K. and, using a series of refrigerants, during ming from that temperature to room tempera- .

ur results for four British bright coals, including mple of anthracite (sample *D*), are in Table 1. se supplement the few published values of which are aware, namely, $20{\cdot}78 \times 10^{-6}$ for anthracite[1] $42 \times 10^{-6}$ for a low-rank bituminous coal[2] bon content 82·6 per cent dry mineral-free s).

e 1. COEFFICIENT OF EXPANSION IN THE BEDDING PLANE OF BRIGHT COAL ($\times 10^{-6}$)

| Coal | *A* | *B* | *C* | *D* | |
|---|---|---|---|---|---|
| cbon, per cent dry, uneral-free basis | 82 | 87 | 90·5 | 94·5 | |
| mperature range (° K.): | | | | | |
| 293– 77 | 40 | 61 | 36 | 51 | 22 |
| 77– 90 | 35 | 53 | 42 | 54 | 12 |
| 90–217 | 43 | 40 | 47 | 23 | 8 |
| 217–273 | 42 | — | 31 | 49 | 36 |
| 273–293 | 35 | 49 | 59 | 31 | — |

The mean values for the full temperature range are probably accurate to $\pm 2 \times 10^{-6}$. The error in the values ascribed to intermediate temperature ranges may be somewhat larger. We are aware of imperfections in both the method and the apparatus. These we hope to reduce. Nevertheless, the values stated are sufficiently accurate to be useful.

The similarity between the observed values for the three bituminous coals (*A*, *B* and *C*) suggests that the differences in the arrangement of solid and space which are consequent upon the change in rank from low-rank non-caking to coking coal have been almost offset by changes in the properties of the solid. The wide range in the values obtained with two sets of anthracite specimens (*D*) reflects the anisotropy of the material.

We do not doubt that if such data had been available a few years ago the inappropriate over-simplification of such a model for coal as that of Bangham[3] would quickly have been apparent.

We hope to continue our measurements with increasing accuracy and completeness.

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## *F*-Centres in Metaphosphate Glass

A NUMBER of investigators[1] have shown that glass on exposure to radioactive and X-radiation becomes coloured. Sheline, Sharp and Arner[2] suggested that this may be due to *F*-centres similar to those produced in alkali halides when bombarded by X-rays and cathode rays. Yokota[3] found that *F*-centres could be created in fused silica and α-quartz by X-irradiation. He further showed that alkali silicate and borate glasses become coloured on X-irradiation due to formation of *F*-centres[4]. Przibram[5] showed that *F*-centres could also be created in borate glass by β- and γ-irradiation from radium.

I have found that *F*-centres can be produced very easily in metaphosphate glass by X-irradiation from a copper target (30 kV., 15 m.amp.). These metaphosphate glasses were prepared by heating sodium dihydrogen phosphate in a platinum tray at 900° C. for 1 hr. Variation in the composition of the glass could be introduced by heating mixtures of sodium dihydrogen phosphate and disodium hydrogen phosphate, and mixtures of sodium dihydrogen phosphate and ammonium dihydrogen phosphate. In the first case, sodium was in excess of the stoichiometric composition, while in the second case phosphate radical was in excess, ammonia disappearing during heating. Composition, however, could not be varied over a wide range, for metaphosphate glass with higher sodium content tended to crystallize out rather quickly.

Absorption spectra measurements were carried out with glass plates (0·8 mm. thick) in a Beckman spectrophotometer model *DU*. The irradiated glass system showed two peaks in the visible region at 510 mμ and 490 mμ respectively, and one in the ultra-violet region at 340 mμ. With increase in sodium concentration in the glass, the intensity of absorption in the visible region increased, with slight shift towards longer wave-length, but that in the ultra-violet region was more or less unchanged.

These facts indicate that the visible band is due to electrons trapped at negative ion vacancies, and the ultra-violet band is probably due to trapped holes at positive ion sites. Comparing the absorption spectrum of metaphosphate with those of borate and silicate glasses, it is noted that the positions of ultra-violet and visible region bands in all three glass systems are the same, suggesting some similarity in the trapping mechanism in all these cases.

Schulman[6] has shown that metaphosphate glasses in which aluminium, barium, silver, etc., have been dissolved can be used as dosimeters for γ-rays by their radio photoluminescence. This phenomenon can be explained as the production of *F*-centres, and Schulman attributed this to the activating influence of the added metal present in the glass. The present communication shows that *F*-centres can be produced very easily without these activators.

Thanks are due to Mr. S. Bhattacharyya for his help.

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## Effect of Chelating Agents on Heterogeneous Catalysis

Chalk and Smith[1] have recently reported that the autoxidation of *cyclo*hexene, catalysed by dissolved heavy metal soaps, is accelerated by chelating agents. It has been discovered in this laboratory that chelating agents may also increase the rate of autoxidation which is heterogeneously catalysed by metallic copper.

The rate of oxygen absorption by transformer oil was compared with that by transformer oil containing 0·25 weight per cent of chelating agent, both in the presence and absence of solid copper. The chelating agents used were α,α′-dipyridyl, disalicylal ethylenediamine, and 'Versenes' 123, 123*a* and 123*b* (the 'Versenes' are commercial, oil-soluble chelating agents and are reported to be amino-acetic acids substituted with long alkyl chains).

Oxidation tests were carried out by placing 10-ml. samples of the oil in Sligh flasks, filling the flasks with oxygen to a pressure of about 800 mm. mercury, and connecting each flask to a manometer. The course of the autoxidation was followed by measuring the decrease of pressure while the flask was kept at 120° C. The copper catalyst used consisted of 35 turns of No. 18 electrolytic copper wire wound on a 0·21-in. diameter mandrel. The transformer oil used was not entirely free from traces of heavy metals, since analysis revealed that it contained 0·1–0·2 p.p.m. of dissolved copper.

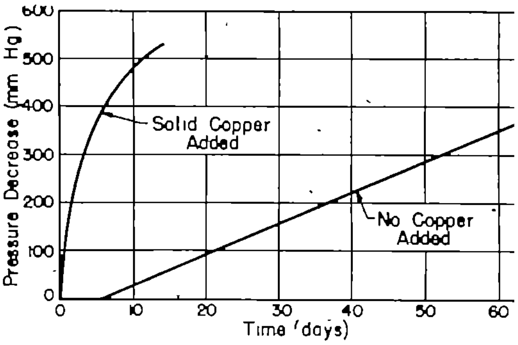

Fig. 1. Oxygen absorption of transformer oil

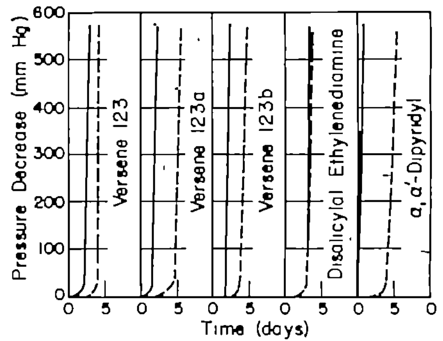

Fig. 2. Oxygen absorption of transformer oil with 0·25 per c chelating agent: ———, solid copper added; – – – –, no copp added

The results shown in Figs. 1 and 2 confirm the that chelating agents will accelerate homogene autoxidation and also show clearly, particularly the case of α,α′-dipyridyl, that they may accelerate the heterogeneously catalysed reactio

It will be noted that, for several chelating age the addition of the chelating agent to oil in con with solid copper results in an induction perio several days before rapid oxidation commen Thus, although these materials are powerful oxidants for heterogeneous catalysis, if observat are confined to the initial stages of the reaction, will appear to be antioxidants.

I am indebted to the Alrose Chemical Comp for a sample of disalicylal ethylenediamine an the Bersworth Chemical Company for sample their 'Versenes'.

ALAN DOBB

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April 18.

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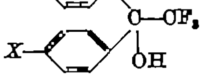
## A New Group of DDT Synergists

In a study of the influence of structural variat on the insecticidal activity of DDT, the di (trifluoromethyl)-carbinols



(*X*=H, F, Cl, Br, $OCH_3$, $OC_2H_5$, $CH_3$, ‘e been prepared by reaction between ethyl ıuoroacetate and the appropriate arylmagnesium mides ; the dinitro-derivative has been synthesized nitration of the diphenyl compound[1]. The in- icidal potency of the new compounds was practic- nil, only the *p*-dichloro-compound exhibiting a ht activity.

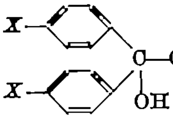
arvicidal tests were somewhat more satisfactory. these tests the contact toxicity for third-stage ræ of *Musca vicina* Marq.[2] was compared with t of γ-benzene hexachloride and di-(*p*-chloro- nyl)-methylcarbinol ; the percentage of normal æ and adults emerging from the larvæ was ermined (Table 1).

Table 1

| | Concentration (gm./sq. m.) | Normal pupæ (per cent) | Normal adults (per cent) |
|---|---|---|---|
| t-(*p*-chlorophenyl)-(tri- tuoromethyl)-carbinol | 1 0 | 56 | 6 |
| | 0·5 | 85 | 66 |
| t-(*p*-chlorophenyl)- nethylcarbinol | 1 0 | 90 | 52 |
| | 0 5 | 92 | 81 |
| Benzene hexachloride | 1 0 | 2 | 1 |
| | 0·5 | 3 | 2 |
| ntrol | — | 96 | 85 |

Table 2.

ERGISTIC ACTIVITY OF THE CARBINOLS



| Carbinol, *X* = | $\frac{\text{DDT}}{\text{Carbinol}} = 10:1$ | $\frac{\text{DDT}}{\text{Carbinol}} = 1:1$ |
|---|---|---|
| Cl | 15 | 25 |
| F | 10 | 16 |
| Br | 12 | 16 |
| $OCH_3$ | 5 | 12 |
| $NO_2$ | 4 | 10 |
| $OC_2H_5$ | 0 | 4 |
| $CH_3$ | 0 | 4 |

The above carbinols have, however, proved to be cellent synergists for DDT. Benzene solutions of T and the synergist were topically applied (micro- p method) to groups of twenty-five represent- ves of a laboratory strain of *Musca vicina* y slightly resistant to DDT (strain *A*) and of a ected strain (*B*), fourteen times more resistant than ain *A*. Mortalities were determined after 24 hr. e synergistic activities (a synergistic activity of *n* ans that it is possible to reduce the dosage of T to 1/*n* without decreasing the effect) observed strain *A* are shown in Table 2.

For strain *B* all these figures were approximately times higher. Comparison with some of the most ive synergists known[3] show that di-(*p*-chloro- enyl)-(trifluoromethyl)-carbinol is 2·5 times more ive than di-(*p*-chlorophenyl)-methylcarbinol, 2·0 es more than di-(*p*-chlorophenyl)-methyl chloride d 1·5 times more than 1,1-di-(*p*-chlorophenyl)- ane.

The close structural analogy between DDT and most potent synergists is noteworthy. Adopting theory of the mode of action of the insecticide ich has recently been proposed by Gunther *et al.*[4], e may assume that the synergists occupy pre- entially the site at which DDT is metabolized and reby inactivated. The synergists would thus event the inactivation reaction and appear to bear same relation to the insecticide as an anti- tabolite to the normal metabolite. Similar theories of ‘competition by displacement’ have been suggested for the phenomenon of synergism by Perry *et al.*[5], and by Speroni and co-workers[6].

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## Ester Groups in Lignin

THE main high-molecular phenolic constituent of woody plant tissues, lignin, is partly soluble in neutral organic solvents. The methanol-soluble fraction known as ‘native’ lignin generally shows an ultra-violet absorption spectrum with strong end-absorption and weakly resolved bands at 280 and 350 mμ[1].

The native lignin from sugar cane differs from other lignin in this respect, having a distinctive ultra-violet absorption spectrum (Fig. 1). This has been attributed to the presence of substituted *p*-hydroxyphenylketone groups[2]; but it has now been shown that these distinctive absorption bands are due to the presence of *p*-hydroxycinnamic ester groups. This is only the second time that ester groups have been reported in a lignin (cf. ref. 3).

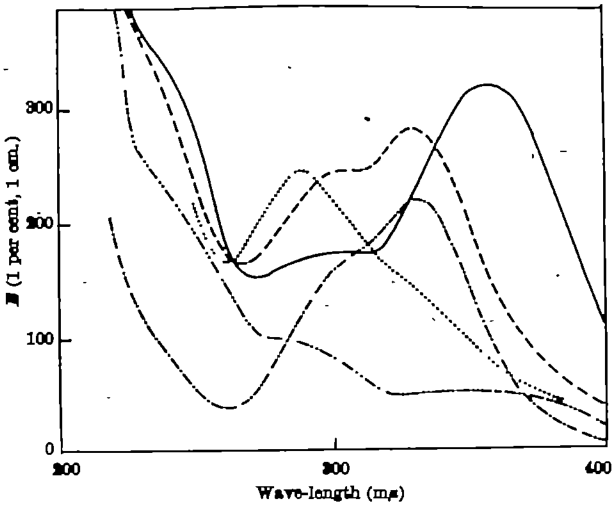

Fig. 1. Ultra-violet absorption spectra of fractions from sugar cane native lignin in aqueous sodium hydroxide

———, Lignin in 0·01 *N* sodium hydroxide ; - - - -, lignin in *N* sodium hydroxide after standing 4 hr. at room temperature (*A*) ; . . . . ., lignin in *N* sodium hydroxide after standing two days at room temperature ; –·–·–·–, material extracted from (*A*) at *p*H 4 by ether ; spectrum measured in *N* sodium hydroxide ; –··–··–··–, material not extracted from (*A*) at *p*H 4 by ether ; spectrum measured in *N* sodium hydroxide

Whereas in aqueous 0·01 *N* sodium hydroxide the absorption spectrum of sugar cane native lignin is unchanged for many hours, in *N* sodium hydroxide the absorption maximum at 355 mμ moves to 330 mμ over a period of about four hours, and a subsequent slower process results in replacement of the two maxima at 300 and 330 mμ by a single maximum at 290 mμ (Fig. 1). *p*-Hydroxycinnamic acid (33 mgm.) was isolated from a solution of lignin (300 mgm.) at the end of the first process of transformation in alkali, by acidification, extraction with ether and recrystallization from water. The acid was further purified by vacuum sublimation (melting point 211–212° decomp., undepressed on admixture with an authentic sample. Found: C, 66·3; H, 5·2; calc. for $C_9H_8O_3$: C, 65·9; H, 4·9 per cent).

The initial transformation of sugar cane native lignin in alkali is paralleled closely by the hydrolysis of methyl *p*-hydroxycinnamate (absorption maximum at 353 mμ in dilute alkali), suggesting that a similar ester linkage is present in the lignin. The later stage of transformation in alkali receives a partial explanation in that *p*-hydroxycinnamic acid decomposes in *N* sodium hydroxide to give a single absorption band at 290 mμ. Paper chromatography of the ether extract at the end of the initial stage of transformation showed the presence not only of *p*-hydroxycinnamic acid, but also of small amounts of *p*-hydroxybenzoic acid, vanillic acid, syringic acid and ferulic acid.

Native lignins from wheat straw, Douglas fir wood and horse chestnut wood were examined for comparison. Only with wheat lignin does the absorption spectrum show appreciable hydrolytic transformation in *N* sodium hydroxide, and paper chromatography of the ether extract showed the presence of *p*-hydroxycinnamic acid and ferulic acid, accompanied by traces of vanillic acid and syringic acid. Douglas fir lignin yielded traces of *p*-hydroxybenzoic acid and vanillic acid; horse chestnut lignin yielded traces of vanillic acid, *p*-hydroxycinnamic acid and ferulic acid.

The infra-red spectra of these lignins in the region 5·5–6·5μ provide additional evidence for the presence of ester groups in two of them. The absorption bands in this region are given in Table 1.

Table 1. Position of Infra-red Absorption Bands (cm.$^{-1}$)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Lignins* | | | | | | | | |
| Sugar cane | 1,695 | 1,662 | | 1,621 | | 1,597 | 1,585 | |
| Wheat straw | 1,697 | | 1,645 | | 1,612 | 1,599 | 1,587 | |
| Douglas fir | | 1,657 | | 1,624 | | | 1,589 | |
| Horse chestnut | | 1,660 | | | | 1,590 | 1,584 | |
| *Model substances* | | | | | | | | |
| Methyl *p*-hydroxycinnamate | 1,694 | | | 1,621 | | 1,598 | 1,581 | |
| Ferulic aldehyde | | 1,660 | | | 1,611 | 1,598 | 1,581 | |
| 3 : 4-Dimethoxycinnamaldehyde | | 1,661 | | | 1,611 | | 1,583 | 1,575 |
| Vanillin | | 1,670 | | | | | 1,586 | |
| Veratric aldehyde | | 1,667 | | | | | 1,588 | |
| Acetovanillone | | 1,657 | | | | 1,591 | 1,582 | |

The bands at 1,695 and 1,697 cm.$^{-1}$ in sugar cane lignin and wheat straw lignin can be allocated, by comparison with methyl *p*-hydroxycinnamate, to ester-carbonyl stretching vibrations. Likewise the bands at 1,657–1,662 cm.$^{-1}$ in the lignins are probably due to aldehyde or ketone stretching vibrations. These spectra were obtained with a single-beam spectrometer using 10 per cent and 7 per cent solutions of lignins and model substances respectively, in dioxan. A thickness of 0·01 mm. of solution used and the band of dioxan at 5·8μ was elimin by subtraction.

It appears from the nature and distribution ester residues in these cases that ester residues attached to pre-formed lignins, and so do not th light on the basic structure of these substances.

This work forms part of the programme of Food Investigation Organization of the Departm of Scientific and Industrial Research.

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March 23.

---

[*] Present address: Chemistry Department, University, M chester 13.

[1] Jones, H. J., Tech. Assoc. Papers, Tech. Assoc. Pulp and P Indust., 32, 311 (1949).

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## Colorimetric Determination of Micro Quantities of Calcium

The reaction of murexide (ammonium purpura with calcium ions to give the colour-change pur to red has long been known. It was recently stud spectrophotometrically in detail by Schwarzenb and Gysling[1]. As a result of this work, Oster and Rinck[2] proposed a method for the colorime determination of calcium. They chose to work pH 6·2, where the colour is very stable. We ha found, however, that if the determinations carried out at pH 11·0 (using potassium or sodi hydroxide), the colours are sufficiently stable ( appreciable change in 15 min.) to be readily termined, while the sensitivity of the method can increased at least fifty times. Thus, quantities calcium in the range (0–8) μgm./10 ml. can be read estimated. At pH 6·2 the method is quite insensit over this range.

The murexide solution was prepared fresh da and contained 20 mgm./l.

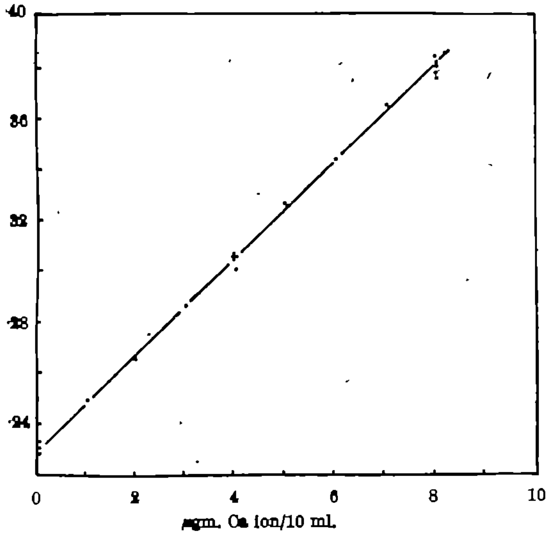
The red colour due to the calcium was determin against distilled water on a Hilger Spekker absorpt meter using the Ilford spectrum blue-green filter N 603 and 1-cm. cells. (At higher calcium concent tions, the loss in the blue colour of the murexide m be determined using the spectrum yellow filter N 606.)

A known volume of calcium solution was added 1 c.c. of 0·03 *N* potassium hydroxide and the soluti made up to 5 c.c. with distilled water. 5 c.c. murexide was added immediately before determini the colour.

Fig. 1 shows the linear relationship between t colour and concentration of calcium. This curve reproducible, and the colour-change over the ran (0–8) μgm. $Ca^{2+}$/10 ml. is quite considerable.

Ammonium, sodium, potassium, aluminium a manganese ions, when present in twenty-fold exc (on a molecular basis) over the calcium, do not sh any interference with the colour due to the calciu A similar result is obtained with barium ions in te fold excess.

There is considerable interference from copp zinc, cadmium, mercuric, silver and cobalt ions ev when present in comparable amounts to the calciu Under the latter conditions of concentratio



ig. 1. 1 ml. potassium hydroxide solution; *x* ml. solution of lcium; distilled water to 5 ml. plus 5 ml. murexide solution (20 mgm./l.). Final pH, 11·2

ontium and magnesium ions give a result which 10 per cent too high, while ferrous and ferric ions e a result 4–5 per cent too low.

The use of potassium cyanide (~ 1 gm./l.) in the assium hydroxide completely eliminated interence from copper, mercuric, silver, cobalt and lmium ions. The effects due to zinc, ferrous, ric, strontium and magnesium ions are largely affected.

We wish to thank the Directors of the County boratories, Ltd., for permission to publish this nmunication.

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hwarzenbach, G., and Gysling, H., *Helv. Chim. Acta*, 32, 1314 (1949).

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## Cellular Electrolytes and Adrenal Steroids

r has long been established that deficiency in enal cortical hormones can give rise to loss of racellular sodium, and that excess of these hornes leads to a retention of sodium and water by ue cells, with a loss of intracellular potassium.

The distribution of electrolytes between red cells l plasma in Addison's disease and Cushing's idrome has been investigated in this laboratory. three cases of Addison's disease the plasma sodium s lowered and the potassium raised; but in the cell these electrolytes remained unchanged. The ults of the red-cell analyses were not unexpected, ce the cellular electrolytes of adrenalectomized mals remain normal unless the animals are mainned on water only. In two cases of Cushing's idrome the plasma sodium was found to be normal l the potassium-level depressed; again, the red- content of both sodium and potassium was mal. It is highly probable that the rates of movent of sodium and potassium across the red-cell nbrane are significantly influenced by adrenal roids, and Streeten and Solomon[1] have demonstrated that corticotrophin (ACTH) or cortisone administered to patients caused a slowing of the rate of influx and efflux of potassium across the red-cell membrane, without leading to the anticipated net loss of cellular potassium. Furthermore, hydrocortisone *in vitro* produced a similar response.

To test whether the human erythrocyte was suitable for the investigation of hormone effects on electrolytes, the following *in vitro* experiment was carried out. Human blood was heparinized and cold-stored at 4°–6° C. for six days. During this period the red-cell sodium concentration doubled, the potassium fell and water increased. The cold-stored cells were next incubated for 3–5 hr. at 38° C. in a Krebs–Ringer bicarbonate buffer. Glucose was added to all samples, and deoxycorticosterone was used to test the influence of adrenal steroids on the active transport of sodium. In samples incubated with glucose alone, there was a considerable extrusion of sodium and water by the red cells. The effect of added deoxycorticosterone was significantly to inhibit this active transport. During the incubation period the red cells gained potassium, a gain which was not found in the presence of deoxycorticosterone. The results of a typical experiment are given in Table 1.

Table 1. EFFECTS OF DEOXYCORTICOSTERONE ON ACTIVE SODIUM TRANSPORT IN HUMAN RED CELLS

Incubation carried out at 38° C. in Krebs–Ringer bicarbonate, pH 7·4; gas phase 5 per cent carbon dioxide in oxygen. Glucose concentration 0·01 *M*. Time 3·0 hr.

| | Sodium (m.equiv./l. cells) | Net sodium change | Potassium (m.equiv./l. cells) | Water (gm./l. cells) |
|---|---|---|---|---|
| Cold-stored red cells | 46·0 | | 70·0 | 740 |
| Red cells incubated with glucose | 34·0 | 12·0 | 76·0 | 728 |
| Red cells with glucose and deoxycorticosterone | 41·0 | 5·0 | 70·0 | 734 |

The effect of deoxycorticosterone on cellular electrolytes was therefore to inhibit the active transport of sodium from the cells; it might, therefore, be expected to give rise *in vivo* to pathological retention of sodium and water. It has previously been found to have a similar action on yeasts[2] and on rat tissues by Schatzmann[3]. Cortisone has been found to be without influence on the sodium transport of human red cells (Maizels, personal communication).

It is generally believed that the active transport of ions in tissue is dependent on the energy metabolism of the cell, and there is some evidence to show that adrenal steroids influence the electrolyte distribution by means of their effect on energy metabolism. The observations reported above may facilitate the study of hormone activity, electrolyte distribution and energy metabolism in human cells.

The investigations recorded above are part of a research programme suggested by Sir Henry Cohen. The use of deoxycorticosterone was suggested by Dr. I. Chester Jones (Liverpool) and the drug kindly given by Ciba Laboratories. I wish to acknowledge discussions with Prof. H. A. Krebs and his colleagues, Prof. M. Maizels and Prof. C. H. Gray. Skilled technical assistance was given by Mrs. Anne Chambers.

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April 1.

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# FORTHCOMING EVENT

## Wednesday, August 10—Friday, August 12

Faraday Society (in the University Laboratory of Physiology, Parks Road, Oxford)—General Discussion on "The Physical Chemistry of Enzymes".

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Physicists (with a university degree or equivalent qualification in physics) at the Research Laboratories, Central Electricity Authority, Leatherhead, for duties which include research on problems associated with the generation and transmission of electricity—Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting AH/643 (August 10).

Lecturer (preferably with special qualifications in micro- and semi-micro- analytical techniques) in Chemistry—The Secretary, The University, Aberdeen (August 20).

Divisional Chief Scientist (fully qualified in one of the pure or applied sciences (chemistry, physics, chemical engineering or fuel technology), and good industrial or research experience)—National Coal Board, Secretariat (H), Cambrian Buildings, Mount Stuart Square, Cardiff (August 24).

Head of the Physics Department—The Principal, Derby Technical College, Normanton Road, Derby (August 29).

Assistant in Natural History—The Secretary, The University, Aberdeen (August 31).

Assistant Lecturer or Lecturer (with a degree or diploma in horticulture and experienced in ornamental horticulture and landscape gardening) in Horticulture, at Canterbury Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 31).

Demonstrator in the Department of Inorganic Chemistry—The Registrar, King's College, Newcastle-upon-Tyne (August 31).

Senior Lecturer in Anatomy—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (August 31).

Research Assistant (with a physics degree) in the Geophysics Section of the Geology Department—The Professor of Geophysics, Imperial College of Science and Technology, London, S.W.7 (September 1).

Lecturer (preferably with an interest in algae, especially marine algae) in the Department of Botany at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Cape Town, September 2).

Lecturer in Sociology—The Registrar, The University, Hull (September 3).

Assistant Lecturer in Metallurgy—The Registrar, The University, Manchester 13 (September 7).

Edward A. Deeds Senior Fellow for research in engineering, metallurgy, chemistry, physics, mathematical physics or any cognate subject—The Secretary, Deeds Fellowship Committee, Queen's College, Dundee (September 7).

Lecturer in Engineering—Joint Clerk to the University Court, Queen's College, Dundee (September 15).

Lecturer (with a good honours degree in metallurgy) in Metallurgy—The Registrar, College of Technology, Manchester 1 (September 15).

Lecturer (graduate in science or technology, and a good knowledge of the theory of structures) in Structural Engineering—The Registrar, College of Technology, Manchester 1 (September 19).

Reader in Soil Science—The Registrar, University Registry, Oxford (September 29).

Director of Adult Education at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 30).

Professor of Metallurgy at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 30).

Chair of Botany at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, October 15).

Assistant Lecturer (Grade A) in the Department of Applied Physics—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Demonstrator in Physics—The Registrar, The University, Nottingham.

Field Studies Instructor (with a degree in geography or a general science degree, and preferably some teaching experience) at Glenmore Lodge, Scottish Centre of Outdoor Training, Aviemore, Inverness-shire—The Secretary, Scottish Council of Physical Recreation, 4 Queensferry Street, Edinburgh 2.

Plant Breeder, Scientific Officer, Senior Scientific Officer or Principal Scientific Officer grade (with at least a second-class honours degree and experience in plant breeding), in the West African Maize Rust Research Unit, Nigeria, to carry out research into maize rust—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/376/01.

Scientific Officers (with a first- or second-class honours degree, or equivalent, in mathematics, physics or economics) with the Air Ministry, for operational research in or near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.384/54A.

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Building Confidence: the Story of British Guiana in 1954. 120+3 plates+4 maps. (London: Colonial Office (Press Sect 1955.)

Liberal Education in a Technical Age: a Survey of the Relation of Vocational and Non-Vocational Further Education and Trai (Published for the National Institute of Adult Education.) Pp. (London: Max Parrish and Co., Ltd., 1955. Distributed by Georg Harrap and Co., Ltd.) 6s. net.

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Smithsonian Institution. United States National Museum. Bull 205: List of North American Recent Mammals. By Gerrit S. Mi Jr., and Remington Kellogg. Pp. xii+954. (Washington, D Government Printing Office, 1955.) 3.50 dollars.

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*Journal of the Institution of Telecommunication Engineers*, Vol. No. 1 (March, 1955). Pp. ii+58+iv. (A quarterly journal.) Ann subscription Rs. 15. Single issues Rs. 5. (New Delhi: Institution Telecommunication Engineers, 1955.)

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# NUCLEAR POWER AND ITS UTILIZATION

CE President Eisenhower first made his proosals, less than two years ago, for an internal pool of atomic materials for peaceful ses, optimism as to the immediate future of r energy has steadily grown. Before the national Conference on the Peaceful Uses of ic Energy had opened at Geneva, Great Britain he United States had given practical effect to proposals for promoting internationally the uctive use of nuclear energy by making fissionmaterial available for use in nuclear research rs overseas and by offering to train foreign ists. On June 11 President Eisenhower, ing at Pennsylvania State University, indicated he proposed to extend this programme by asking ess to agree to meet half the costs of building ch reactors for free nations, including a supply e necessary nuclear fuel, and to provide, within ity considerations, information and experts to friendly nations in the construction of full-scale r stations.

ese proposals are of special interest to the underoped countries, for President Eisenhower exly contemplated support of the voluntary groupf the resources of several nations within a single n, in order to acquire and operate together a rch reactor which individually they lacked the ical or material resources to use effectively. have also undoubtedly contributed to the more ful climate of opinion in which the Geneva rence has met. Concerned essentially with the nge of technical information and opinion on a range of subjects from piles and power plants, e biological hazards of radioactive materials, the sal of wastes and the uses of radioactive rials in industry, in medicine and in agriculture, ccess or failure largely turns on the extent to n free discussion and exchange of views and mation are unhindered by questions of secrecy. dent Eisenhower's proposals in June gave raging evidence that this danger was remote the potential spread of knowledge was unlikely ll into operation the restrictive clauses of the ahon Act.

t until the Conference concludes can it well be how far a more realistic and reasonable view of cy in nuclear science and technology has come revail. The Anglo-American agreements on ar energy, published shortly after President hower's statement in June, were disappointing indicated that even between the United States Great Britain we had still a long way to go before ll exchange and cross-fertilization of ideas in ar research was possible, and the overlapping fort, particularly by scarce scientific man-power, ced to an inescapable and justifiable minimum. e will indeed be a greater exchange of information he effect of weapons on civil defence, on the ration of electric power, and on fissile materials; while it is still so difficult to separate the effort nded on nuclear research and development for peaceful purposes from that expended for military purposes, an agreement which provides for no co-ordination of fundamental research programmes and no exchange of information on the design and manufacture of nuclear weapons scarcely amounts to partnership.

Whether, in view of what the National Science Foundation has already reported as to the man-power situation, the United States can continue to afford the waste of man-power and technical resources thereby involved is their affair; but Great Britain at least can scarcely regard with indifference the loss of any opportunity of conserving her limited resources at a time when the demand upon them is still increasing. Since the publication in February of the White Paper outlining the Government's programme for the development of nuclear power in Great Britain, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, has announced that six more nuclear reactors are to be built in Cumberland. These reactors, Mr. Geoffrey Lloyd said in the debate on the Queen's Speech on June 13, are additional to those proposed in the £300 million programme announced in February. They will be designed to produce both electric power and fissile material for military purposes, and will be of the same kind as those now being constructed at Calder Hall. The Minister also said that four main industrial groups have now been formed to develop this industry. They include Associated Electrical Industries – John Thompson; the English Electric – Babcock and Wilcox; the General Electric Company – Simon Carves; and C. A. Parsons – Head Wrightson – A. E. Reyrolle, registered recently as the Nuclear Power Plant Co.; and Foster Wheeler, Ltd., is engaged in research on the cooling of nuclear power reactors and has facilities for the design, manufacture and erection of equipment for reactor cooling. It should also be noted that the Institutions of Civil, Mechanical, Electrical and Chemical Engineers, together with the Institute of Physics, early in June constituted the British Nuclear Energy Conference as a permanent body, under the chairmanship of Sir Charles Hinton, for organizing meetings, symposia, the publication of papers, etc. This development was welcomed by the Minister, who also referred to the success of the training courses for engineers arranged by the Atomic Energy Authority. The new design organizations staffed by engineers so trained, he said, are already at work, producing ideas of their own and still in close touch with engineers of the Atomic Energy Authority.

This stepping up of the Government's plans, Mr. Geoffrey Lloyd told the House of Commons in the debate on the National Coal Board on July 20, will enable nuclear energy to contribute substantially to power production as from 1960. In that debate the Minister indeed proposed to meet the coal shortage by substituting oil for coal on a large scale during the next five years; but he gave no sound basis for the assumption that even the present output of coal can be maintained. It might well be sounder to expand still further the programme for building nuclear stations. An expenditure of some £60 million on such stations would allow us to save about a quarter of the £80 million we are at present spending on the import of coal, apart from economies concerned with the production of plutonium and the possible reduction in capital investment in the railways, which carry most of the country's coal.

It is true that electrical engineers expressed the opinion at the British Electrical Power Convention that nuclear power is being developed faster than is technically desirable, and stressed the importance of examining means of getting adequate supplies of concentrated fissile materials for the advanced types of generating stations to be built in the later stages of the new nuclear programme. Despite the generous tributes paid to the work of the Atomic Energy Authority and the contracting firms associated with the developments, it was emphasized that the United States, in view of the different lines upon which production for military purposes is proceeding there, has a considerable potential advantage in the design and operation of the advanced types of nuclear generating plant contemplated in the British programme. Sir Claude Gibb in particular stressed this potential advantage possessed by electrical engineers in the United States, and it is clear that the Anglo-American agreements as well as the present international conference offer considerable advantages to Britain.

None the less, Britain's own contributions are important, though it is well to remember that, as Prof. W. R. Hawthorne remarked in an article in the *Westminster Bank Review* last May, we are not in such a stagnant period of scientific invention in respect of the older sources of power that we need inevitably depend on nuclear energy alone. In fact, nuclear energy is unlikely to ease the fuel position much in Britain in the next fifteen years, although the nuclear power programme offers savings of about five or six million tons of coal per annum by 1965. Sir Francis Simon, in an article in *Lloyds Bank Review* of April, regards the White Paper as a little too optimistic; he assumes that after a development period of fifteen to twenty years nuclear electricity will cost about the same as electricity from coal. To build up a nuclear power system equal to our present generating capacity will involve expenditure of about £3,000 million, and in view of other capital commitments such a system is unlikely to be complete in less than twenty to twenty-five years.

Sir Francis Simon thus thinks it will be about the middle of the next century before we can count on nuclear fission meeting most of the power requirements of Britain. Although he regards the use of nuclear power to drive large power stations of the same magnitude as those burning the conventional fuels as the first main application of nuclear energy—and stresses throughout this development the importance of saving coal by using it more efficiently—he points out that nuclear energy makes possible the provision of large or medium-sized power stations in out-of-the-way places, to which the transport of conventional fuels is either impossible or prohibitively expensive. This was also stressed by Dr. J. Bronowski in an article in the special ninetieth anniver issue, entitled "Atoms for Peace", of the York periodical, *The Nation*, dated June 18. Bronowski, in fact, regards the ability of the nu pile to offer concentrated power precisely w it is wanted in regions remote from either or water-power as the most important applica of nuclear energy in large and thinly popul regions, like South Africa, which are rich in mine In the same journal, Prof. M. L. Oliphant makes n the same point in respect of the tropical and zones of Australia; but Sir Francis Simon goe to show how important this possibility is to Bri Under-developed centres are often under-devel because they have no power available, and he ar that the export of nuclear power stations is an i example of the kind of export on which Britain have to depend increasingly. We are only at very beginning of such developments. No nu power station has yet run under realistic conditi Commercial generating stations based on the C Hall experiment may be begun by about 1957 commence to operate in 1961; but although Dounray power station is to be of the fast-bre type, it is not anticipated that a commercial sta of this design can be tested in operation before 1 Many stations working on different principles have to be built and tested before we know whi the most reliable and economic, and while i national co-operation can facilitate the intercha of ideas between the best scientists and technolo in different countries, few countries can muster necessary scientific and industrial resources to at successfully such problems of development.

Sir Francis Simon considers that, for the time be only the United States, Great Britain and the So Union can be considered as serious competi for the nuclear export market to under-devel countries, where the negligible weight of nuclear offers possibilities in remote areas to which trans of coal or oil would be prohibitively expensive. urges that there are strong incentives, politica well as economic, for getting a hold on this ex market, but he stresses particularly the econ factor. The export of nuclear power station particularly suited to Great Britain. Apart from British genius for science and technology which already contributed to the present developme Britain's economy is large enough to permit deve ments on the necessary scale. Even an increas the power consumption of the non-industrial countries to one-third of that of the present Br consumption per head of population would re power stations worth twenty to thirty thou million pounds, while in the long run the fiel practically without limits.

Nor is this ideal and almost unlimited field British enterprise the only possibility to be sidered. Sir Francis does not answer the ques whether the coming of nuclear power heralds a industrial revolution, other than to suggest tha the middle of next century the world will prob derive most of its energy from nuclear sources, that for the under-developed countries nuclear p will usher in a new era by enabling industry t blished in places deprived of the conventional s. None the less, a resolution adopted by the eign Ministers of the Federal German Republic, gium, France, Italy, Luxembourg and The Netherls at their meeting at Messina on June 1 and 2 mes that the development of nuclear energy for eful purposes holds a prospect in the near future new industrial revolution out of all proportion that which has taken place during the past dred years. The six signatory States consider rdingly that it is necessary to study the creation common organization to be entrusted with the onsibility and the means for ensuring the peaceful elopment of nuclear energy, while taking into unt the special arrangements made by certain ernments with third countries.

he means contemplated comprise the establisht of a common fund to provide for research and elopment; free access to raw materials and free hange of techniques and technicians, by-products specialized equipment; the pooling of results; financial assistance in exploitation and coration with other countries. It seems clear from Prime Minister's remarks, quoted by Sir Francis on, that the British Government is fully alive to scope and potentialities of this entirely new ort trade throughout the Commonwealth and pire, and the possibilities of raising living dards in wide areas through nuclear power. ertheless, although he claimed that within two s the first power stations producing electricity ld be working in this field, and that already y British firms are exploring markets overseas their new products in this field, the reception n to the Messina resolution suggests that the ortunities in Europe are being overlooked.

he Messina resolution may, of course, prove to be of good intention rather than firm resolve; but ffers something more than the European Organion for Nuclear Research which Britain is already porting, and there are several reasons for anticing prompt and fruitful action. The position of many of itself supplies a practical incentive for peration and integrated effort in Western Europe. hough Dr. Adenauer has disclaimed any intention xploiting the military uses of nuclear energy or naking nuclear weapons, it is not to be expected Western Germany, with its record in scientific arch and development, will play no part in this field of human endeavour now being opened up. y by an integrated scheme in which all share the k, use the results and are aware of what is being e, can Germany participate without arousing the s and jealousies of her neighbours.

should also be remembered that in a new field nuclear energy, there are no established interests hinder development and demand reconciliation adjustment. Great Britain, moreover, has a ial interest in bringing about a Western European lear organization. The division of labour alone, time when on all sides we learn of the limitations h the shortage of scientific and technical skill es on the development of nuclear power, is itself fficient reason for Britain participating as actively a communal European programme as in the European Organization for Nuclear Research at Geneva. There are also the sharing of benefits in development, the diffusion of prosperity in building up a gigantic new industry. The tributes paid by Sir Francis Simon and others to the great ability, enterprise and vision of the team which Britain possesses in the Atomic Energy Authority all reinforce the suggestion that the British Government would be wise to take the initiative and offer active assistance from the start in bringing such a nuclear community into existence.

The nature and degree of British participation and assistance are open to consideration and for definition in advance. They may well fall short of full participation, while providing the leadership and initiative that British technical achievements warrant; and the commitments must be carefully weighed, particularly in respect of the demand which they will make for trained scientific and technical man-power.

That demand requires evaluation with imagination and realism, keeping in mind the competitive demands for man-power made by other aspects of Britain's economy—including fuel, as Prof. Hawthorne indicated—and also considerations of economics and prestige. A bold grasp of the export opportunities for Britain in the field of nuclear energy would seem imperative. In regard to man-power, the uniformity with which the limitations due to shortage of skilled personnel has been reiterated is impressive. In his statement on June 13 in the debate on the Queen's Speech, Mr. Geoffrey Lloyd was emphatic that such limitations, rather than financial considerations, determine the pace at which the Government is expanding its programme, and on July 20 he said explicitly that progress depends upon the mental outlook of the scientists, engineers and designers with the necessary skill in this special sphere, who are numbered in hundreds rather than in the thousands required. This admission was taken up by Mr. Austen Albu in opening an adjournment debate in the House of Commons on scientific and technical man-power during the following day; but the same point was stressed both by Prof. Hawthorne and Sir Francis Simon. Prof. Hawthorne, while emphasizing the need for more technologists, gave a specific warning against sending too many able young engineers to Harwell for training in nuclear engineering lest the technological man-power available for other new developments be decreased excessively, although he admitted that advances in one branch of engineering stimulate advances in all the others.

Sir Francis Simon is no less emphatic as to the great need to increase the supply of men who are able to practise science and technology, either for the development of nuclear energy or any other form of energy. The key role in all these developments falls to scientists and technologists, and Sir Francis in his article in *Lloyds Bank Review* stresses particularly the importance of building up a sufficiently strong and balanced community of scientists and technologists. It is not enough for sufficient support to be provided for research in nuclear physics. Other fields of physics, chemistry and the engineering sciences are all equally important in the development of nuclear power; and quite apart from the importance of other fields of technology to Britain's economy, the development of nuclear power is itself affected by our failure to provide adequately for road and rail transport development and to deal with the scientific and technical man-power situation with vision and imagination as well as with energy and adequate finance.

If the great opportunities which the development of nuclear power offers to Britain are to be used effectively, more will be required than what Mr. Lloyd described on June 13 as a 'shop window' at the Geneva Conference. The Government must give a positive lead, and make sure that, although the country is not in a position to offer nuclear fuel to the under-developed countries in the way that the United States can, the world is left in no doubt as to the value of the contribution in plant and technique which Britain can offer. Moreover, the absence of any such restricting legislation as the McMahon Act makes it easier for us to share our knowledge and experience than for the United States; and neither Europe nor the countries in the Colombo Plan should be left unaware of the benefits which Britain can bring them, or her advantage over the United States in this respect.

In all this, something of prestige is at stake, but much more also. For Britain to take full advantage of the possibilities for her economic future which nuclear energy offers, the Government must support the Atomic Energy Authority with a well-thought-out and comprehensive policy; it must be fully alive to what is involved in the way of educational policy and balanced scientific and technological development. It means tackling the problem of science teachers with energy and imagination. It means a programme for the expansion of technological and technical education, and keeping that expansion in balance with the expansion of university education. It means also close attention to secondary education, so that the supply of school leavers of the appropriate and broad education is to be forthcoming. It means attention to the nation's resources in scientific and technical research, and seeing that the development of natural resources as well as those of the public services is kept in balance.

Something of the challenge of the situation is to be glimpsed in Sir Francis Simon's article. Already Britain possesses in the Advisory Council on Scientific Policy and in other bodies much of the organization required. Some changes, however, may well be required, for example, in the responsibilities for university and technological and technical education, as between the Minister of Education, the Lord President of the Council and the University Grants Committee; and if the opportunities are to be used, there is much work to be done by the voluntary bodies. It can at least be hoped that the International Conference on the Peaceful Uses of Nuclear Energy will bring home to professional bodies generally the great opportunities which such developments hold for Britain's economic future, and that they will neglect no opportunity of securing the energetic and imaginative action which the prospect demands.

# MAGNETODYNAMIC COSMOGONY

## On the Origin of the Solar System

By Prof. H. Alfvén. (The International Series
Monographs on Physics.) Pp. vi+194. (Oxfo
Clarendon Press; London: Oxford University Pr
1954.) 30s. net.

THE author is presenting here a new theory
the establishment and evolution of the sc
system. He is well known for his contributions
electro- and magneto-dynamics, and he makes su
processes play a major part here, too. The book
a very valuable source of suggestions of subtle p
cesses that may be of relevance to this and ot
problems; and it serves to remind that a wide ra
of complicated electromagnetic effects may have
be understood for the solution of many astronomi
problems. If the discussion is uncertain and spe
lative for including such effects, others are
leaving them out. No criticism should attach to th

But if the work is to be regarded as a compl
theory of the derivation of the solar system, and t
is clearly what the author intends, then each one
the chain of processes or events would have to
shown to have at least a high degree of plausibili
This has not been accomplished. A major link in t
chain concerns the separation by diffusion of t
different constituents of a gas cloud. It is suggest
that a large cloud ($10^{17}$ cm.) is suspended agai
solar gravity by a magnetic field, and a very stro
dipole moment of the early Sun is assumed. T
gravitational force would then act on the no
ionized constituent, and this would diffuse inwa
relative to the ionized component which would
magnetically held. Late in the book there is a br
mention of the importance of the linkage of the li
of force, stating that the lines of force necessary
support the gas against gravity must not link t
cloud and the Sun. Indeed, this is a vital point,
a field of solar origin must inevitably link the Su
it cannot then support the cloud but only sligh
delay its infall by re-routing the material alo
longer paths. But the diffusive separation requi
some $10^8$ years and therefore a high stability of t
configuration. It is hard to see why the solar fi
was introduced in that discussion. An alternati
support is briefly mentioned; this is a magnetic fi
of interstellar clouds of gas. Such a field will not li
the Sun, and could, if of adequate strength, give t
desired support. But it can do so only if its lines
force are effectively anchored in gas far away a
unaffected by the solar gravitation. But by linki
the gas to interstellar material one is even furth
from any possibility of extreme stability with
motion of less than $10^{17}$ cm. in $10^8$ years. The avera
velocities between stars and gas clouds are $10^4$
$10^5$ times as high. Not only is the requirement n
obtained in this way, but indeed it is hard to see h
an extended gaseous mass surrounding the Sun co
resist the interstellar streams, even if it is not ma
netically connected to them.

There are other links in the chain of processes th
one would like to see more fully discussed. T
mechanism of transfer of angular momentum to
disk surrounding the Sun has long featured as
central problem in the subject; it may be that
magnetic interaction with the Sun is responsible, b
the process will have to be understood, and the lin
of its effectiveness evaluated.

THOMAS GOLD

# THE STATISTICS OF CHANGE

Introduction to Stochastic Processes, with Special Reference to Methods and Applications
Prof. M. S. Bartlett. Pp. xiv+312. (Cambridge: the University Press, 1955.) 35s. net.

HE theory of stochastic processes is the mathematics of systems which change in accordance h probability laws. There are many applications for example, to the study of epidemics, cosmic ray wers, irregularities in textile processing, queueing d storage problems, the growth and mutation of terial populations, and communication theory. of. M. S. Bartlett has made distinguished con- butions to many branches of the theory, and now has produced this masterly introduction to the ole field. He writes as a statistician and applied thematician and is therefore thoroughly justified avoiding detailed discussion of various matters, uch, while of considerable mathematical interest, n easily divert attention from the aspects of most portance in applications. The result is that he has en able to cover concisely a remarkable range of thods and problems and that, while the book is ghly mathematical, the mathematics is always ected towards obtaining a working answer to the blems under discussion. The pure mathematical pects of stochastic processes have been dealt with a recent book by J. L. Doob ; the point of view the two books is entirely different, and Prof. rtlett's is the only one at present available for the re applied worker in this field.

After a preliminary chapter devoted to basic finitions and to recalling some results in prob- ility theory, there is a chapter on random walks d Markov chains occurring in 'discrete time' ; one the applications described is to the statistical chanics of nearest-neighbour systems. There is xt a chapter on the corresponding processes in tinuous time. Particularly noteworthy here is discussion of passage and recurrence time prob- ns, based on an elegant symbolism for determining Laplace transforms, or probability generating ctions, of the distributions of the times taken for cified types of transition to occur. This section the book is completed by a long chapter on mis- laneous applications. The topics discussed here lude population growth and epidemic models.

The next group of chapters deals with stationary cesses, that is, systems which are in statistical ilibrium. After a preliminary chapter, there is an count of the spectral function and of the generalized monic analysis of stationary processes. This is lowed by a discussion of recurrence times and, ong other things, a brief account of applications the theory of turbulence. The third chapter of this up deals with prediction and communication theory. The final two chapters discuss problems of tistical inference connected with stochastic pro- ses, the last chapter being about the correlation d spectral analysis of stationary time-series. This thers together in a valuable way recent work on s subject. The emphasis is on situations where the ject of the statistical analysis is to examine the ucture of the observed process. It would have en interesting to have had also some discussion of er applications, for example, to problems of npling, where the precise structure of the process not the point at issue. It might also have been pful to have had some mention of processes which, while stationary, show appreciably greater long-term fluctuations than processes usually considered in the theory. An example is when the spectral density behaves like $\omega^{-\alpha}$, $0 < \alpha < 1$ as $\omega$ tends to zero. This seems to happen in some applications, for example, in certain textile problems where there are sources of random irregularities with very long wave-lengths.

The presentation is open to minor criticism. In detail the writing, though clear, is very concise, and the book is not easy reading. Some familiarity seems desirable with the elementary parts of the subject (such as those given in the book by W. Feller); results for simple processes are almost always obtained as special cases of general formulæ, rather than used for preliminary illustration of the ideas involved, as would, perhaps, have been advisable in an introductory work. Also, the assumptions for special applications are occasionally set out only in symbolic form. This will cause no difficulty to anyone reading the book systematically, but is hard on the reader who wishes just to find out what is assumed in the discussion of some particular application of interest. However, the book is a characteristically original, impressive and important contribution to the subject, and deserves to be widely read.

D. R. Cox

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# MEASUREMENT AND AUTOMATIC CONTROL

Instrument Engineering
(McGraw-Hill Publications in Aeronautical Science.) By Charles Stark Draper, Prof. Walter McKay and Prof. Sidney Lees. Vol. 1: Methods for Describing the Situations of Instrument Engineering. Pp. xvi+269; 51s. Vol. 2: Methods for Associating Mathematical Solutions with Common Forms. Pp. xxviii+827; 120s.
(London: McGraw-Hill Publishing Company, Ltd., 1952, 1953.)

THESE volumes are out of the ordinary, both in magnitude and in presentation of the subject-matter. They are the first two of three volumes—the third is not yet available—which combine the functions of introductory text-book and comprehensive reference book of mathematical techniques relating to "the art and science by which the properties of matter and the laws of nature are made useful to man in the observation and control of physical processes".

The authors are members of the Aeronautical Engineering Department of the Massachusetts Institute of Technology, and these books are the outcome of twenty years experience in research and postgraduate teaching in the field of aircraft instrumentation and control. This background has largely influenced the presentation of the subject-matter, and made possible the accumulation of the very large number of most useful results of mathematical analysis which are now made more widely available.

The need to find a common language and symbolism for mathematicians, physicists and a diversity of engineers—aeronautical, electrical and mechanical—in a field to which all have combined to contribute has led the authors to devise an elaborate, but most carefully defined, nomenclature and symbolism, which are used throughout the volumes. This leads, however, to such distressingly cumbersome statements as: ". . . it appears that, from the standpoint of physical fact, the ***ith to kth actuating input function product–reference input function product performance function ratio function*** reduces to the ratio of the reference input function product to the ith to kth input function product" (Vol. 1, p. 134). Even the corresponding mathematical statement is little shorter, because of the use of "self-defining symbols" in the statement of general relations. A simple example is sufficient to indicate their form and use: the standard deviation of $x$ is given by $(SD)x \equiv (\boldsymbol{RMS})\,[(D)\,x]$, in which $(D)x \equiv x - (Av)x$ (Vol. 1, p. 148). The authors, of course, accept the use of "working variable symbols" in deriving results, but consider that all results other than those derived for purely educational purposes should be formulated finally in terms of "self-defining symbols" (Vol. 1, p. 109), and they conform rigidly to this practice.

When the reader has overcome the initial difficulties of interpretation—the difficulties of translation even from American to English terminology (for example, fitting constant (FC) ≡ constant of integration) give one especial sympathy for the non-English-speaking reader—there are available in these volumes a most thorough exposition of a rigorously systematized way of analysing physical systems mathematically (Vol. 1), and analytical, graphical and numerical methods for deriving the solutions of the resulting differential equations, with—perhaps the most valuable feature of the work to the British engineer—nearly two hundred clearly reproduced large-scale graphs presenting data concerning every aspect of these solutions (Vol. 2). There are, also, in Vol. 1 useful introductions to dimensional analysis and statistical methods, and in Vol. 2 a chapter on the analysis of second-order discontinuous systems, having "non-linear terms of the rate-determined step type", due, for example, to the effect of Coulomb friction or of relay-operated controlling devices.

To sum up, these volumes are most welcome publications, in making generally available the very thorough exposition and useful graphs which have previously only been available locally. Because of the language and notation it seems unlikely that they will be considered suitable for teaching purposes on the eastern side of the Atlantic, but as reference books they are likely to prove of lasting value and should be available in every library of books on instrumentation and control engineering.

G. D. S. MacLellan

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# MAMMALIAN BIOCHEMISTRY

## Principles of Biochemistry

By Prof. Abraham White, Prof. Philip Handler, Prof. Emil L. Smith and Dr. DeWitt Stetten. Pp. xiii + 1117. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 112*s.* 6*d.*

THIS book is described on the dust-cover as "an integrated presentation of fundamentals". It might at first sight be doubted whether, with four authors at work, much integration could be achieved; but in fact they have succeeded so well that it is worth mentioning how they went about writing the book. The first draft of each chapter was assigned to one of the four authors and, when completed, was criticized by the other three. They met regularly for such discussions for several days at a time, and in some instances a chapter written by one of them was rewritten by another. In the end, each author had contributed to each chapter. As a result, this book shows none of the overlapping or lack of c tinuity of style or matter which is so often found a book by several authors.

The subject is treated in seven sections which d in turn with the chemical composition of the ce the enzymes, intermediary metabolism, the bo fluids, specialized tissues, the hormones and nutriti Intermediary metabolism is introduced by a valua chapter on the general methods used in investigat metabolism—experiments on whole animals, isolated organs and on tissue preparations, the stu of patients with inborn errors of metabolism, the of isotopes as tracers, and so on. The last secti nutrition, is at first sight surprisingly brief for a bo of this size; but clearly so many topics bear on nutrition have already been covered earlier the book—vitamin A under the lipids and under biochemistry of the eye, various members of vitamin B complex under individual coenzymes, so on—that there is correspondingly less remain to be dealt with in the nutrition section. All same, a chapter of one and a half pages on chemi elements in nutrition does seem almost ludicrou short. This tendency towards the curtailing of top considered under nutrition will presumably conti as more and more becomes known of the prec biochemical function of the vitamins. In books theoretical biochemistry, the vitamins will tend be dealt with separately in connexion with metabolic reactions which they influence rather th as a heterogeneous group of organic compounds wh the body needs but cannot make. But the vitam are closely linked by the early history of their covery and investigation, and it will be a great p if in the text-books this history gets lost sight of a mass of details of chemical reactions and spec catalysts.

The style of writing throughout the book scholarly and clear, and it is evident that the auth are writing from a wide experience of teaching. T book is well produced, with the structural formu and chemical equations admirably set out. There occasional slips or misprints (for example, in structural formulæ of the nucleosides and nucleoti on pp. 186–188, where the groups attached to sugar rings should all be inverted), but these are and far between. The book relies largely for figures on reproductions from published work, on the whole these have not been adequat assimilated into the text. For explanation of figures the reader is almost entirely dependent the smaller-print legends; these are sometimes almost telegraphic brevity, and it would have m for easier reading if there had been a little m comment on the figures in the main part of the te

While the book is mainly on mammalian b chemistry, it deals to some extent with comparat biochemistry, and there are frequent references the biochemistry of micro-organisms and plants. example, the chapter on carbohydrate metabol begins, very reasonably, with an outline of the p cesses of photosynthesis. The references at the e of the chapters, many of them to books and rev articles, are well chosen, up to date and by no me confined to American publications. For und graduate medical students, in any event in Brit this book will probably be considered too large too costly. For science students and for those enga in teaching and research, it will be welcomed a stimulating and a well-written text-book.

D. C. Harriso

# CURARE ALKALOIDS*

By Prof. P. KARRER, For.Mem.R.S.
Chemical Institute, University of Zurich

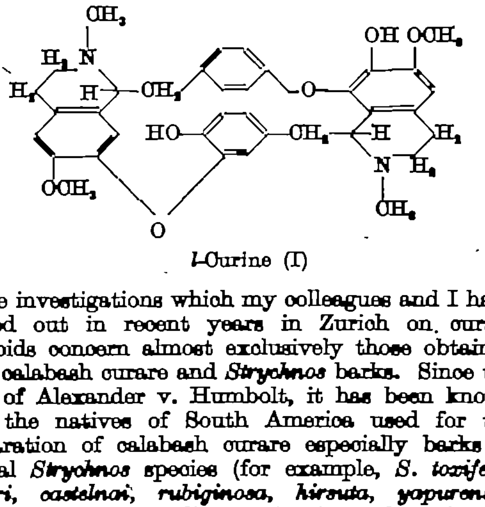
ARROW poisons have been known for centuries and have been used in certain regions of Africa, Asia, South America and also Europe. The African and Asiatic poisons are almost exclusively of a glucoside nature. In certain Asiatic countries the commonest and most important arrow poison is made from the latex of *Antiaris toxifera*, a member of the Moraceae, which contains the glucosides α- and β-antiarine; in Africa it is very often made from one of the Apocynaceae, *Acokanthera*, the toxic principle of which is the glucoside ouabain. In Europe, from prehistoric times until about the fifteenth century, it is possible that extracts of species of aconite, *Veratrum album*, snake poisons, etc., were used as arrow poisons. The toxic principle of the South American arrow poisons is alkaloids; this poison is called curare and its alkaloids curare alkaloids.

Three different kinds of South American curare are known: pot-curare, tubocurare and calabash curare. They not only differ in their containers (unglazed clay pots, bamboo tubes and calabashes or gourds), but also in the nature of their active principles and in their toxicity. The calabash curare is by far the most toxic, and therefore the most desirable one but also the most difficult one to obtain.

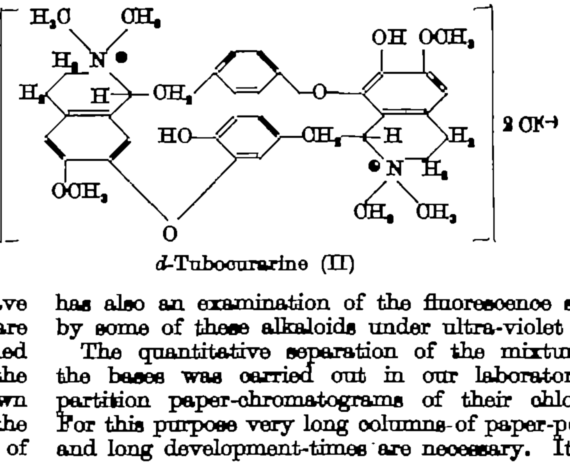
Wintersteiner introduced *d*-tubocurarine in medicine and it is still the only natural curare alkaloid used for clinical purposes. Its commercial name is 'Intocostrine'. The activity and toxicity of *d*-tubocurarine appear to be low compared with those of certain calabash alkaloids.

The most important and most active South American arrow poison, the calabash curare, has for the frog a toxicity of 0·5–1 mgm. per kgm. The first chemical work on this arrow poison dates back to the pharmacologist Böhm. However, it was not until 1937–41 that H. Wieland and his co-workers were able to isolate for the first time some pure alkaloids in a crystalline form.

The calabash curare usually contains a very great number of different alkaloids. In a sample originating from the Rio Negro region, we were able to demonstrate by paper chromatograms the occurrence of more than thirty different bases. For distinguishing the different spots on the paper chromatograms, we have used the colour reactions with ceric sulphate, which gives with the different alkaloids, red, blue, yellow, green, purple or yellowish-green colours. Furthermore, colour tests with cinnamic aldehyde, nitric acid and sulphuric acid have been made, as has also an examination of the fluorescence shown by some of these alkaloids under ultra-violet light.



*l*-Curine (I)



*d*-Tubocurarine (II)

The investigations which my colleagues and I have carried out in recent years in Zurich on curare alkaloids concern almost exclusively those obtained from calabash curare and *Strychnos* barks. Since the time of Alexander v. Humbolt, it has been known that the natives of South America used for the preparation of calabash curare especially barks of several *Strychnos* species (for example, *S. toxifera*, *jubleri*, *castelnai*, *rubiginosa*, *hirsuta*, *yapurensis*, *triplinervia*, *curare baillon*, etc.). A number of other plants, which are admixed when curare is prepared (*Cocculus* species, Menispermaceae, Araceae, Euphorbiaceae), seem to contribute nothing or very little to the toxicity of the poison.

From tubocurare and pot-curare some di-*iso*quinoline-alkaloids have been isolated which have the character of di-tertiary bases or di-quaternary salts. Examples are *l*-curine (= *l*-bebeerine) and *d*-tubocurarine; the first has the character of a tertiary base, the latter is a di-quaternary di-*iso*quinolinium-salt. For the preparation of tubocurare, and pot-curare probably especially, *Chondrodendrum* species are used, in the barks of which in some cases the same alkaloids occur as those found in the above-mentioned kinds of curare.

The quantitative separation of the mixtures of the bases was carried out in our laboratory by partition paper-chromatograms of their chlorides. For this purpose very long columns of paper-powder and long development-times are necessary. It took more than a year to separate twenty-three alkaloids of the above-mentioned mixture in pure crystalline form. The chemical composition of these substances is very similar, as can be seen from the following formulæ:

| | | $R_c$* | | | $R_c$* |
|---|---|---|---|---|---|
| C-alkaloid *A* | $C_{20}H_{25}O_2N_2^+$ | 0·23 | C-dihydrotoxiferine | $C_{20}H_{23}N_2^+$ | 1·22 |
| C-alkaloid *B* | $C_{19}H_{23}ON_2^+$ | 0·34 | C-alkaloid *UB* | $C_{19}H_{23}O_2N_2^+$ | — |
| C-alkaloid *C* | ? | 0·34 | C-alkaloid *M* | ? | 1·45 |
| C-alkaloid *D* | $C_{20}H_{21}ON_2^+$ | 0·35 | C-calebassinine | $C_{19}H_{23}O_2N_2^+$ | 1·68 |
| C-alkaloid *E* | $C_{19}H_{23}ON_2^+$ | 0·36 | C-fluorocurine | $C_{20}H_{25}O_2N_2^+$ | 2·10 |
| C-toxiferine *I* | $C_{20}H_{21}N_2^+$ | 0·42 | C-fluorocurinine | $C_{21}H_{25}O_2N_2^+$ | 2·23 |
| C-alkaloid *F* | $C_{20}H_{25}O_2N_2^+$ | 0·49 | C-fluorocurarine | $C_{20}H_{23}ON_2^+$ | 2·25 |
| C-alkaloid *G* | $C_{20}H_{23}ON_2^+$ | 0·65 | C-alkaloid *L* | ? | 2·50 |
| C-alkaloid *H* | ? | 0·71 | C-mavacurine | $C_{20}H_{25}ON_2^+$ | 2·70 |
| C-calebassine | $C_{20}H_{25}ON_2^+$ | 0·80 | | | |
| C-alkaloid *I* | $C_{19}H_{23}ON_2^+$ | 0·89 | | | |
| C-curarine | $C_{20}H_{21}N_2^+$ | 1·00 | | | |
| C-alkaloid *J* | $C_{19}H_{21}N_2^+$ | 1·04 | | | |

$$* R_c = \frac{\text{distance travelled by the alkaloid}}{\text{distance travelled by curarine}}$$

Solvent = methyl ethyl ketone saturated with water + 1–3 per cent methanol

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* Substance of two lectures delivered in the University of London School of Pharmacy) on March 10 and 11.

From calabashes of different origin we were able to isolate other new alkaloids, and also from barks of several *Strychnos* species (*mitscherlichii*, *toxifera*, *melinoniana*) new bases of this group have been obtained; most of them have the character of quaternary salts, but some are tertiary bases. Up to date, the following pure calabash- and *Strychnos*-bark alkaloids are known:

* + C-curarine I (refs. 2, 8, 9, 10)
* C-curarine II (ref. 3) (C-strychnotoxine I*a*) (ref. 11)
* + C-curarine III = C-fluorocurarine (refs. 3, 8, 9, 10)
* + C-toxiferine I = toxiferine I (refs. 1, 4, 6, 8, 9, 17)
* + C-toxiferine II = C-calebassine (refs. 4, 5, 8, 9, 10, 17) (= C-strychnotoxine I)
* + toxiferine II (ref. 4) (= strychnotoxine II (ref. 11)
* C-dihydrotoxiferine I = C-alkaloid *K* (refs. 4, 8, 9)
* C-isodihydrotoxiferine (ref. 4)
* + C-alkaloid *A* (refs. 5, 8, 9, 10)
* + C-alkaloid *B* (refs. 5, 8, 9, 10)
* + C-alkaloid *C* (refs. 8, 9, 10)
* C-alkaloid *D* (refs. 8, 9)
* C-alkaloid *E* (refs. 8, 9)
* C-alkaloid *F* (refs. 8, 9)
* C-alkaloid *G* (refs. 8, 9)
* C-alkaloid *H* (refs. 8, 9)
* C-alkaloid *J* (refs. 8, 9)
* C-alkaloid *L* (refs. 8, 9)
* C-alkaloid *M* (ref. 13)
* C-alkaloid *O* (ref. 12)
* C-alkaloid *P* (ref. 12)
* C-alkaloid *UB* (refs. 7, 8, 9)
* + C-alkaloid *Y* (refs. 5, 13)
* C-alkaloid *X* (refs. 7, 8, 9)
* C-calebassinine (refs. 8, 9)
* + C-fluorocurine (refs. 8, 9 14)
* + C-fluorocurinine (refs. 8, 9, 10)
* + C-mavacurine (refs. 11, 14)
* C-xanthocurine (ref. 12)
* + C-guaianin (ref. 12)
* + C-alkaloid I (refs. 8, 9, 10)
* C-alkaloid 1 (ref. 11)
* C-alkaloid 2 (ref. 11)
+ fedamazine (ref. 14)
+ caracurine I (ref. 14)
+ caracurine II (ref. 14)
+ caracurine III (ref. 14)
+ caracurine IV (ref. 14)
+ caracurine V (ref. 14)
+ caracurine VI (ref. 14)
+ caracurine VII (ref. 14)
+ caracurine VIII (ref. 15)
+ caracurine IX (ref. 15)
+ nordihydrotoxiferine (ref. 15)
+ melinonine *A* (ref. 16) (= tetrahydroalstonine-chlormethylate)
+ melinonine *B* (ref. 16)
+ "toxiferines III to XII" of H. King (ref. 17) (homogeneousness not proved)

* = alkaloids found in calabashes.
+ = alkaloids found in barks of *Strychnos* species.

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[16] Schlittler, E., and Hohl, J., *Helv. Chim. Acta*, 35, 29 (1952).
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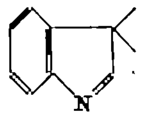
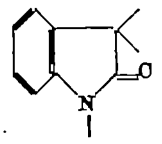
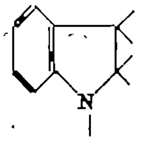
The ultra-violet spectra of the calabash- and *Strychnos*-bark alkaloids show that most of these compounds are indole derivatives. It is possible to divide them into about eight groups, which probably possess the following chromophores:



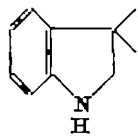
C-Curarine
C-Alkaloids *G* and *E*
C-Guaianine
Caracurine V



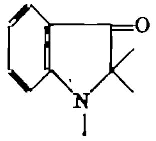
C-Toxiferine
C-Dihydrotoxiferine
C-Alkaloids *H* and 2
Caracurine VI



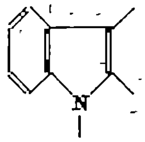
C-Alkaloids *A*, *F*
I, II, X, Y
Caracurine IV and VII (?)



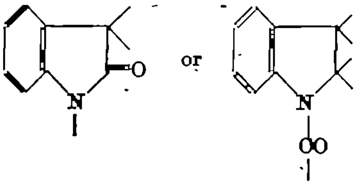
C-Alkaloids *B*, *C*, *D*
Caracurine II and III



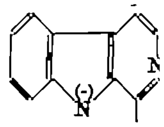
C-Fluorocurine
C-Fluorocurinine



C-Alkaloids *J*, *L*, I
C-Mavacurine
Toxiferine III
Melinonine *B*



Calebassinine
C-Alkaloids *UB* and *M*



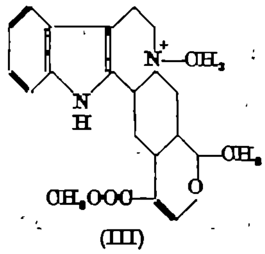
C-Xanthocurine
Fedamazine

The elucidation of the constitution of the calabas and *Strychnos* bark alkaloids is an objective whic still lies in a rather distant future. Some fir degradation experiments on calabash alkaloids wer conducted by Wieland and his co-workers. B dehydration reactions on dihydrotoxiferine I, the succeeded in obtaining β-ethylindole and *iso*chinolin whereas from C-toxiferine II some β-ethylpyridir was obtained; they suggested the presence of *is* chinoline—or chinoline—or indole-rings in C-curarin

We were able to get by distillation with zinc du from C-norcurarine, which itself had been obtained b thermal decomposition of the quaternary chloride C-curarine I, β-ethylpyridine, β-ethylindole, skatol carbazole and *l*-methylcarbazole.

The production of β-ethylindole after distillatio with zinc dust of norcurarin makes it probable tha C-curarine is, like many other plant bases, derive from tryptamine. The isolation of carbazole an *l*-methylcarbazole, however, excludes a constitutio based upon the harman type (yohimbine bases). The dehydrogenation products obtained indicate th relationship of C-curarine with the *Strychnos* alkaloid. Thus strychnine, on vigorous degradation, gav β-ethylindole, β-collidine and carbazole.

An alkaloid melinonine *A* (III), which E. Schlittle discovered in the bark of *Strychnos melinoniana* an which is without curare activity, has proved to b the chlormethylate of tetrahydroalstonine, an indol alkaloid the constitution of which was already known

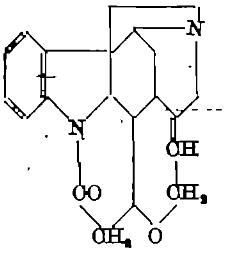


(III)

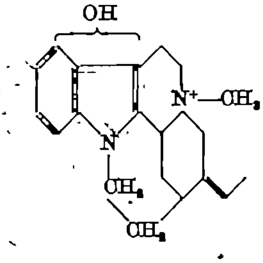
A thorough investigation of the two calabash kaloids fluorocurine and mavacurine in our labor-ory showed that between these two compounds, hich always occur together, interesting connexions :ist and it was possible to get an insight into their ructure.

The indoxyl derivative fluorocurine can be reduced 7 sodium borohydride to hydrofluorocurine, and the tter is easily transformed by acids into the indole rivative mavacurine. We have followed many gradation reactions which have enabled us to clear the constitution of these three alkaloids, with e exception of the position of one OH-group which ccurs in these compounds.

Hydrofluorocurine (V) readily undergoes the so-lled Emde degradation; that is, when subjected reduction with platinum and hydrogen in alcoholic lution, a carbon atom attached to the quaternary itrogen atom is split off; at the same time, hydro-nation of the C=C double bond of hydrofluoro-rine takes place. On degradation with chromic acid, e Emde base (VII) gave a methyl-ethyl-acetic acid X); this proves that the position of the side chain the hydrofluorocurine relative to the N(b)-atom of e compound corresponds to formula (V). The mde degradation of mavacurine (VI) leads to a bstance of the constitution (VIII), an indole



Strychnine

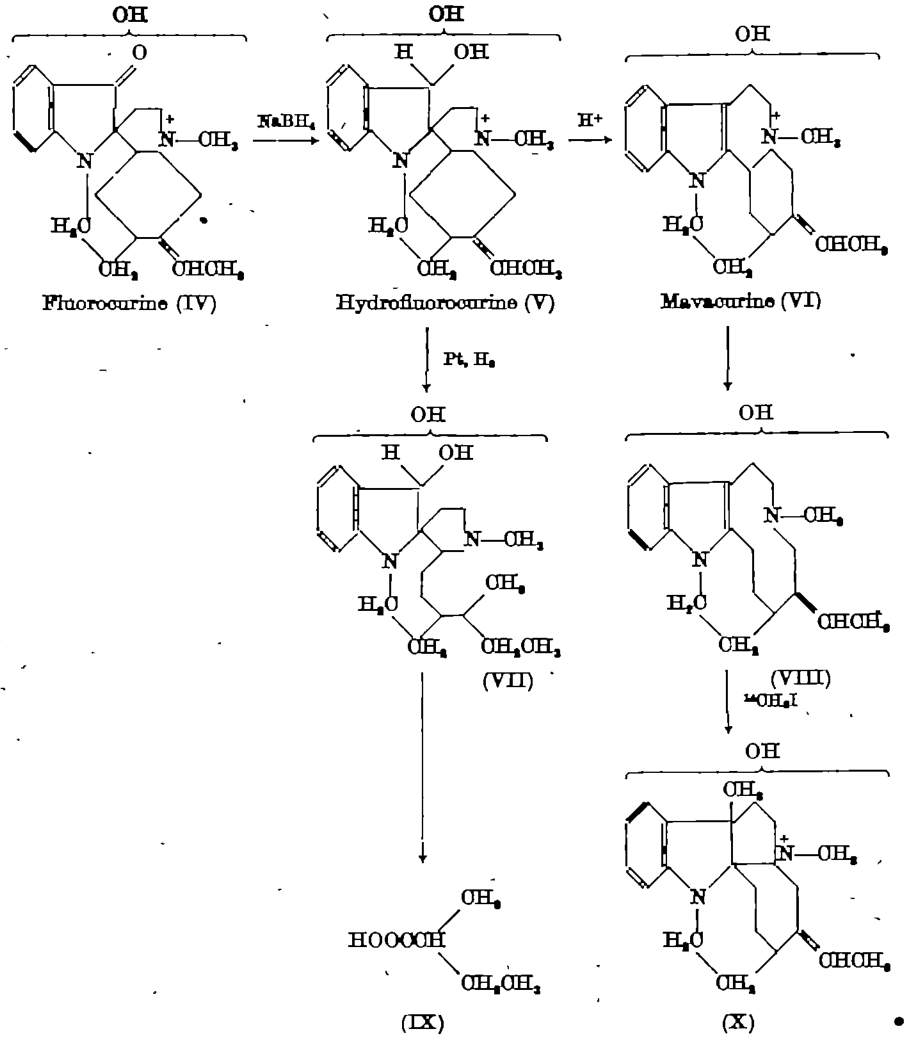


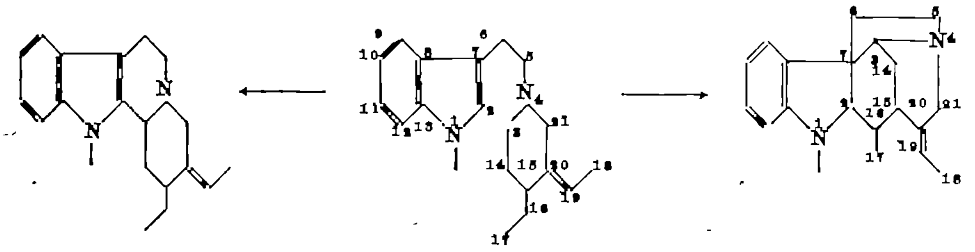
Mavacurine

derivative, which could be methylated by methyl-$^{14}$C iodide to an indoline derivative (X) containing a CH$_3$-group on the carbon atom 3. A number of other reactions of fluorocurine and mavacurine agree with the formulæ IV and VI proposed for these two alkaloids.

It is a remarkable fact that the carbon double bond which occurs in fluorocurine and mavacurine has the same position with regard to the N(b)-nitrogen atom of the two alkaloids as that in strychnine to the corresponding N(b)-atom.

Already Sir Robert Robinson and R. B. Woodward have pointed to possible genetic relationships between the yohimbine and strychnine alkaloids. If in the





(*B*) (*A*) (*C*)

hypothetical substance *A* a bond between the two carbon atoms 2 and 3 is formed, a compound *B* of the β-carboline or yohimbine type arises. But if in substance *A* the carbon atoms 3 and 7 on one side and the carbon atoms 2 and 16 on the other side are connected by bonds, a compound *C* of the strychnine type would be formed. Further investigations will show if type *C* is also realized among the curare alkaloids.

Formulæ *B* and *C* show very clearly the identical position of the carbon double bond in mavacurine and fluorocurine on one hand and of strychnine on the other.

During recent years compounds with curare activity have aroused great medical interest; they find practical application in surgery during anæsthesia, causing complete relaxation of the muscle, thereby enabling the quantity of the anæsthetic to be reduced. For practical purposes *d*-tubocurarine ('Intocostrine') especially is used, and to a limited extent also synthetic compounds. For many of these synthetic substances the formula of *d*-tubocurarine, which contains two quaternary ammonium salt groups, served as a model. But the halogen alkylates of strychnidine and dihydrostrychnidine which hav been investigated in our laboratory contain, like th calabash alkaloids, only one quaternary ammoniu salt group and are about as toxic and as active 'Intocostrine'. I have already mentioned that som calabash alkaloids, for example C-curarine, a probably related to strychnine with regard to the constitution. It is true that the curare activity the halogen alkylates of strychnidine is about hundred times less than that of C-curarine and abo three hundred times smaller than that of the calabas alkaloid C-toxiferine I.

With their lethal doses of about 1–8γ per kgn for mice, the calabash alkaloids *F* and *G* belong the most toxic substances which are known to-da 1 gm. of these compounds would paralyse at least hundred tons of mice.

A group of colleagues and pupils of mine pa ticipated in the investigations on calabash curare I mention particularly Prof. H. Schmid, who too part in these investigations from their beginnin and Dr. P. Waser, Dr. A. Ebnöther, Dr. J. Kebrl Dr. H. Asmis, Dr. H. Bickel, Miss Bächli and E Meyer.

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# AN ATOMIC STANDARD OF FREQUENCY AND TIME INTERVAL

## A Cæsium Resonator

A FREQUENCY standard (Fig. 1) based on a natural resonant frequency of the cæsium atom has been constructed at the National Physical Laboratory and used for calibrating the quartz clock standards with an accuracy of ± 1 part in $10^9$ (0·0001 sec. per day). It makes use of the atomic beam magnetic resonance technique developed by Rabi and his collaborators[1].

The resonance observed is that due to transitions between the hyperfine structure energy-levels caused by the interaction between the nuclear and electron spins. For observational purposes a uniform magnetic field is applied so that these energy-levels are split into their Zeeman components. The frequency of the central line of the Zeeman pattern is, however, to the first order, independent of the value of the field, being given by[2,3]

$$\nu = \nu_0 + 427 H^2,$$

where $H$ is the field in oersteds and $\nu_0$, which is approximately $9\,192 \times 10^6$ c./s., is a fundamental constant of the atom. The frequencies of the other lines have a much larger, linear dependence on the field and provide a convenient means of definin its effective value.

All the allowed transitions have been observe and from measurements made under a variety conditions the frequency of the central line zero field was found to be 9 192 631 830 ± 10 c./ in terms of the present adopted frequency of th quartz standard, which is based on a provision uniform time-scale[4] estimated by the Royal Greer wich Observatory. The sharpness of the reso ance is indicated in Fig. 2, which is typical the resonance curves we have obtained. As, i practice, the observations are made in the presen of a small uniform field, it may be convenient t define the standard as the frequency of the centr line at a specified field. We propose to use the val obtained when the field is adjusted to make th frequency of the adjacent (3·1–4·1) line exact 500 kc./s. higher than that of the central line becaus by such a procedure, the difficult measurement effective field is replaced by a simple frequen measurement. The frequency of the central line f this condition is 9 192 632 050 ± 10 c./s. Th potential precision of the cæsium standard at th National Physical Laboratory is considerably highe than the 1 part in $10^9$ at present claimed; but speci

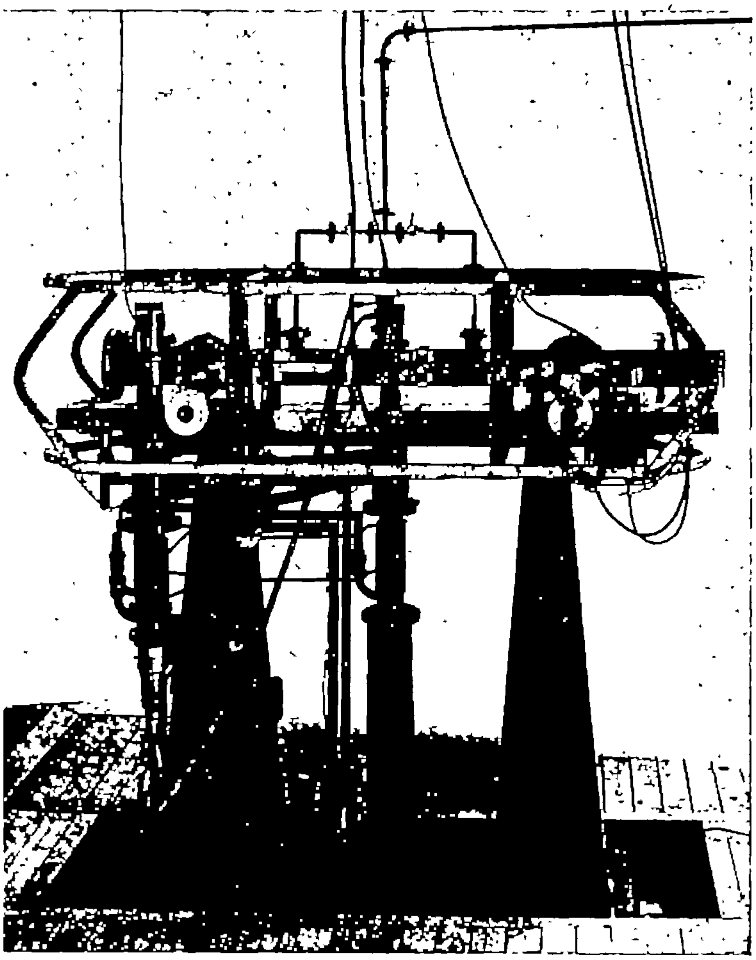

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Fig. 1. The atomic beam chamber supported on two pedestals, the oil diffusion pumps, and the coils for producing the appropriate d.c. field. The radio-frequency field for exciting the resonance is applied to two cavity resonators, which are coupled to an oscillator by means of the waveguide feeds on the top of the beam chamber

lectronic techniques will have to be developed before his higher precision can be utilized. The accuracy iven is that which has already been achieved and hich can be used with our existing quartz standards nd techniques of frequency measurement[5,6].

The apparatus is designed to enable many of the arameters to be varied through a wide range so hat any effect of such variations on the observed esonant frequencies can be studied. When the ermissible tolerances have been determined, a simpler nodel can be designed. During this investigation the pparatus will be used for periodic checks on the requency of the quartz clock which constitutes our vorking standard of frequency and time-interval. A omparison between these results and the values lerived from the unit of Universal Time should give nteresting information concerning the variations of he period of rotation of the Earth, which are known o be of the order of 1 part in $10^{8}$ and which at present imit the accuracy of frequency standardization. It has een suggested that Ephemeris Time[7], which is based n the sidereal year, should be used for eliminating he variations in the length of the day. The unit of ime in this system can be given with the required recision only some years in retrospect, although it s hoped[8] by means of observations of the Moon at a number of observatories to reduce this delay to one year. Whatever system is used, an astronomical unit of time accurate to 1 part in $10^{9}$ will be at least one year in arrears and will, of course, be an average value over that period. The great advantage of an atomic standard is that it enables the frequency standardization to be effected by measurements lasting only a few minutes. The value thus determined can be made available throughout a large area of the world by means of standard frequency transmissions[9,10].

The pioneer work on atomic standards of frequency has been carried out in the United States, and before starting this work one of the authors had many helpful discussions, in particular with Dr. H. Lyons and Profs. P. Kusch, C. H. Townes and J. R. Zacharias. Lyons[3] built a cæsium standard at the National Bureau of Standards, Washington, D.C., and obtained a value of 9 192·632 Mc./s. for the frequency of the central line. Later he has used the Ramsey method of excitation, as used in this experiment, giving a much sharper resonance, but has not published any results so far as we are aware. More recently, Zacharias, Yates and Haun[11] have described a somewhat different cæsium beam apparatus, and Townes[12] has described an oscillator based on a transition in the ammonia molecule; but in neither case are absolute values of frequency given. The results reported here appear, therefore, to be the

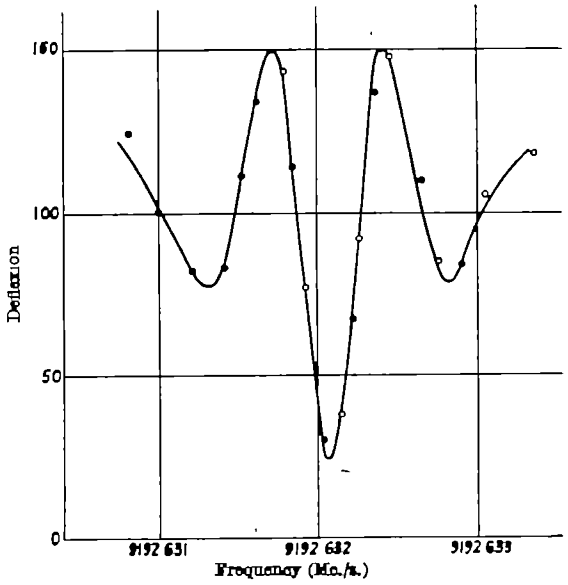

Fig. 2. Plot of the 3 0–4 0 transition in cæsium. Zero on the meter deflexion is arbitrary, the resonance dip being about ⅓ of the total beam current

first examples of the use of an atomic frequency standard with an accuracy greater than that obtained by using a unit of astronomical time. They also represent the highest accuracy ever achieved in the measurement of any physical quantity in terms of a definitive standard.

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J. V. L. PARRY

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June 11.

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## Definition of the Second of Time

THE preceding communication by Essen and Parry describes a means by which frequencies and intervals of time may be measured with an accuracy of 1 in $10^9$, and holds out a prospect of even higher accuracies.

Ephemeris Time, on which the definition of the second adopted by the International Astronomical Union and the International Committee of Weights and Measures depends, is derived from the motion of the Moon. If the position of the Moon at any time can be determined to 0·05 sec., a period of four years would be necessary to obtain an accuracy of 1 in $10^9$ in time and frequency derived from astronomical observation. Essen and Parry mention Markowitz's proposals for reducing this period to one year; these depend on a reduction of the errors by repetition of observations. Such a reduction would involve a study of systematic errors in star places and in the corrections for differential refraction that would certainly take many years. During this time the atomic clocks will be improved, probably by a greater factor than the astronomical determinations.

It thus seems probable that for the foreseeable future the accuracy of the measurement of frequency and of time intervals relative to laboratory standards will exceed that by astronomical means, and that the astronomically defined second is therefore incapable of realization with the accuracy necessary for microwave spectroscopy. The natural way of escape from this difficulty is to define a 'physical second' in terms of the natural period of the cæsium atom, choosing the numerical value so that it agrees as well as may be with the current estimates of the second of Ephemeris Time. Experience of the working of the machinery for obtaining international agreement on such matters suggests that some years are likely to elapse before a decision could be reached. The purpose of the present communication is to solicit views on the desirability of abandoning the astronomical second for the most refined physical measurements and to encourage other suitably equipped laboratories to make determinations of the cæsium frequency of the highest accuracy.

It is possible that the new accuracy in the measurement of frequency will reveal some unexpected phenomena. It is not self-evident that the tim shown by atomic and astronomical clocks will kee in step indefinitely. In fact, Dirac, Milne, Jorda and others have suggested that what are usuall regarded as the 'constants of physics' may chan by amounts of the order of $1/T$ per year, where $T$ the 'age of the universe' in years. If $T$ is abo $4 \times 10^9$ years, changes of this order may soon b measurable over intervals of a few years. This is matter that can only be settled by experiment an gives an added interest to the development of metho of precise time-keeping.

E. C. BULLARD

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June 16.

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# EXPLORATION OF THE EARTH' UPPER ATMOSPHERE USING HIGH-ALTITUDE ROCKETS

## BRITISH RESEARCH PROGRAMME

### By SIR DAVID BRUNT, Sec.R.S.

THE wind, temperature, humidity and othe properties of the atmosphere up to heights c about twenty miles can be studied directly by mean of instruments carried up by free balloons. Observa tions of this kind are regularly made by meteorolo ical services throughout the world. Although th atmosphere at greater heights is very tenuous, i necessarily plays an important part in many phen omena. Thus long-distance radio propagation is onl possible because of the existence of reflecting layer the ionosphere, at altitudes of 60 miles and above—indeed, a very important region extends upward from a height of 90 miles. Meteors are mainl evaporated at the 60-mile level, and the aurora, a least in high latitudes, is located at about the sam level. The electric currents which give rise to th variations of the earth's magnetic field circulate i this region, and it is also the seat of a night-tim air-glow quite distinct from the aurora or the lig of moon and stars.

Before the Second World War, information abo the upper atmosphere could only be obtained b indirect methods. The remarkable developments c rockets as weapons led to the possibility of carryin instruments into the upper air in vehicles of this kin This was first achieved in the United States in 194 using captured V2 rockets. Since that time stead progress has been made and many interesting result have been obtained. The greatest height reache so far has been 240 miles.

A research programme of this kind is expensiv and until recently was exclusively carried out b American scientists and technicians. It is ver desirable that work should be carried out in othe countries, to obtain data under different conditio and locations and employing different technique A programme has already been commenced i France, and an extensive programme is now bein initiated in the United Kingdom through the co-opera tion of the Ministry of Supply, particularly the Roy Aircraft Establishment, and the Gassiot Committe of the Royal Society. The programme aims at havin available, within two years, rockets able to carr 100 lb. weight of scientific instruments up to height f 120 miles or more. The design, development, upply and firing of the rockets will be carried out by he Ministry of Supply. Five university research groups, from University College, London (Prof. S. W. Massey), the University of Birmingham Prof. J. Sayers), The Queen's University of Belfast Profs. D. R. Bates and K. G. Emeléus), University College, Swansea (Dr. W. J. G. Beynon) and the Imperial College of Science and Technology, London Prof. P. A. Sheppard), will be initial participants in he scientific programme. The work will be co-ordinated through a special sub-committee of the Gassiot Committee of the Royal Society. The first experiments will include determination of atmospheric emperature and density, the study of the nature of he ionosphere, a search for very fine meteoric dust below 60 miles altitude, and determination of the heights of the regions from which the night air-glow s strongest. While the development of the rockets s proceeding, work on the scientific instruments required will proceed in parallel, so that both should be available at nearly the same time.

Although this programme has been arranged independently of the International Geophysical Year, 1957–58, it is hoped that it will be in operation during this period and add substantially to the British contribution to the Year.

## OBITUARIES

### Sir Harold Tempany, C.M.G., C.B.E.

Sir Harold Tempany's forty-three years in the Colonial Agricultural Service (now called the Agricultural Branch of H.M. Overseas Civil Service) stretched a good way on either side of the great changes which followed on the Imperial Agricultural Conference of 1927. These gave the Service the beginnings of a unity, enlarged it in numbers and resources, provided training for its cadets and placed at its head an agricultural adviser to the Secretary of State for the Colonies. The late Sir Frank Stockdale was the first to fill this post (1929). Tempany joined him as assistant adviser in 1936 and, succeeding him in 1940, was in office during the hard years up to his retirement in 1946.

Variety in the earlier half of his career gave width to the knowledge of climates, soils, agriculture and administration on which his success in the diversified tasks of the latter half depended. Soon after graduating at University College, London, where chemistry, always central in his technical thinking, was his main study, he was appointed assistant agricultural chemist, Leeward Islands, in 1903, and a few years later chief chemist and superintendent of agriculture. In Mauritius during 1917–29, as director of agriculture, he was also responsible for the co-operative credit societies, and became the first principal of its College of Agriculture and a member of its Council of Government. Malaya was his next Colony. While director of agriculture for seven years from 1929, he put new life into the investigation of the food crops and livestock of its peasant farming, formerly overshadowed by its great export crop, rubber. The training of local assistants and general agricultural education also profited greatly from his interest.

By 1940, when Tempany became agricultural adviser in the Colonial Office, Stockdale had put new spirit into the whole Colonial Agricultural Service and made the Colonial Advisory Council for Agriculture, Animal Health and Forestry an influential body, warm in support of his exertions. Soil erosion throughout the Colonial Territories was, at last, being checked; the basic importance of the peasant economy had become recognized; specialist research had begun to be intelligently related to major problems; and study of husbandry and farming systems to be effectively promoted. Further, it was accepted that agricultural development in a territory could not spring from unconcerted pushing of individual commodities but required a policy based on primary physical and ethnic considerations.

In 1940 Tempany, who in his four years as assistant adviser had had a hand in all these developments, became, as adviser, responsible for doing what was possible to carry them on while also wrestling with the acute war-time food-supply problems of all the Colonial territories.

The Colonial Development and Welfare Act, 1940, greatly enlarged the funds for research, and a committee of the Colonial Advisory Council for Agriculture, Animal Health and Forestry was set up to report on research organization in those subjects. In its prolonged, arduous, discussions it fell to Tempany, particularly, to maintain free scope for technical agriculture and science, while conceding a due authority to administrative control. The present Colonial Agricultural Research Committee was set up, conformably with the recommendations, and the idea of a regional basis for research was also adopted. In 1946, a commission of three, under Tempany, visited East Africa for the conference at which initial arrangements for an East African regional organization were drawn up.

At formal meetings, Tempany's conscientious marshalling of facts sometimes tended to irritate his less-patient colleagues who, none the less, respected his tenacity and his high aims for the Service. It was in travel and when dealing with problems out on the land that he was seen at his best. But, indoors or out, he was unfailingly industrious, conscientious, fair-minded and kindly.

Tempany had periods of service on the board of governors of the Imperial Institute, the governing body of the Imperial College of Tropical Agriculture, the Sudan Government London Scientific Advisory Committee on Agricultural Research, the Chemical Council and the Council of the Royal Institute of Chemistry, and in 1950 he received a silver medal of the Royal Society of Arts. Most of his writing went into official papers: he published "Principles of Tropical Agriculture" (1930: with G. E. Mann); "The Practice of Soil Conservation in the British Colonial Empire" (1949); and "Agriculture in the West Indies" (1942). Leisure for writing, for which he longed, and happy opportunity, came in 1946 when, on retiring, he became editor of *World Crops*.

In 1911 he married Annie Frances Agnes, eldest daughter of Robert Goodwin, of Antigua, who died in 1945; their son died, in Nairobi, only two days before the death of his father in London on July 2. His second marriage, in 1946, was to Kate, youngest daughter of William Welfare. F. L. Engledow

### Prof. R. H. A. Plimmer

The distinguished biochemist and one of the founders of the Biochemical Society, Robert Henry Aders Plimmer, emeritus professor of chemistry in the University of London, died on June 18 at the age of seventy-eight.

At the time of his death, Prof. Plimmer was a member of the staff of the Department of Biochemistry at the British Postgraduate Medical School, Hammersmith.

Born on April 25, 1877, the eldest son of Alfred Aders, of Manchester, he adopted the name of his stepfather, Henry George Plimmer, F.R.S., an eminent bacteriologist who undoubtedly influenced him in his choice of a scientific career. He was educated at Dulwich College, University College, and in Geneva and Berlin, and obtained his D.Sc. (London) in 1902 and worked in the Lister Institute for two years as a Grocers' Company research student. In 1904 he returned to University College as an assistant in the Department of Physiological Chemistry, his first teaching post. He was to remain at University College for fifteen fruitful years, during which time he became assistant professor and finally reader in physiological chemistry. He was elected a Fellow of the College in 1906. Together with Bayliss and Starling, he helped to plan and equip the new Physiology School, and he reorganized the teaching of physiological chemistry. His well-known text-book, "Organic and Bio-chemistry", dates from this time, as does the valuable series of "Monographs on Biochemistry", of which he was co-editor with Hopkins, and to which he contributed "The Chemical Constitution of the Proteins". Protein analysis, which he had studied in Emil Fischer's laboratory at Berlin, became one of his main lines of research, and he was long regarded as a leading authority on this subject.

Biochemistry was just beginning to be recognized as a subject in its own right, and the time appeared to be ripe for the formation of a club or society with the object of encouraging closer co-operation among workers in this field. The lead was taken by Plimmer and J. A. Gardner. They called a meeting at University College in January 1911, which led to the founding of the Biochemical Society with Plimmer as its first secretary; Gardner became treasurer in 1913. The present flourishing, vigorous Society owes much to the initiative and foresight of these two co-founders, who steered it through its difficult early days. Plimmer was made an honorary member in 1943 and later wrote the "History of the Biochemical Society" up to the time of the First International Congress of Biochemistry held at Cambridge in 1949.

During the First World War, Plimmer was attached to the R.A.M.C. and worked for a time at the Army Medical College, Millbank. He was commissioned to assay the energy values of the common foodstuffs—a task which entailed many thousands of analyses. The results of this work were later published by H.M. Stationery Office.

In 1919 Plimmer was appointed head of the Biochemistry Department at the Rowett Institute for Research in Animal Nutrition, Aberdeen. His old school friend, John Q. Rowett, had generously contributed towards the founding of this Institute, and had also financed the last Antarctic expedition of Sir Ernest Shackleton, another old Dulwich College boy. But Plimmer was not happy away from London and, when the opportunity came, he applied for the chair in chemistry at St. Thomas's Hospital Medical School, London, the post he was destined to occupy with distinction for twenty-one years—from January 1922 until December 1942.

At St. Thomas's Plimmer found congenial colleagues and facilities for research. He was a successful teacher, beloved by his students, to whom he gave every encouragement while exercising strict discipline. His lectures on inorganic and organic chemistry, bio chemistry, toxicology, and the Nightingale Lecture in elementary science for nurses, were models o lucidity. Full of energy and drive, he carried out a astonishing amount of research on the nutritiv values of foods and their relative vitamin content Plimmer's poultry farm on the roof of his departmen was a source of great interest and, incidentally, man a delicious meal for his colleagues. He was a advocate of the 'balanced diet', and, together wit his wife, wrote several popular books on food value "Food, Health, Vitamins", written by Prof. and Mr Plimmer, ran through nine editions and containe their famous 'square meal' chart.

Plimmer loved hard work at his laboratory bench but he also thoroughly enjoyed his leisure hours a home with his wife and family. Always a kee motorist, he toured extensively on the Continent wit his family during vacation. He enjoyed watchin first-class cricket, loved good music, frequently visite Glyndebourne, and was an ideal host.

On the outbreak of war in 1939, teaching con tinued at St. Thomas's until the Hospital wa severely damaged by bombs in September 194 The staff and students then moved to the Mano House, Godalming, and were permitted to use th laboratories in the nearby Charterhouse Schoo While at Godalming, Plimmer reached the age o sixty-five and retired from St. Thomas's in Decembe 1942. He was too full of energy to remain idle fo long, and he gladly accepted Prof. E. J. King' invitation to work in the Biochemistry Departmen of the British Postgraduate Medical School, Hammer smith. Greatly beloved by all his colleagues, h continued actively working there from January 194 until the end of his life.

The death of his wife in July 1949 was a great blo to him; but he was comforted by the presence of hi eldest daughter and her family, who lived with hi until a few months before his death.

JOHN LOWNDES

## Prof. Gustave Magnel

THE death of Prof. Gustave Magnel on July deprives civil engineering of one of its leading figure Prof. Magnel had a world-wide reputation as th originator of the Magnel–Blaton system of prestres ing concrete, according to which the prestressing wire are formed into a cable of rectangular section b means of spacer grilles, and are anchored by stee wedges hammered into 'sandwich plates'.

Gustave Paul Robert Magnel was born at Essche in the province of Antwerp in 1889, and graduate in civil engineering in the University of Ghent i 1912. His early working years were spent in Englan where, during the First World War, he worked a assistant, and later chief engineer, for the firm o D. G. Somerville and Co., of London.

After the War he returned to Ghent, and to hi old University, where he became professor of struc tures and reinforced concrete, and director of th concrete laboratory. Between the Wars he becam one of the earliest enthusiasts for prestressed con crete; it was during the Second World War that h developed his own system of prestressing. The syste did much to widen the scope of the new and revolu tionary technique of prestressing, and has been use in many different countries for bridges, buildings an circular structures such as tanks and silos. Pro Magnel himself designed most of the early structure restressed by his system—as a consulting engineer e had an international reputation.

As a university professor, Magnel was acknow-dged to be outstanding. His lectures were remark-ble for their clarity of exposition, and the same uality marked his writings. His numerous technical ooks are standard text-books; they cover a wide ange of subjects, and contain an unusual wealth of ractical detail. Chief among his published works are: Pratique du Calcul du Béton Armé" in four volumes, f which Volume 4 is "Le Béton Précontraint", Cours de Stabilité des Constructions" in four olumes—the complete University course in struc-ures—and "Le Calcul pratique des Poutres Vieren-el". "Le Béton Précontraint" has been translated to English, and published in Great Britain. He as also the author of numerous papers in French nd English (in a paper given before the Institution Civil Engineers in 1949 he introduced the Magnel-laton system of prestressing to Britain), and he itiated the publication of the bilingual periodical *récontrainte–Prestressing.*

As a lecturer, Prof. Magnel was well known in the nited States and in South Africa, as well as in Britain, his perfect command of English no less than his command of his subject always ensuring him an appreciative audience. Wherever he went he was an outspoken crusader for high-quality concrete and was forthright in his condemnation of slipshod workmanship.

Prof. Magnel had been honoured both in Great Britain and in the United States as well as in Belgium. A member of the Belgian Royal Academy, he was elected a member of the Institution of Structural Engineers in 1934, and of the Institution of Civil Engineers in 1950. He was also a member of the American Society of Civil Engineers and the American Concrete Institute, and a holder of the American Frank P. Brown Medal. He was chairman of the Belgian Prestressed Concrete Group, and senior vice-president of the International Federation of Prestressing. In this capacity his keen intellect, sound judgment and always unruffled courtesy, as well as his genius for smooth organization, will be sadly missed at the forthcoming International Congress at Amsterdam. His dynamic, yet always kindly, personality will be missed by all who knew him.

BETTY CAMPBELL

# NEWS and VIEWS

## hemistry at the Imperial College, London :

### Prof. E. A. R. Braude

In taking up the appointment of professor of ganic chemistry at the Imperial College of Science d Technology, London, Dr. E. A. R. Braude llows a distinguished line starting with Hofmann d continuing to recent times through Frankland, mstrong, Tilden, Thorpe and Heilbron. South ensington has been celebrated not only as a centre research in the subject but also as a training ound for students, from the time of Perkins, father d son, onwards. In the appointment of Dr. Braude e College has selected one of the leading young itish organic chemists, who has a wide and im-rtant range of interests; at the same time, it has cured the services of one deeply experienced in the ecial educational methods associated with this hool. Dr. Braude was born in 1922. After a dis-nguished undergraduate career at the Imperial llege, he continued there as a postgraduate research udent under Sir Ian Heilbron. He was awarded e Ph.D. degree in 1945. He was appointed assistant cturer in 1946, lecturer in 1947, and reader in ganic chemistry in 1952. He was awarded the eldola Medal of the Royal Institute of Chemistry r 1950, and received the D.Sc. degree in the same ar. He is a member of the Council of the Chemical ciety.

### Prof. G. Wilkinson

The chair of inorganic chemistry in the University London tenable at the Imperial College of Science d Technology, from which Prof. H. V. A. Briscoe tired last year, has been filled by the appointment Dr. G. Wilkinson, who graduated there as a Royal holar in 1941 and was elected Frank Hatton prize-an. Dr. Wilkinson then undertook research in organic chemistry at the College until, in 1943, was appointed to a research post in the joint itish–Canadian–United States atomic energy pro-t, serving for three years at Montreal and at Chalk ver. After the War, he was a research associate, engaged in Prof. G. T. Seaborg's laboratory in the University of California, on investigations of radioisotopes leading to quantitative studies of the reaction of high-energy protons with the heavier elements; he later held a similar post in Prof. C. D. Coryell's laboratory at the Massachusetts Institute of Technology, working on the conditions of formation of complexes by phosphorus halides. Since 1951, as assistant professor of chemistry at Harvard University, he has been directing a research group studying, *inter alia*, the properties of bis-*cyclo*pentadienyl compounds of the transitional elements, and in association with Prof. R. B. Woodward and others has been responsible for considerable progress in this new field of chemistry. Last year Prof. Wilkinson, as John Simon Guggenheim Fellow, spent some months in Prof. J. Bjerrum's laboratory at Copenhagen. By his delight in experimental investigation, his experience as a lecturer on inorganic and nuclear chemistry, and his administrative services as secretary to the Department of Chemistry at Harvard, he will take to the Imperial College enthusiasm for the development of studies in modern aspects of inorganic chemistry and wide knowledge of the facilities now available for that purpose.

## Physics at King's College, London :

### Prof. W. C. Price

His many friends on both sides of the Atlantic will be pleased to know that the title of professor of physics in the University of London has been conferred on Dr. W. C. Price in respect of his appointment at King's College. Dr. Price has held the post of reader in experimental physics in the College for several years, and is well known as a spectroscopist who has worked mainly on the structure of polyatomic molecules, both in the vacuum ultra-violet and in the infra-red spectral regions. He was the first to show that the short-wave spectra of a large number of basic molecules, such as acetylene, ethylene, benzene, water, the alkyl halides, etc., can be interpreted as a succession of electronic transitions which converge to limits corresponding to the photo-ionization of particular electrons within the molecule. This phase of Dr. Price's work was started while he was a Commonwealth Fellow at the Johns Hopkins University during 1932–35 and developed later at Cambridge, where he was on the staff of the Physical Chemistry Department and held a fellowship of Trinity College.

During the later years of the Second World War, Dr. Price became attached to Imperial Chemical Industries, Ltd. (Billingham Division), where he applied infra-red techniques to industrial problems, particularly those concerned with the war effort. During 1946–47 he was research associate at the Molecular Spectroscopy Laboratory in the University of Chicago, and in 1949 he took up his appointment at King's College, London. His contributions in infra-red spectroscopy include the experimental evidence for the bridge structure of diborane and its metal derivatives, the elucidation of the nature of the vibrations of the peptide link, the theory of infra-red reflexion spectra from molecular crystals, and high-resolution studies of emission spectra of molecules and radicals. Dr. Price has during the past few years contributed greatly to the teaching duties and administration of the Physics Department at King's College.

## Ford Prize for Peaceful Uses of Atomic Energy

ON the opening day of the Geneva Conference on the Peaceful Uses of Atomic Energy, it was announced by the Ford Motor Co. that it will put aside one million dollars to provide an annual prize for the best contribution to the subject. The award is to be made by an international jury, and the honorarium of 75,000 dollars and a medal may go to an individual or a group of scientists, irrespective of race or political views. If no award is made, the money is to be used for providing fellowships for scientists likely to contribute to the advancement of the peaceful application of atomic energy. This munificent gesture is a response, the Company states, to President Eisenhower's appeal to industry to offer an incentive in finding new ways of using atomic energy for the benefit of the human race, and has been made by Mr. Henry Ford and his brothers as a memorial to their father.

## New Reactor at Harwell

A FULL-SCALE, very low-power model of the Dounreay fast reactor has been built at Harwell and should be in operation before the end of this year. It has been named ZEUS (Zero Energy Uranium System) and will provide data relating to the design and operation of the Dounreay experimental plant. ZEUS is a fast reactor like ZEPHYR (the Zero Energy Fast Reactor), and the reacting core contains only the fuel, its canning material, and the coolant; there is no moderating material such as heavy water or graphite to slow down the neutrons. The fuel is uranium highly enriched in uranium-235 (from the diffusion plant at Capenhurst), instead of the plutonium fuel used in ZEPHYR. The fuel is in the form of long tubes which are mounted vertically to form a hexagonal-shaped core. The core is surrounded by an envelope of natural uranium, the purpose of which is to absorb the neutrons from the core and so produce plutonium. The Dounreay reactor and ZEUS are both breeder reactors in the sense that the amount of plutonium produced in the
reactor should exceed the amount of uranium-2
burned in the core. It is not expected that t
breeding margin will be as high as it was in ZEPHY
where the amount of fresh plutonium produced in t
reactor was found to be about double the amou
consumed in the core. The operating power-level
ZEUS will be only about one-millionth of that of t
proposed Dounreay reactor. This will be sufficie
for experimental studies. Because of the compl
technical problems which they pose, fast reactors w
not play a prominent part in the early stages of t
utilization of atomic energy; but when they do com
into widespread use they will make it possible for
substantial supply of fissile material to be obtain
economically from a relatively modest supply
uranium.

## Radio-astronomy at Cambridge

THE University of Cambridge has accepted t
offer of a gift by Mullards, Ltd., of ten annual su
scriptions of £10,000 each, for continuing a
extending the work in radio-astronomy which is no
being carried out at the Cavendish Laboratory.
is intended to set up a new observatory on a s
near Cambridge, which will be known as the Mulla
Radio-astronomy Observatory. The grant will ma
it possible both to obtain the use of the land
provide laboratory buildings, and to construct ne
instruments. It is hoped in this way to develop
number of the lines of research which now appear
offer great promise. During the past two years
survey of radio stars has been completed at Ca
bridge which led to the location of nearly tw
thousand radio sources. Only a small fraction
these could be related to optically observable objec
and an analysis of their apparent distribution
space has suggested that most of them represent a
extremely rare and intense class of source; on th
interpretation most of the sources observed lie beyo
the reach of the most powerful optical telescope
in regions where the predictions of different cosm
logical theories diverge. The extension of the
observations, their comparison with cosmologic
theories, as well as work on the general emissi
from the galaxy and on the structure of the out
layers of the solar atmosphere, represent some of t
investigations which it is hoped to undertake at t
new Observatory.

## International Co-operation on Purification Brackish Water

GREAT BRITAIN has joined an international schem
for research on de-salting saline waters by electr
dialysis; the work will be carried out in The Nethe
lands. In many countries, difficulty is being found
providing the increasing quantities of fresh water r
quired for domestic and industrial use. For examp
sea-water is infiltrating into freshwater wells in t
Thames estuary and it is becoming more and mo
difficult to suggest other sources that do not invol
expensive, long-distance pumping. Talks on t
possibilities of various methods of de-salting wat
have been going on for some time under the auspic
of O.E.E.C. One promising process is electrodialys
—the removal of salts from a liquid flowing betwe
pairs of ion-selective membranes, by means of
electric field. Research on this method is already w
advanced in The Netherlands. The Dutch recent
offered to carry out development work in co-operati
with other countries showing an interest. Gre
Britain has joined The Netherlands, South Afric

Australia and Algeria (representing France) in paying for this work; the problems to be solved are mainly those of bringing up the process from small to large pilot-plant scale. In Britain, an Admiralty team has been working on scale- and foam-prevention in the distillation of sea-water. The Department of Scientific and Industrial Research has now given 5,000 for an extension of that programme to cover other waters. A Dutch scientist is joining the team. Two other processes have been put forward by the French, namely, certain aspects of ion-exchange and of solar distillation, which may be suitable for use in very hot, dry areas; no co-operative group for their study has yet been formed.

### New Discovery at Swanscombe, Kent

Some time must necessarily elapse before a complete study can be made of the portion of a human skull bone discovered at Swanscombe by Mr. and Mrs. B. O. Wymer, Mr. J. Wymer, and Mr. Adrian Jones on August 1. It can, however, be confirmed that the bone is a right parietal, and it fits perfectly with the left parietal and occipital which were discovered on the same site by Mr. A. T. Marston in January 1935. This in itself is very satisfactory, and will enable further evidence to be obtained from the bones as a whole. Meanwhile, the remarkable fact that another portion of the same skull has been found after an interval of twenty years is a striking justification of the policy of the Nature Conservancy in preserving sites of scientific importance. The remaining region of the Swanscombe skull has still to be discovered, and it is very much to be hoped that it will be found during the further excavations which it is understood are to be made. It is therefore of the greatest importance that the site should be protected from damage.

### Commonwealth Agricultural Bureaux

The growth of the Commonwealth Agricultural Bureaux, like so many other British organizations, has been one of adaptation and adjustment, often on an empirical basis, to the needs and mood of the time. It dates back to 1909, when recommendations were made for forming an Entomological Research Committee, duly leading in 1913 to the foundation of the Imperial Bureau of Entomology, and to 1920, when an Imperial Bureau of Mycology was started. In addition to these two bodies, now named the Commonwealth Institute of Entomology and the Commonwealth Mycological Institute, respectively, eleven other Commonwealth centres were later founded, as follows: Institute of Biological Control, Bureau of Agricultural Parasitology, Bureau of Animal Breeding and Genetics, Bureau of Animal Health, Bureau of Animal Nutrition, Bureau of Dairy Science, Bureau of Forestry, Bureau of Horticulture and Plantation Crops, Bureau of Pastures and Field Crops, Bureau of Plant Breeding and Genetics, and Bureau of Soil Science. Though these centres are situated in Great Britain, they are essentially Commonwealth organizations and are in the hands of an Executive Council which comprises one member from Great Britain and one from each of the Dominions of the British Commonwealth (including the Republic of India and the Federation of Rhodesia and Nyasaland) and one member representing the Colonial Territories. One of the recommendations of the Commonwealth Agricultural Bureaux Conference of 1946 was that the Executive Council should issue a conspectus showing the subjects or aspects of subjects covered by the journals of the institutes and bureaux. At the same time it was decided to incorporate a brief account of the history and origin of the Commonwealth Agricultural Bureaux organization. As a result, the conspectus was issued in 1949 giving a short description of the history, work, administration and finance of the Bureaux and a detailed review of the subjects covered by each institute and bureau. The conspectus has now been revised and is a valuable pamphlet of nearly fifty pages (London: H.M.S.O., 1955) showing the state of the Commonwealth Agricultural Bureaux at the time of going to press in October last year.

### National Institute of Agricultural Botany

In his address to the Fellows of the National Institute of Agricultural Botany, Cambridge, at the annual general meeting of the Institute on July 14, Sir William Slater said that a fundamental feature of the Institute's work has been the introduction of greater precision into the evaluation of the different varieties of agricultural and horticultural crops, and as a result the farmer and grower now have information upon which they can rely. With regard to plant breeding, he believes that undue emphasis is sometimes laid on a search for an ideal variety incorporating all possible good qualities, whereas a sound range of good varieties of known performance, from which the farmer can select according to his requirements, may be preferable. Prof. T. J. Jenkin, chairman of the Council, in presenting the annual report for 1954, referred to the arrangements for transfer from the Welsh Plant Breeding Station of the certification of the Aberystwyth strains of grasses and clovers, and for sowing an additional acreage of foundation seed as the first stage towards full responsibility by the National Institute of Agricultural Botany for the production of stock seed of these strains. A recommended list for the potato crop has been produced for the first time, the certification schemes for cereals have been developed and a new scheme inaugurated for vegetables. Considerable progress has also been made in the national certification scheme for herbage plants. In conclusion, he was able to announce the authorization by the Ministry and Treasury of a capital grant for a much-needed extension to the headquarters building and for improvements in glasshouse accommodation.

### Institute of Science Technology

In 1948, the Science Technologists Association was formed for technicians in science laboratories in educational institutions and in industry who were not covered by the Institute of Medical Laboratory Technology. The membership has now grown to approximately 1,300, and many branches have been formed providing for local activities. The Education Board of the Association has arranged examinations at both certificate and diploma level, and the Association has assisted in the training of technicians in other ways and has maintained a technical information service. A primary purpose of the Association had always been the formation of an Institute of Science Technology, and this was accomplished at an extraordinary general meeting of the Association held on May 21. The Institute has been granted a certificate of incorporation and has taken over the affairs of the Association. Membership of the Institute will consist of Fellows, honorary Fellows, associates, ordinary members and registered students; the training scheme approved by the Institute is a five-year course of study (three years for a certificate followed by two further years for a diploma) leading to the associate grade. Information on the aims of the Institute, examination syllabuses and details of membership may be obtained from the registered office of the Institute: Hon. General Secretary, F. W. L. Croker, Chemistry Department, Imperial College of Science and Technology, London, S.W.7.

## Engineering Appointments in Great Britain during 1954

During 1954 the Professional Engineers Appointments Bureau (9 Victoria Street, London, S.W.1) submitted particulars of more than nine thousand engineers for vacancies notified in civil, mechanical and electrical engineering, and this is the highest annual number recorded since the Bureau was set up nine years ago by the Institutions of Civil, of Mechanical and of Electrical Engineers. There has been an increase in the number of registrations with the Bureau, many from overseas, and this increase contributes to the better service which the Bureau can offer to employers. On the other hand, because of the full employment position, there is a reluctance on the part of many engineers to change their employment unless substantial benefits are likely to result. The main demands in civil engineering have been for engineers with wide design experience, good contractors' experience and for young engineers prepared to accept overseas posts; there has also been a big increase in technical vacancies notified by local authorities. In mechanical engineering requirements have been varied and have included posts for engineers with experience in chemical engineering plant, hydraulics, servo-mechanisms, production and management. The major proportion of electrical vacancies have called for experience in the sphere of electronics and light-current engineering, including instruments.

## Forestry in Northern Ireland

In an introduction to a well-illustrated pamphlet issued by the Minister of Agriculture in Northern Ireland, entitled "Forestry in Northern Ireland" (pp. 20; Belfast, 1954), a brief historical review is given of the forests of the region in the past. It was not until 1903 that a definite step to stop deforestation, which the great storm of that year had increased, was taken. A forestry branch of the Department of Agriculture was inaugurated, technical instruction was undertaken and Avondale in Co. Wicklow was acquired as the first forestry centre and training school. Progress has been made since then. The forest policy laid down is governed by three principal factors. First, there is the compelling need, which two World Wars have demonstrated, to reverse the centuries-old process of deforestation and to create home-grown timber resources equal to emergency requirements. Secondly, it is necessary to provide productive work in areas of serious unemployment; and thirdly, though private planting can contribute usefully, under present economic conditions any such contribution must be small. A Forestry Act (Northern Ireland) was passed in 1953, and afforestation and other work is proceeding under the Act. As in so much of Britain, sitka spruce is the most important single species in the reafforestation programme.

## The German Plastics Industry

The German Forschungsgesellschaft Kunststoffe e.V., a union of 189 firms, was founded in 1953 with the object of promoting the scientific investigatic and practical application of plastics (*Kunststoffe*) ar the development of the industry. It has founded tl Deutsche Kunststoff-Institut in Darmstadt, und the direction of Prof. K. H. Hellwege and in tl grounds of the Technical Institute, and the ne Institute is expected to be functioning fully at tl end of 1956. It will comprise laboratories and worl shops, a library and documentary department, and separate hall of manufacture equipped with all tl necessary machinery. The staff will comprise eigh to ten physicists, chemists and engineers. The co will be largely met by members of the Forschung gesellschaft, with assistance from the State of Hess The programme of research will be under the directio of a board, including the chairman of the Forschung gesellschaft, State and town officials, the Rector the Technical Institute of Darmstadt, and repr sentatives of science and industry. The foundatio stone was laid last May, with appropriate ceremonie in which the Minister of Education participated. casket containing specimens of various plastics wa enclosed in the foundation stone. The organizatio has recently established a literary service called *Literatur-Schnelldienst*, which is available to membe and non-members. This is planned to appear monthl and takes the form of a prompt documentation b titles and short abstracts of all publications an patents, both German and foreign, of interest in a branches of the science and technology of plastic This publication, a specimen of which in the form o photostat copies of sheets has been received at th office of *Nature*, is apparently issued by the Arbeits gemeinschaft Deutsche Kunstoff-Industrie, 4 Güter platz, Frankfurt-am-Main 1, the director being D H. Saechtling. The price of the *Literatur-Schnelldiens* is given as 80 DM. to members of the Forschungs gesellschaft and 200 DM. to non-members per annum

## Announcements

The Wellcome Trustees announce that, with th approval of the chairman of the Medical Researc Council, they have appointed Brigadier J. S. K Boyd to be a Trustee as from January 1, 1956, i succession to Prof. T. R. Elliott, who is retiring fron the trusteeship in October. Brigadier Boyd i relinquishing the directorship of the Wellcom Laboratories of Tropical Medicine on December 31 and will be succeeded by Dr. R. S. F. Hennessey who, until his recent retirement, was director o medical services, Uganda.

The following lecturers in the University o Aberdeen have been appointed readers in the subject stated, as from October 1: Dr. H. W. Kosterlit (physiology); Dr. T. N. Morgan (materia medica) Dr. W. P. D. Wightman (history and philosophy o science); Dr. W. T. H. Williamson (soil science).

The French Society of Metallurgy is holding it annual "Journées Métallurgiques d'Automne" i Paris during October 24–29. Further informatio can be obtained from the Société Française d Métallurgie, 25 rue de Clichy, Paris 9$^{e}$.

The Scottish Group of the Nutrition Society i holding a symposium in Aberdeen on September 1 on "Cholesterol and Fat Metabolism in Relation t Diet and Disease". Both the biochemical and clinic aspects of the subject will be considered. Furthe particulars can be obtained from Dr. A. M. Thomson Department of Midwifery, University Medical School Foresterhill, Aberdeen.

# CONFERENCE ON THE EFFECTS OF NUCLEAR WEAPONS

A WORLD conference of scientists to consider the effects of nuclear weapons was organized by the World Association of Parliamentarians for World Government and held at the County Hall, London, during August 3–5. The Right Hon. Clement Davies, president of the Association, opened the conference, and the Right Hon. Walter Elliot took the chair during the subsequent sessions.

Earl Russell opened the debate and moved his resolution urging Governments to acknowledge publicly that their purposes cannot be furthered by world war. He asked scientists to collect together the results of their investigations of the effects of nuclear warfare, and then see that they are clearly expressed in simple language and disseminated as widely as possible. Not only nuclear physicists, but also geneticists, meteorologists, authorities on soil and crops, and other experts will be needed in the investigations. Some of the work has been done already, but what is needed is a series of reports by internationally acknowledged authorities on the subjects concerned.

These reports would make it clear that a nuclear war would not bring victory to either side, but would probably create a planet destitute of life, except for a few mosses and fungi. If nuclear weapons are intended only as deterrents, and there is no intention of using them, then it would seem simpler and more economical to have the deadlock admitted and the impossibility of war acknowledged. War can no longer serve as an instrument of policy. We cannot wait to learn this by experience, because the experience would probably be that of universal death.

It is only the first steps that depend upon men of science as such. Their pronouncements will have to be taken up and clarified and emphasized by leaders of public opinion, who will have to make their weight felt by statesmen of East and West alike.

Another important sphere lying within the scope of science is the possible peaceful uses of atomic energy and of other scientific discoveries. The tendency of the general public to think of scientists as merchants of death must be combated, and it must be made clear that science could and would bring benefits to mankind as great as the disasters it has been rendering possible. If the world were liberated from fear of war, science could abolish poverty and raise the standard of living throughout the world, make deserts fertile, and ameliorate inclement climates.

Collective hatreds have darkened history since the dawn of organized society. They are about to cease, either because no one will be left alive to feel them, or because men will have learnt the elementary wisdom that only by overcoming collective hatred can the human race survive.

Earl Russell was followed in the debate by a number of distinguished speakers, including Prof. J. de Castro, Prof. M. L. Oliphant, Prof. E. Rabinowitch, Prof. A. J. Ayer, Prof. A. Topchiev, Lord Boyd Orr, Lord Beveridge, Prof. C. H. Waddington, Prof. R. W. Ditchburn and Prof. G. Boschi. They generally welcomed his proposals, in some cases with reservations, and stressed the dangers of nuclear weapons and the importance of developing the peaceful uses of nuclear energy.

On the second day, the scientists divided into three commissions to study the destructive potential of nuclear weapons and the hazards of the large-scale peaceful use of nuclear energy, the international control of atomic energy, and the individual and collective responsibility of the scientist. The other delegates debated the responsibility of Parliaments in the nuclear age.

The main task of the three commissions was to define more precisely their terms of reference and, where possible, to pose the questions that need to be answered. It is proposed that their reports be circulated to interested scientists all over the world with a request for comments, suggestions and details of scientific and technical investigations bearing upon them. These will be incorporated in a final report to be presented at another conference to be held in The Hague about a year hence.

The first commission examined the destructive potentials of nuclear weapons, the possible consequences of their massive use in war and in tests, and the possible harmful effects of the peaceful uses of atomic energy. It was agreed that its investigations should be carried out under the following headings: (*a*) physical destruction; (*b*) effects on individuals; (*c*) effects on animals and crops; (*d*) long-term genetical effects on human beings, animals and plants; (*e*) meteorological effects; (*f*) effects of a rise in the general level of radioactivity in the atmosphere and the soil. Prof. J. Rotblat, of the Physics Department, Medical College of St. Bartholomew's Hospital, Charterhouse Square, London, E.C.1, was appointed secretary of the commission.

The second commission examined the technical problems of the supervision and control of the production and use of nuclear weapons with the view of enforcing their prohibition. A number of questions for further study were posed and classified under five headings: (*a*) Detection of existing weapons and fissile materials: Can direct physical methods or other indirect methods be used for the detection of existing nuclear weapons and fissile materials, and if so, what are they? (*b*) Inspection of means of delivery of nuclear weapons: Can surprise attacks be made impossible by setting up a system of control of the means of delivery of such attacks, or of dangerous concentrations of air, naval or land forces for such an attack; for example, by establishing points of control in ports, road junctions, airfields, etc.? (*c*) Control of mines and plants producing or employing fissile materials: Are the possibilities of the control of diversion from these plants of fissile materials affected by new scientific or technical developments, and are there methods by which the conversion for military uses of materials used in power plants can be made difficult or preventable? (*d*) Adaptation of controls to possible future developments: Can the control methods be made flexible enough to be adaptable to possible new developments such as new methods of initiation of thermo-nuclear reactions? (*e*) Nuclear weapon tests: How could nuclear tests be detected and how effective could be the cessation of such tests?

The commission said that the study of these questions would be greatly facilitated by closer international co-operation of scientists, and by the reduction of secrecy to a minimum. Dr. P. E. Hodgson, of the Physics Department, University College, London, W.C.1, was appointed secretary of the commission.

The third commission examined the responsibility of scientists for the direction of their work, the uses to which it is put, and public knowledge of its implications. Dr. J. Bronowski, of the National Coal Board, Central Research Establishment, Stoke Orchard, Cheltenham, Glos, was appointed secretary of the commission.

The representative character of the conference was increased by the presence of a delegation from the U.S.S.R. comprising Academician A. Topchiev, professor of organic chemistry and general secretary of the Academy of Sciences of the U.S.S.R., Prof. O. A. Golounsky, director of the Institute of Criminology, University of Moscow, Prof. A. V. Kusin, a biochemist, and Prof. M. A. Markov, a theoretical physicist. The atmosphere of the discussions was cordial, and their conclusions unanimous.

The final day of the conference was devoted to the presentation and discussion of the reports of the three commissions. At its close, Earl Russell moved his resolution, which had been slightly modified as a result of the previous day's discussions: "Since in any future world war nuclear weapons will probably be employed and since such weapons threaten to bring immeasurable suffering for humanity, and material destruction, and possibly even the end of mankind, we urge, therefore, the governments of the world to realize and to acknowledge publicly, that their purposes cannot be furthered by world war; consequently we urge the full and open examination of the implications of recent scientific developments for humanity as a whole and the promotion of peaceful means for the settlement of all matters of international dispute". The resolution was carried unanimously.

P. E. HODGSON

# LONG ASHTON RESEARCH STATION

## FIELD-DAY

FIELD-DAY was held at Long Ashton on July 20 in conjunction with the fifty-second annual general meeting of the governors, members and associates of the National Fruit and Cider Institute. Captain D. M. Wills, chairman of the governors, presided.

In reviewing the work of the Station during 1954, the director, Prof. T. Wallace, referred to the promising results obtained from foliage sprays and soil dressings of chelated compounds of iron in the control of lime-induced chlorosis of fruit trees. Although these compounds, derived from ethylenediamine tetra-acetic acid and related substances, are as yet expensive, he believes that the residual effects obtained from a single application to calcareous soils make it likely that they can be developed to replace the present tedious technique of injecting pellets of ferrous sulphate into the trunks of affected trees. The chelates have been found to be photosensitive, and it is therefore necessary to water them well into the soil to prevent their breakdown at the soil surface.

In a brief account of the work of the Agricultural Research Council Unit of Plant Nutrition, Prof. Wallace recalled Dr. Nicholas's participation in experiments at the McCollum Pratt Institute which had shown molybdenum to be an essential constituent of the flavoprotein enzyme, nitrate reductase; he outlined investigations that are being made on other metallo-flavoproteins and on the valency changes of molybdenum within plants.

In a tour of the plantations, members saw three-year-old trees of Cox's Orange Pippin and Bowden's Seedling that had been newly grassed-down in further studies of the effect of cover crops on the availability of soil nutrients and of their interaction with fertilizer treatments. Experiments made with cider-apples between 1946 and 1952 had shown that, compared with clean cultivation or annual cover-crops, a grass cover rapidly increased the potassium and phosphate status of the leaves while decreasing the nitrogen status; the effects on tree growth and fruit yield had not been readily determinable as the trees had been well established when the covers were sown.

Current trials with growth-substances were demonstrated. In the search for a compound suitable as a thinning-agent for heavy-bearing varieties of apple naphthylacetamide has been tried for the first time in place of α-naphthalene acetic acid (NAA), which had caused a loss of marketable crop in a number of consecutive years. Sprays of the amide applied four days after petal-fall gave variable results: they had drastically over-thinned test branches of Crawley Beauty when used at half the strength (50 p.p.m.) recommended in the United States, whereas they had failed to effect any thinning of Laxton's Superb even when used at 1½ times the recommended strength.

From the bareness of their branches it was possible to distinguish trees of Worcester Pearmain that had received sprays of 30–50 p.p.m. 2:4:5-TP (2:4:5-trichlorophenoxy propionic acid) in August 1953. Treatment had permitted apples of good quality to be harvested fourteen days in advance of the normal crop, and had seemed likely to prove valuable to growers anxious to catch the early market. Damage to the treated trees had, however, become apparent early in 1954, when their yield was only 25 per cent of that from untreated controls. The uncertainty attending empirical trials of growth-substances has served to emphasize the importance of the investigations that Long Ashton has been making since 1946 into the production of natural auxins during the development of apples and other fruits.

Members were also shown experiments to decide the best method of rooting gooseberry cuttings, and demonstrations were made of the frame-working and top-grafting of apples and of the spraying of dwarf pyramid apples by an automatic machine developed at the Research Station.

Laboratory exhibits illustrated the techniques used in determining the performance of spray machinery and materials: these included measurements of droplet size, of the distribution and persistence of various formulations of copper compounds on potato leaves, and of the residues of DDT and captan on apples and other fruits. A new method for the determination of small amounts of captan has shown a maximum deposit of 19 p.p.m. on fresh strawberries successfully sprayed in 1954 against *Botrytis*, using three applications at 0·25 per cent. While no taint had been apparent in the fresh fruit, a slight taint had developed during the storage of canned fruit.

Other exhibits showed the use of radioactive tracers to follow the passage of systemic insecticides through bean and apple plants; and the production of cankers on apple trees by inoculation with mycelium or spore suspensions of *Gloeosporium perennans* and the formulation of a BHC – DDT emulsion as a substitute for winter washes for apple trees. The need or supplementing this emulsion with a later spray against the red spider mite (*Metatetranychus ulmi* Koch) was stressed, and favourable reports were made of the acaricide chlorbenside (*p*-chlorphenyl -chlorbenzyl sulphide), which has given nearly complete kill of the winter eggs of the mite when pplied at 0·05 per cent just before hatching of the ggs.

In an array of casks and bottles appropriate to the occasion, the Cider and Fruit-juices Section included attractive samples of concentrates and syrups prepared from black currants, strawberries and raspberries. Paper chromatograms showed the amino-acids distinctive of apple and pear juices and the changes in organic acids taking place during fermentation. Besides the bacterial breakdown of malic acid to lactic and succinic acids, the reduction of quinic acid to dihydroshikimic acid has recently been observed, a finding of some interest because of the role postulated for quinic acid in aromatic biosynthesis. Chromatograms of leaves of apple and pear and of the apple–pear hybrids produced by Mr. M. B. Crane at the John Innes Institution demonstrated that the hybrids had inherited the phenolic (tannin) components of both parents.

The cider-house contained a collection of gooseberries showing the characters that are being used in their classification, which is at present very confused; there was also a selection from the many varieties of perry pear collected during the past two years in a survey of West Midlands orchards, arising out of revived interest in perry. The longevity of perry pears ("He who planteth perry pears planteth truly for his heirs") was illustrated by a recent photograph of a vigorous tree planted at Holme Lacy, Herefordshire, in 1790, and reputed at one time to have occupied ¾ acre and to have yielded five to seven tons of fruit in one year.

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# ENDOCRINOLOGY AND AGEING

A MEETING of the British Society for Research on Ageing was held at the Ciba Foundation, 1 Portland Place, London, on June 9.

The opening paper was read by Dr. V. Korenchevsky on "Endocrinological Aspects of Gerontology". He pointed out that in studying the relationships of the endocrine glands to ageing processes the following three points have to be taken into account: (1) the changes in each gland with age; (2) the effects of their hypo- or hyper-secretion, as the case might be, in old age; (3) the use of hormones in treating the ailments of old age.

In the case of the testis, Dr. Korenchevsky listed seven changes which are characteristic of both ageing and castration and twelve which differ in these two conditions. Among the former are atrophy of liver, kidneys, heart and skeletal muscles, an increase in fat deposition and fatiguability and a pale, lifeless, non-elastic skin. On the other hand, the adrenals and the pituitary are atrophied in old age, but hypertrophy as a result of castration. Dr. Korenchevsky pointed out that castration can accentuate old-age changes, quoting the results of his own experiments on senescent rats, and those of previous workers, who have shown that castrated men of forty look like old men of sixty.

The thyroid gland in old age shows degenerative and sclerotic changes; but in some cases an apparently normal or even hyperactive gland has been found. However, the fact that most thyroids show degenerative changes in old age has for some time led to thyroid deficiency being thought of as a primary cause of ageing. Experimental evidence shows that thyroid deficiency is not itself the primary cause of ageing; but it can intensify and accelerate those degenerative processes which are present both in ageing and thyroid deficiencies. There is a possibility, on the other hand, that excessive thyroid secretion might accelerate ageing by wearing out the organism.

Ageing and hypofunction of the adrenal have some six effects in common, namely, increased fatiguability, asthenia, tendency to skin pigmentation, low basal metabolism, accumulation of toxic metabolites, mental depression and apathy. On the other hand, adrenal hypofunction produces hypotension and old age tends to produce hypertension.

The conclusions presented by Dr. Korenchevsky were that while degenerative changes in the three endocrine organs considered can produce, and therefore intensify, many of the conditions present in old age, they are not the basic causes of ageing. Experiments on senescent rats by Dr. Korenchevsky and recent clinical observations show that the hormonal treatment might be useful only in those cases of old age in which there is a deficiency of the respective endocrine. The treatment removes this deficiency and the intensifying effect which it exerts on the processes of ageing.

Following Dr. Korenchevsky's general survey, three papers were read—two on the ageing ovary and one on hormonal changes in the menopause. These included a thoughtful discussion of the ovary by Prof. P. L. Krohn, an interesting paper on hormonal relationships in the menopause by J. A. Loraine and a detailed account of a critical series of researches carried out in Amsterdam by Dr. O. Mühlbock and Drs. L. Boot and P. J. Thung. The latter paper was read by Dr. P. J. Thung.

Prof. Krohn pointed out that in considering the ageing processes it must be remembered that the ovary is a composite organ with several jobs to do; for example, it has not only to produce ova but also a series of reproductive hormones. The ageing of these two functions may not always run in parallel. Also a specially produced tissue, such as the corpus luteum, has a life and an ageing time-table of its own, not necessarily related to the other ovarian changes. Furthermore, the fœtal ovary (for example, in the mare) may be twice the size of the mother's ovary, due to great overgrowth of the interstitial elements, and the subsequent degeneration of these cells might be described as a form of ageing. While all these factors must be taken into account in studying the ageing ovary, the reactivity of the endometrium to hormonal stimulation must also be considered. The uterine endometrium in women, for example, remains after the menopause responsive to the injected hormones for a considerable period of time. Presumably, therefore, the menopause is due to ovarian hormonal changes rather than to change of reactivity of the uterus. Presumably this again is a case of ovarian functions ageing at different rates, for women have been known to become pregnant after several years of amenorrhœa, which suggests that the ovulatory processes have not aged as rapidly as the hormonal. That a completely menopausal ovary is still fulfilling some sort of function is indicated by the fact that a second series of menopausal symptoms can follow the removal of post-menopausal ovaries.

The reproductive life in animals seems to continue, although becoming reduced, as the animal becomes older, and a post-menopausal period in women is a biological luxury of very recent origin.

Apart from the ageing of the ovary, the ageing of the individual ova must be considered. Two schools of thought exist here. The first believes that the ovary receives its quota of ova early in its life, and the other that new ova are constantly being destroyed and formed. This controversy has not yet been settled, although Prof. Krohn expressed some bias towards the former view.

Dr. Loraine directed attention to the fact that gonadotrophin titre in both the urine and the serum of menopausal and post-menopausal women is relatively high. It was shown by Heller and Shipley in 1951 that women who are less than twenty-five years beyond the menopause have a gonadotrophin excretion significantly higher than those in whom menopausal symptoms occur more than twenty-five years before the investigation. Menopausal gonadotrophin resembles in its biological properties the gonadotrophins excreted by men and by non-pregnant women. It has been generally assumed that menopausal urine contains entirely, or predominantly, follicle-stimulating hormone. Recent work in Edinburgh has, however, shown that this material is in addition a relatively rich source of a hormone stimulating interstitial cell activity.

Bioassay methods have indicated that although the amount of oestrogen excreted by menopausal women is less than in those living a normal reproductive life, it is surprising that it still occurs at such a relatively high level considering that the menopause is a condition characterized by ovarian failure. Parkes in 1937 suggested that the adrenals might be the source of post-menopausal oestrogens. An accurate, sensitive and apparently specific chemical method by estimating separately oestriol, oestrone and oestradiol 17β has now been developed in Edinburgh by Brown. Confirmation of the bioassay work has been obtained in preliminary experiments using these methods.

Two theories have been put forward to account for menopausal symptoms. The first is the theory of gonadotrophin excess, and the second the theory of oestrogen lack; but there is now a good deal of evidence that the former is not correct. Even though the oestrogen withdrawal theory seems more likely, there are still several objections to this, and it seems that neither of the hormonal theories explains the cause of menopausal symptoms.

Dr. Thung pointed out that the involutionary changes in the mouse ovary are similar to those in man, the most characteristic of these changes being the decrease in the number of follicles until, finally, only a few degenerative follicles are left; however, there are some changes which take place in the ageing mouse ovary which are very different from those found in the ageing human ovary.

This is due to fundamental differences in structure between the two types of ovary. The human ovary has a connective tissue core, the medulla, around which lies a relatively thin cortical portion which contains the follicles and corpora lutea. By comparison, the mouse ovary contains very little interstitial tissue and no medulla: it is little more than a cluster of follicles and corpora lutea. Also, the mouse ovary during its reproductive period (abou one year) produces a much larger number of follicle both mature and atretic, than the human ovary in similar period. Moreover, each of these follicles destined to a shorter existence. The human ovary ageing becomes progressively more fibrotic, wherea in the mouse ovary very little fibrous scar tissue formed—the cells of the degenerating follicles simpl disintegrate and disappear. The pellicles surroundin the degenerating ova survive as crinkled remnant and often become calcified. In strains of mice su ceptible to amyloid degeneration, more parenchym is present in ageing ovaries; and hyaline infiltratio may occur, particularly in the corpora lutea, whic may afterwards also become calcified.

In ageing mouse ovaries, large phagocytic cell filled with lipo-fuscin pigment (ceroid) appear an increase in number with age.

These aged ovaries may still show some function activity; for example, an oestrous cycle persists i the vagina of the mouse (vaginal smear techniqu long after the loss of fertility, and these have in som cases been observed to persist even up to the momen of death. This suggests that some part of the ovar continues to secrete oestrogenic hormones. Th may, in fact, be the germinal epithelium, which n only becomes more obvious but also seems to have proliferative tendency in the old ovary, resulting i small ingrowing tubules and producing certain ce groups which look like small follicles without ova.

G. H. Bourne

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# WINTER OBSERVATIONS ON A ZONE OF CLIMATIC MODIFICATION IN THE NORWEGIAN ARCTIC

## By N. C. NEGRI

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DURING the post-war period of exploration, n less than seven scientific expeditions visited th Lyngen Peninsula, 250 miles beyond the arct circle on the north coast of Norway. However, a these parties confined their observations to th summer months; consequently there was no information relating to the prevailing winter conditions i the region. By the autumn of 1954 the need fo such observations was such that the newly forme Mount Everest Trust Foundation agreed to spons a "comprehensive winter survey". The Roya Geographical Society approved the final plans, an supplied much of the necessary equipment.

This article summarizes the climatological observations made in a zone of modification at the hea of a fjord on the north-west coast of the peninsul The inner reaches of this fjord were separated fro the main valley by two spits and an island. Fo the purposes of comparison, the expedition established a full-scale meteorological station half a mil north of these spits.

The mountain basin south of the spits clearly ha an unusual local climate, for we observed the sal water within it freezing, although the temperature a the station was above 29° F. After a brief invest gation of the general conditions in the basin, w reached the conclusion that the cause of the phenomena was a cold air stream from the south. Thi much was obvious; but the task of locating the ource of this air stream was a complex problem, ith the normal difficulties of field-research increased y the extreme conditions of the locality, and the mited daylight. We decided that the only certain method of fixing the position of the source would be y establishing the relative situation of the lowest emperature in the basin at sea-level, and tracing he source from there. We accomplished this by ircumnavigating the basin, measuring the temperature at frequent intervals. Eventually we succeeded n compiling sufficient reliable figures to plot isoherms for the region. Simultaneously with these ourneys, we ascended the slopes of the mountains sing from the basin, in order to determine the ertical extent of the climatic zone. The inversions ecorded on all occasions showed the temperature at ,000 ft. to be 10° F. higher than that at sea-level. The curve of this temperature gradient indicated hat the rise took place mainly in the upper 500 ft.

All the temperature-recording journeys proved beyond doubt that the very lowest temperatures occurred at a point just south of the fjord-ice at the base of a wide defile leading to a glacier-filled cwm, at an altitude of 1,500 ft. As the mountain walls n either side of the defile reached heights exceeding ,000 ft., it was safe to assume that the glacier cwm nd the defile itself were both free from wind, and herefore unlikely to be affected by cold air currents rom the interior of the peninsula. It followed from this hat the source of the cold air stream was the glacier.

The sequence of events from the time that a parcel of cold air accumulates near the snout of the glacier can now be traced. By virtue of its greater density, the glacier-cooled air would push itself under any comparatively warm air in the vicinity, and flow down the subsidiary valley formed by the rock walls of the defile. On reaching sea-level, it would attain a state of almost complete stability, that is to say, there would be little or no convection within the air itself, or heat exchange between the snow cover of the basin and the air. In relation to the latter, it should be remembered that, for a climatologist working during the Arctic night, the polar nocturnal constant relieves him of problems of solar or terrestrial radiation.

Having reached the valley floor, the parcel of air would flow over the surface of the fjord-ice toward the open water in the north. As it approached the warmer air near the water, it would cease to be a evel stratum, and become instead a wedge of air, behaving in exactly the same manner as a macroclimatic cold front. The water in the fjord was always 20° F. warmer than the air from the south, and therefore a fog layer 5 metres thick and 3 metres above the surface of the water would form at the point of occlusion.

Our conclusion from the above was that, during winter months when the moderating factors of radiation and reflexion were set at nought by the absence of the sun, the local climate of the mountain basin was entirely dependent upon the glacier at the southern extremity of the fjord valley; also, that this modification of macroclimate was quite out of proportion to the relatively small area occupied by the glacier.

The significance of such an area is obvious when one considers the difficulties of studying the relationship between glaciers and climate in the lower atitudes of Europe, where the climatologist has to account for an extremely wide diurnal temperature-range and other complicating agents, such as nocturnal heat exchange, ablation of the snow, and erratic winds. All these disturbing influences are removed during the period after the winter solstice, and it is possible to obtain almost perfect continuity in climatic observations until the return of the sun in February. So it may be said that, in the glaciated areas of Arctic Scandinavia, the climatologist has a virgin field, easily accessible, and abounding in possibilities for winter research on a smaller, and consequently more accurate, scale than is at present possible in Austria or Switzerland.

# AUTOMATION IN THE SOVIET UNION

THE U.S.S.R. claims to have achieved the automatic factory, but little detail is available; more definite information, at least indicating some of the lines along which research in this field is proceeding or is contemplated in the Soviet Union, may possibly be found in reports of two recent conferences: one on the modern theory of machines, and the other on the progress of automation in the consumer goods industries—mainly food and textiles.

The first of these, reported in *Vestnik Akad. Nauk SSSR*, No. 12, 1954, is by I. I. Artobolevskii and co-workers, and is chiefly devoted to the paper they themselves read at the conference, with a few brief notes on some of the other papers. The meeting was organized by the Institute of Machine Construction (affiliated to the Academy of Sciences of the U.S.S.R.), and was an attempt to strengthen the scientific foundations of the machine construction industry.

Artobolevskii's paper emphasizes the importance of the theory of machines and mechanisms, especially in relation to the growing demands of automation. Discussing first of all the general theory, he thinks this is fully developed only in the case of prime movers, and as yet very imperfectly in other directions. A main factor to-day is the greatly increased speed of operation and general efficiency, the effect of which still requires close study. But the most important direction for the development of modern machine design is that of automatizing and mechanizing technological or industrial operations. In recent years in the Soviet Union many types of automatic machine have been evolved. Automatic and continuous production lines have been widely adopted. Most of the heavy and laborious operations in mining, metallurgical, building and other industries have been mechanized. Soviet scientists have discussed many fundamental questions relating to automatic machines and mechanisms. More especially they have outlined the general theory of the cyclogram automatics, analysed problems of regulation and control, suggested means and methods for design of individual types of mechanisms, and so forth.

Many difficulties in the theory of automatic machines still await discussion and solution. Among the fundamentals, for example, are the dynamics of free-flowing bodies or material to be mechanically ground, screened and conveyed; the dynamics of bending or flexing of fibres and threads in textile, cable-making and similar machines; the hydrodynamics of viscous liquids to be treated in separators, centrifugal or other; the aerodynamics of air currents in wind motors and the like, including the various kinds of pneumatic mechanisms. These matters and many others demand specialists in mechanics, physics and chemistry, and their close co-operation. The author also refers to the need for rationalizing the form or geometry of the working organs and tools in a wide range of varied operations. A valid theory of working processes and operation should form the basis of generalizing methods of tool-form design.

A study of power and kinetic characteristics is also essential, and needs carefully planned experiment, with the development of methods and instruments for recording movements, speeds, accelerations, forces involved, and capacities. An important part here will be played by the new electronic, acoustic and electromagnetic devices, radioactive isotopes, the piezo-effect and other means now being applied. Calculation and design of automatic machine units involves furthermore a precise knowledge of their "kinetic layout (scheme) in principle", and more specifically their operational cycles and relations.

The cyclogram theory requires further development, since the determination of one or the other working cycle depends not only on the particular process or function, but also on speeds and accelerations of the several units, and the forces actuating these. From analysis of all these characteristics a general cyclogram may be constructed, conforming to the optimum performance of the machine with minimum expenditure of power on unproductive wastes or losses and maximum equalization of torque on the driving shafts.

The author proceeds to analyse the various mechanisms taking part in the operations: driving, transmission, directing, controlling, speed variation, stopping, etc. Special reference is made here to the design of cam mechanisms of the three-dimensional type, with the complaint that, in their kinetic and other aspects, theory has been little developed in the Soviet Union. Much the same applies to lever mechanisms, to non-stepped drives—so important in automatic machines—and to other units. Research in hand in some institutes in these and some other fields must be both intensified and extended.

Some of the fundamental differences between automatic and non- or semi-automatic machines are noted. In the former, a control unit called a 'datchik' appears to be of primary importance. It has been variously designated by British engineers as a booster, a pickup, etc. By means of suitable 'datchiks', variations in such parameters as speed, pressure, temperature, volume or density, are transmitted to the appropriate controls. In general terms, the author refers to certain lines of progress in the Soviet Union in the matter of controls not only for solids, but also for other forms of product, in statistical controls and computers, in programming, and so forth.

Other matters discussed also in general terms include the effect of clearance or play in kinetic couples, resilience, forces of dry and lubricated friction—requiring new methods of study and experiment—and temperatures. The hydrodynamic theory of friction is said to be well developed on the mathematical side, but less so on the experimental. The author considers that one of the most important parts of modern machine theory relates to machines in series or aggregates. Hitherto it has been developed quite separately for prime movers on one hand and the operative machines on the other; but under modern conditions the boundary line between these two classes is sometimes quite obliterated. It is now essential to regard the aggregate as one entity.

Somewhat more definite, but still largely in gener terms, is an article in an earlier issue of *Vestnik Al* (No. 8, 1954) by N. N. Shumilovskii on some problem of automation in the Russian consumer good industries, primarily as a means of increasing outpu of these goods and removing some of the bias i favour of heavy industries that has lately marke Soviet economy. His article is based on a recen conference sponsored by the Institute of Automatic and Telemechanics in collaboration with Ministr of Consumer Goods Production. Some of the funda mental requirements for conversion to complet automation and the creation of the automatic factor are indicated. These include close examination o particular cases of complete automation, preferabl of a more or less standard type, so that the experienc gained can be widely applied.

Some of these basic problems were discussed in paper by V. A. Trapeznikov, with a certain amoun of detail in other papers read at the conference. B way of example, conditions in the cotton industr were considered, in its different divisions: spinning weaving and finishing. In the first there is a con tinuous production line, with almost complet mechanization; but there is scope for more automation. In weaving, automatic machines are mainl used, but certain difficulties still remain: maintainin constant (*a*) tensions of thread at various stages (*b*) temperature, level and viscosity of sizes, and (*c* moisture content of yarn; (*d*) automatic warning o flaws, and stoppage for breaks or completion of bale or wrong patterns, etc. Various manual operation remain to be mechanized and automatized: feedin yarn, joining ends, winding and cutting threads, an removing product. Automatic control is also widely used in finishing; but much scope yet remains. A few solution strengths are controlled: sulphuri acid, sodium hydroxide and hypochlorite; but ther is no suitable automatic control of moisture conten of fabric after drying. In printing, too, the superposing of different coloured patterns in multi-colou work, along with other operations, should be automatized. Continuous automatic lines with cascade electric drives should be developed, providing the required range of speeds and automatic control of tensions.

The problems are widely different in tanning. Here there may be forty to fifty operations, of which up to 60 per cent may be mechanized in the best Soviet factories. With the aid of conveyors, cranes, telpher lines, automatic loaders, etc., mechanization at least (automatic or not) could be raised to 90 per cent. Suggestions for automatic continuous production lines have already been put forward by inventors and innovators, with a series of mechanized units of a new kind. Measuring devices, automatic controls of humidity, of dyeing, drying, spraying and fixing have yet to be perfected.

The author proceeds to discuss the progress made in some of the food industries, where automatism is in various stages. During the past few years, breadmaking has been highly mechanized; but automatic controls are still lacking in respect of moisture content of dough, temperature and moisture in the ovens, level of dough in the kneaders, and in other directions. In the confectionery trades much also yet remains to be done, although it is claimed that an automatic device has been evolved for caramels, with pressure and temperature control, and with automatic discharge periodically during continuous operation of the vacuum cooker.

In dairy work, although mechanization is said to have reached an advanced stage, from which the transition to almost complete automation should be relatively easy, this has not been accomplished. The so-called Meleshin method of making butter is cited as an exception; the process is said to have many features of interest, though none of these is described. The production cycle-time is reduced from 20 hr. to 40 min.; the butter is of high quality and keeps well in storage. It ought not to be difficult to extend automation generally throughout the dairy and allied industries, at all events so far as concerns the control of fat, sugar and other ingredient contents.

In the oils and fats industry, modern plant has been more extensively adopted, including continuous instead of batch operation both in production of the oil and in its refining. Some progress is reported in the matter of automation, but methods are still imperfect in respect of controls for certain operations: determinations of oil and moisture content, automatic weighings and feeds. Reference is made to new devices for automatic quality-control of products and of filter-press operation based in some way on dielectric losses; but no details are given. W. G. Cass

# BASIC RESEARCH IN THE UNITED STATES

The concern which is felt in the United States over the increasing dependence of basic research upon Government support is reflected in three papers contributed to a symposium on the roles of Government, industry and the university in basic research. The symposium was held in Berkeley, California, on December 30, 1954, and the papers have now been published in *Science* (121, 781; 1955). Discussing the role of Government, P. E. Klopsteg, of the National Science Foundation, defines basic research as the systematic endeavour, without preconception, to increase our knowledge and understanding of Nature, and he suggests that, if this definition could be applied precisely, the Government funds given for this purpose, estimated at 116 million dollars, 120 million and 131 million dollars for 1953, 1954 and 1955, respectively, would be drastically revised downwards. Nevertheless, the Government contribution is now many times greater than before the Second World War, and without discussing all the implications of such dependence on Government support, apart from the possibility of an ultimate deterioration in the quality of research and of bureaucratic interference with the administration of institutions of higher learning, Mr. Klopsteg thinks that Government policy should seek to encourage greater support of basic research both by corporations and individuals. For this he suggests that the income-tax law pertaining to charitable donations should be revised so as to encourage donations by taxpayers to basic research by one of three methods outlined which provide strong incentives for giving.

While the Government would still have an important responsibility for the direct support of research in its own laboratories and for the support of such research at educational institutions and of large projects by team research, Mr. Klopsteg considers that the proposals he makes would check the trend towards almost exclusive dependence on Government support. Institutions would derive their major support from private donors and corporations. Research would be kept free, and the severity of many problems originating in the inadequacy of funds for higher education would be reduced.

Mr. M. E. Speght, of the Shell Oil Co., New York, discussing basic research in industry, gives the number of research workers in the United States as 450,000, of whom more than a third have a bachelor's degree. Expenditure on industrial research laboratories is put at 2,500 million dollars, of which 1,100 comes from Government sources, and about 150,000 persons are employed in such work. Taking the total man-power, research costs are estimated at 7,000–10,000 dollars a year; but for professional workers the medium costs are about 15,000–25,000 dollars a year. Defining basic research as scientific inquiry carried on, not under pressure of immediate needs or in hope of quick profit, but with reasonable hope of some eventual payment, Mr. Speght estimates that industry employs some ten thousand people, four thousand of whom are professionals, and spends a hundred million dollars a year on such work, of which about ten million dollars is in support of research in universities and other non-profit institutions. The limits on basic research are most likely to be set by the number of worth-while ideas that the scientific worker of the organization can propose; but Mr. Speght agreed that a greater investment in the search for new knowledge is necessary if the present rate of technological advance is to continue. He also believes that industry's contribution, particularly to universities and their affiliated research institutes, will continue to increase, and he does not think that this trend can be interrupted by a business recession.

Discussing the role of the university, Prof. K. S. Pitzer recognized the inadequacy of university budgets in the United States even for the present level of basic research, and welcomed the effect of all Government aid to research. The administration of Government funds for this purpose by various Government agencies has been excellent; but he criticized the practice of breaking down the funds into very small units tied closely to particular projects. Funds made available to the universities on a broad basis are used very much more effectively, and he thought that both Government and industry could contribute to improved methods in the future.

# GRANTS TO STUDENTS IN TRAINING COLLEGES IN BRITAIN

The Working Party on Grants to Training College Students, on the recommendations of which the increased grants recently announced by the Minister of Education are based, was appointed in January 1954, with Mr. A. E. Miles Davies as chairman, to work out the costs which students at training colleges in Great Britain are called upon to meet and which are known to vary substantially and merit examination; the amount which parents or students should be required to contribute; the distribution of the balance over all local education authorities; and the reduction of the range of "incidental expenses". The then Minister of Education, Miss (now Dame) Florence Horsbrugh, in appointing the Committee, made it clear that she could not entertain any suggestion for relieving local education authorities of their present responsibility for sharing this expenditure with the Exchequer in the usual proportions. Accordingly, the more radical proposals of the National Union of Students and of Political and Economic Planning fell outside the terms of reference of the working party; it may be noted that Prof. R. Pascal, of the University of Birmingham, demurred at these latter proposals in an article in the *Universities Review* last October and gave as his main reason that they would abolish the association of the local authorities with the universities in this connexion—an association which, like the Association of University Teachers in its "Report on University Development, 1944", he believes to be of real value.

The report of the working party* opens with a brief survey of the present system and then discusses the two main criticisms. The first is that the grants for personal expenses which are made to about 60 per cent of all students, usually ranging between £20 and £50, but sometimes exceeding £80, are now generally considered to be inadequate; the gross cost to local education authorities is about £510,000, and the Exchequer meets some 60 per cent of this. Some suitable candidates are accordingly deterred from entering upon a course of training, and others, apart from completing their course only at the cost of hardship to themselves and their parents, are adversely affected by uncertainty about their resources, by enforced parsimony in their outlay on books and other necessary items or loss of social and cultural opportunities for development.

Secondly, there are wide variations among the education authorities in the amounts of assistance they offer and their arrangements for relating grants to income. Some limit their assistance to students with net parental income less than £500, and under the schemes of some thirty authorities a parental net income somewhat above £500 may disqualify a student from receiving any assistance towards personal expenses. About half the authorities make grants to students whose parental net incomes exceed £500, even though these students are at the same time required to pay a student's contribution under the Ministry's regulations, and the scales of some fifteen authorities provide for grants at net incomes exceeding £900. One or two authorities do not exercise their powers to make grants, and a few offer loans instead of grants or in conjunction with them.

In both these respects the financial position of training college students compares unfavourably with that of students at universities who are being assisted either by the Ministry or by local authorities. It was common ground, from the outset, among members of the working party that the present arrangements are vulnerable to complaints of unjustifiable variation, and investigation of the amount of personal expenses amply confirmed the criticism of general inadequacy. Their inquiry revealed an unexpectedly wide range of variation in estimates of personal expenses taken as a whole and for particular items such as clothing; but they formed the opinion that the wide diversity of practice among the training colleges in their interpretation of their responsibility for providing tuition, board and lodging, which leads to such variation, is undesirable, and they are convinced that the colleges should jointly review their arrangements in this respect with the view of adopting broadly similar practices in the division of expenditure between themselves and their students.

In making its proposals for a standard rate of grant, the working party envisages a grant which, for personal expenses, at the maximum, should cover the essential needs of students of no means, and for vacation expenditure should reasonably involve some contribution from their families towards their support in the family household. On these considerations and on the basis of the available evidence, it recommends that a total grant of £160 throughout the period of the two-year course should be generally adopted as the standard maximum grant, providing adequately for necessary personal expenses for a student of no means and also a reasonable contribution towards maintenance during vacations. For a student of no means it also recommends that the standard grant for personal expenses should be increased by an amount assessed individually to cover the ascertained cost of travel between home and college at the beginning and end of each term. Day students who live at any considerable distance from the training college should also be eligible for a similar allowance towards the cost of their daily travel. The standard rate of grant should be subject to triennial review at the same time and by the same machinery as the review of the university standard figures of maintenance. In view of the heavier expenditure incurred in the student's first year, it recommends that £30 of the total grant should be paid as an initial allowance before the student enters college and the rest in two equal annual instalments of £65.

The working party also considered the needs of women students attending three-year specialist courses in housecraft or physical education and a request for a higher annual rate by representative principals from the colleges providing the courses. The working party reached the conclusion that, for a housecraft student, a total grant of £240, £45 being given as an initial allowance and the remainder in three annual instalments, should be adequate, but for students of physical education it recommends an initial allowance of £55 and three annual grants of £65. For certain groups of one-year students it recommends a maximum grant for personal expenses at the rate appropriate to the first year of a two-year course, namely, £95. While for students who proceed directly to a supplementary course on completing their normal training, a maximum standard grant for personal expenses of £65 should be reasonable, for serving teachers the only satisfactory form of financial assistance is secondment on salary for the duration of their training, and general adoption of this practice is recommended.

It is clearly desirable that a system of standard grants for personal expenses should be accompanied by a uniform method of assessing parental contributions, and the working party finds in the income scale used for awards at universities made by the Ministry and by local education authorities a suitable general pattern for assessing a parent's capacity to contribute towards the cost of his children's education and training. Moreover, adoption of a single income scale for assessing grants for personal expenses would enable arrangements for both types of grant to be assimilated into a single scale, and the parental contribution would act in the first instance to reduce the amount of grant payable for personal expenses: a contribution towards boarding costs would fall due only when the assessed contribution exceeded the maximum of the grant for personal expenses. Under the scale, it would also become necessary for the home' local education authority to undertake the ntire responsibility for assessment, and the working party points out that administration of this system of assessment would be simplified by adoption of a uniform standard boarding fee at all training colleges.

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* Ministry of Education. Report of the Working Party on Grants to Training College Students. Pp. 28. (London: H.M.S.O., 1955.) 1s. net.

The total additional cost of these proposals, over and above the present annual expenditure on grants for personal expenses of £510,000, is estimated at about £1,400,000, of which £892,000 would fall on he Exchequer and £508,000 on local rates. The financial arrangements for teacher training as a whole would be simplified, and the working party also uggests including in the one pattern the personal and dependant's grants paid by the Ministry to ome older one-year students, and also grants to day tudents towards the cost of their home keep while attending college, thus bringing the annual expenditure covered by the proposals to about £2,080,000.

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# BARLEY ROOTS: NITROGEN ASSIMILATION AND RESPIRATION

IT has already been shown that the respiration of barley seedlings is closely dependent on the supply of nitrogenous nutrients. In culture solutions containing ammonium salts or nitrates, barley seedings show a rapid increase in carbon dioxide production, this being initially largely confined to the root system. The relation between respiration and the assimilation of nitrogen by roots has now been more fully explored by A. J. Willis and E. W. Yemm (*New Phytol.*, 54, 2, 163; 1955). These investigators have presented and discussed a considerable series of observations and have reached the following conclusions.

The assimilation of nitrogen in excised roots of barley leads to high rates of respiration. The greatest respiratory increases are shown by roots deficient in nitrogen and rich in carbohydrate. Roots cut from seedlings which are grown under conditions of nitrogen deficiency and which have not exhausted their endosperm reserves show smaller carbon dioxide increases when external sources of nitrogen are supplied than roots from older seedlings. Increases in both carbon dioxide production and oxygen uptake result from treatment of roots with ammonium salts, nitrates, nitrites and hydroxylamine, although there are secondary toxic effects of hydroxylamine. The form of the respiratory response depends upon the source of nitrogen supplied: ammonium salts give rise to very rapid increases in gaseous exchanges, while with nitrate the greatest increases are not shown until about 9 hr. after its addition to the roots. The effects of other anions and cations supplied with the nitrogen source are small. At very low concentrations of the nitrogen supply the respiratory increase is limited, and all the available nitrogen is exhausted from the culture solution.

These effects of nitrogen compounds on respiration are different in form and magnitude from salt respiration. The salt respiration of roots grown under the conditions used here has been demonstrated to be very much smaller than the respiratory increases found on supplying the roots with inorganic nitrogen. Measurements of respiratory quotients and evidence from direct analysis indicate that nitrogen is rapidly metabolized in the roots, and that high rates of respiration are associated with the synthesis of nitrogen compounds in the tissues.

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# THE EFFECT OF CERTAIN DRYING CONDITIONS ON THE PUTREFACTION OF CATTLE HIDES AND GOATSKINS

IT is unfortunately true that, after flaying, African prepared hides and skins are left lying in heaps for an unnecessarily long time in wet and filthy conditions, and it is not surprising that putrefactive damage forms one of the more common blemishes of East African hides and skins.

Putrefactive damage can be diminished by measures which will decrease the bacterial population. One of the most effective ways of preserving hides and skins is to reduce their moisture-content to a level where bacterial action and growth become impossible. Air-drying is the most commonly used method of preservation in East Africa because (*a*) it is a quick, cheap and easy method for African conditions, (*b*) chemicals are not generally available for salting or pickling, (*c*) transport charges on dried hides and skins are lower than on salted or pickled stock, and (*d*) no special storage or transport facilities are required.

A series of experiments was carried out by Dr. R. L. Sykes to determine the extent to which putrefaction could be controlled by certain methods of drying (*Colonial Plant and Animal Products*, 4, No. 3; 1954).

The traditional local African method of air-drying is to peg hides and skins on the ground, flesh-side up, to dry in the sun. The products, which in the past were called 'sun-drieds' and are now known as 'ground-drieds', are dirty, unattractive articles shunned by most tanners because, not only are they difficult to handle and soak back, but also because they give rise to unpredictable and serious losses during processing. Up to twenty-five years ago the bulk of East African hides and skins were prepared in this manner; but, as the result of tests on drying procedures carried out by a few pioneers, certain tanners realized that, when dried in sheds, the resulting 'shade-drieds' possessed superior leather-producing values and gave significantly lower tannery losses. The difference was so outstanding that controlled tests were carried out in 1932 by the Imperial Institute and the Kenya Veterinary Department. These experiments confirmed the earlier tannery observations, and as a result the drying of hides and skins in open-sided sheds after suspension within a vertical rectangular frame was advocated.

From its 1932 tests the Imperial Institute drew the important conclusion that the essential factor in air-drying was suspension and not shade.

The 1932 trials also led the Imperial Institute to suggest that hides could be dried in the open provided the heat from the meridian sun could be tempered by orientating the plane of the hides in an east-to-west direction and by inclining it to the vertical so that the plane lay parallel to the rays of the midday sun.

It was not always easy to make uneducated producers understand what was required, and, since the midday sun in East African latitudes strikes a vertical plane obliquely, it was found more practicable to advocate vertical frames when drying hides in the open.

Neither this experimental evidence, nor the fact that many Uganda hides are so satisfactorily dried in the open in the wet season that tanners cannot distinguish them from shed-dried articles, have convinced the more conservative critics, who are still doubtful whether drying in the open can ever be successful in moist humid climates. The experiments have shown that, under a variety of climatic conditions, some being most adverse, it is possible to dry cattle hides and goatskins satisfactorily. Provided the hides and skins are properly suspended for drying, the site, the presence of shade, or the method of suspension has little effect on the incidence of putrefactive damage. Similarly, under these conditions, a short delay of one hour in the cleaning, after flaying, has no effect on quality.

The majority of the putrefactive damage which occurs in hides and goatskins is avoidable and must be attributed to the carelessness or ignorance of the owner or producer. Any reasonably quick method of drying by suspension can thus be relied upon to eliminate putrefactive damage to hides and skins and no insuperable difficulty should be associated with normal drying methods in African reserves. This suggests a method by which a campaign for hides improvement, supported by the necessary legislation, should be able to develop the confidence of native producers and eliminate putrefactive damage almost completely.

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# REDUCTION OF CYTOTOXIC AZO COMPOUNDS BY HYDRAZINE AND BY THE XANTHINE OXIDASE–XANTHINE SYSTEM

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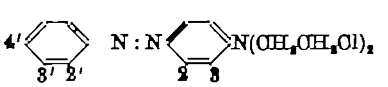
IT has been shown[1] that many aryldi-2-halogenoalkylamines can inhibit tumour growth, provided that the compound contains halogen atoms of a certain level of chemical reactivity[2]. In attempts to obtain derivatives of greater selectivity of action, compounds have been prepared which have chlorine atoms of low chemical reactivity but which could be activated by a change in the molecule such as could readily occur *in vivo*. Derivatives of the azo-compound (I) are suitable compounds for trial, since the parent substances contain chlorine atoms of low reactivity, whereas reduction products (hydrazo-compounds or amines) would be more reactive. It was hoped that such reduction of the azo-linkage would occur in the organism—compare the reduction of 'Prontosil' to give sulphanilamide[3]—but that it would not take place equally well at all sites and that some measure of specificity of action would result.



$$C_6H_5N:NC_6H_4N(CH_2CH_2Cl)_2 \quad (I)$$

A number of these azo-derivatives of 'aromatic nitrogen mustards' have already been described[4] and a long series of derivatives has now been prepared by us (unpublished work). Many of these compounds are effective inhibitors of the growth of the transplanted Walker rat carcinoma (personal communication by Prof. A. Haddow), and this suggested that the postulated reduction of the azo-linkage did, in fact, occur.

In order to obtain further evidence for the proposed mechanism of activation, an attempt has been made to correlate the ease of reduction of an azo-compound (I) with its biological activity. Since most of the compounds were sparingly soluble in water, the rates of reduction in 50 per cent aqueous alcohol at 24° C. and at *p*H 8 were initially investigated. Of the reducing agents examined, the most consistent results were obtained using hydrazine. The reaction, which was followed by measuring the characteristic light absorption at 400 mμ due to the azo-compound, was found to be first-order with respect to azo-compound, and in Table 1 the relative rates of reduction referred to the parent substance (I) are given. It can be seen that there is a definite indication that biological activity is associated with reducibility. Two apparent exceptions, the 2'-methyl- and 2'-carbomethoxy-derivatives, are almost certainly converted into the more readily reduced 2'-carboxy-derivative *in vivo*.

It was next felt desirable to ascertain whether any naturally occurring enzyme could effect the reduction of an azo-linkage; and since various dyestuffs are known to act as hydrogen acceptors in the xanthine oxidase–xanthine system, it seemed logical to examine this enzyme. In this case it was necessary to employ purely aqueous solutions, and accordingly the rates of reduction of various acidic derivatives, which have adequate water-solubility in pyrophosphate buffer at *p*H 8·2, were examined at 24° C. under anaerobic conditions. The suggestion to use this enzyme arose in discussions with Prof. F. Bergel, Mr. P. Avis and Mr. R. C. Bray, who kindly made available a concentrate of xanthine oxidase from cow's milk (stage *M5*) prepared as described by Avis *et al.*[5]. It was established that the azo-compounds

Table 1

| Compound substituent(s) in (I) | Rate-constant for hydrazine reduction | Tumour-growth inhibitory activity |
|---|---|---|
| 2-MeO,2'-COOH | 617 | + ve |
| 2-Me,2'-COOH | 519 | + ve |
| 2-Me,2'-COOH,4'-Me | 512 | + ve |
| 2-MeO | 468 | + ve |
| 2'-$SO_3H$ | 395 | − ve |
| 2-Me,4'-COOH | 366 | + ve |
| 2-Me | 359 | + ve |
| 2'-COOH | 235 | + ve |
| 2' : 3'-benz] | 204 | − ve |
| 2'-Cl | 193 | − ve |
| 2'-Me | 187 | + ve |
| 2'-Br | 170 | − ve |
| 4'-$SO_3H$ | 146 | − ve |
| 4'-COOH | 136 | − ve |
| 3'-COOH | 126 | − ve |
| 3'-MeO | 122 | − ve |
| 2'-COOMe | 118 | + ve |
| 3'-Me | 109 | − ve |
| 3'-Cl | 107 | − ve |
| None | 100 | + ve |
| 4'-Cl | 98 | − ve |
| 4'-Me | 97 | − ve |
| 4'-Br | 97 | − ve |
| 3'-Br | 97 | − ve |
| 3'-$NO_2$ | 85 | − ve |

Table 2

| Compound substituents in (I) | Per cent reduction by xanthine oxidase–xanthine at pH 8·2 in 30 min. | Tumour-growth inhibitory activity |
|---|---|---|
| 2-COOH,4'-NO$_2$ | c. 85 (in 5 min.) | + ve |
| 2-MeO,2'-COOH | 70 | + ve |
| 2-Me,2'-COOH | 49 | + ve |
| 2-Me,2'-COOH,4'-Me | 42 | + ve |
| 2'-COOH | 34 | + ve |
| 2-COOH,2'-CN | 34 | + ve |
| 4'-SO$_3$H | 5 | − ve |
| 2-Me,4'-COOH | 4 | + ve |
| 4'-COOH | 4 | − ve |
| 2'-SO$_3$H | 2 | − ve |
| 3'-COOH | 2 | − ve |

ere unaffected by the enzyme alone or by xanthine one under the standard conditions.

The correlation between reducibility and biological tivity shown in Table 2 is even more striking. The tes of reaction are expressed in this instance as rcentage reduction of the azo-linkage in a given me. One of the outstanding exceptions in Table 1—e 2'-sulphonic acid derivative—is now seen to be it slowly reduced by xanthine oxidase. The only iomaly in Table 2 is the 2-methyl-4'-carboxy-rivative, and here again it seems probable that idation of the methyl group to a carboxyl group ill occur *in vivo*. It has, in fact, been shown that per cent of the 2 : 4'-dicarboxy-derivative is reduced ider the standard conditions.

The implication of a flavin–adenine–dinucleotide enzyme in the *in vivo* reduction of azo-linkages has en discussed by Miller and Miller[6], and it is now ggested that xanthine oxidase may be the enzyme volved. It is realized that other dehydrogenases ay be able to effect the reduction, and this point under investigation. The protective action of etary riboflavin in butter yellow carcinogenesis uld be a consequence of increased xanthine oxidase tivity which converts the dye into relatively active reduction products. Our *in vitro* experiments dicate an initial formation of hydrazo-compounds with both hydrazine and xanthine oxidase, since azo-compounds are re-formed on oxidation with iodine. Eventually this property is lost and, in the later stages of the reaction, fission of the molecule to give amines probably occurs.

If xanthine oxidase is the enzyme involved in the reduction of azo-compounds, it should be possible to increase the effectiveness of carcinogenic azo-dyes by simultaneous administration of known xanthine oxidase inhibitors, and also to increase the effectiveness of growth-inhibitory azo-'mustards' by suitably increasing the xanthine oxidase content of the tissues, for example, by increased riboflavin and protein intake. Those azo-compounds which are activated in the manner proposed should be particularly effective against neoplasms in which xanthine oxidase content is high, for example, in hepatomas[7]. It is hoped to test these points in the near future.

Full details of the preparation of the various azo-compounds and the reduction studies will shortly be published elsewhere.

This investigation was supported by grants to this Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service, and was carried out during the tenure of an overseas C.S.I.R.O. research studentship by one of us (G. P. W.). We thank Prof. A. Haddow for permission to quote the results of tumour-growth inhibition studies, and Prof. F. Bergel for his interest in this work. [April 4

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# OCCURRENCE OF TECHNETIUM-98 IN NATURE

By EDWARD A. ALPEROVITCH* and J. M. MILLER

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WE wish to present a preliminary report of results obtained in the course of a systematic arch[1] for long-lived technetium-98[2] in terrestrial aterials. This investigation was undertaken in an tempt to shed some light on the cosmological and trophysical[3] problems raised by recent observations technetium in the sun[4] and several stars of spectral pes *S* and *M*[5].

In view of the expected low abundance[1] of the ld–odd nucleus $^{98}$Tc, a highly sensitive method of tection, neutron activation analysis, was chosen. pon exposure to slow neutrons, a sample containing chnetium-98 will, by the $(n,\gamma)$ process, yield tech-tium-99*m*, which can be readily identified by its 6-hr. lf-life and 140-keV. γ-ray. The formation of this tter isotope may be regarded as proof of the presence of technetium-98, if its production by three alternative processes can be ruled out:

(1) $^{98}\mathrm{Mo}(n,\gamma)^{99}\mathrm{Mo}$, followed by $^{99}\mathrm{Mo} \rightarrow {}^{99m}\mathrm{Tc} + \beta^-$

(2) $^{99}\mathrm{Tc}(n,n')^{99m}\mathrm{Tc}$

(3) $^{99}\mathrm{Ru}(n,p)^{99m}\mathrm{Tc}$.

It is imperative for this reason that the concentrates to be isolated from selected minerals[1] be free of all traces of molybdenum, ruthenium and $2 \times 10^5$-year technetium-99. Since many other elements also interfere by the formation of γ-emitting activities, the following separation factors are required: Mo $\sim 4 \times 10^{10}$; Re $\sim 10^{10}$; Ru $\sim 10^{9}$; 59 other elements, $10^{6}$–$10^{11}$.

A procedure meeting these requirements was developed by a combination of anion-exchange chromatographic and distillation techniques. The

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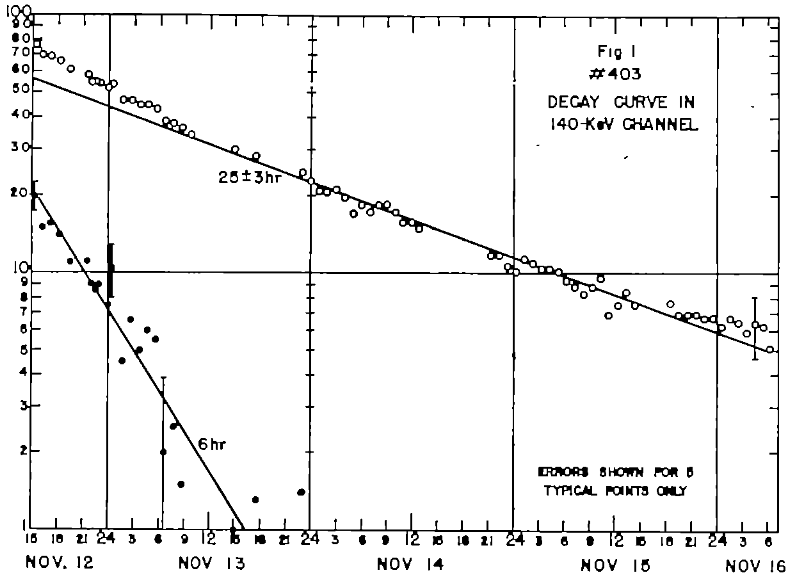

Fig. 1

minerals were dissolved by means of a fusion with sodium hydroxide and peroxide, and the sulphides of group II elements, along with any technetium present, were precipitated by hydrogen sulphide from acid solution. The sulphides were dissolved in a mixture of nitric, sulphuric and phosphoric acids, and the solutions steam-distilled under conditions in which technetium is known to be volatile. The distillate was then processed on 'Dowex-1' anion-exchange columns, and rhenium removed by elution with 0·2 *f* perchloric acid. The final concentrate, carried on copper sulphide or as mixed ammonium salts, weighing 0·1–1 mgm., was irradiated in the Brookhaven reactor for 12–70 hr. at a neutron flux of (2·4–3·6) × $10^{12}$ neutrons cm.$^{-2}$ sec.$^{-1}$. After irradiation, the copper was removed by cation exchange; the technetium, along with any molybdenum present, was co-precipitated with copper sulphide (procedure *A*), and counted with a scintillation spectrometer. In later work, the sample was processed on an anion-exchange column after the irradiation, and since technetium and molybdenum are separated in this step, a separate check for molybdenum was necessary. To accomplish this, the molybdenum was either carried on copper sulphide (procedure *B*), a method that was shown by separate tracer experiments to give a quantitative yield of molybdenum, or the molybdenum was carried o molybdenum sulphide (procedur *C*). In the latter case, a know amount of inactive molybdenur was added to the irradiate sample before any chemical prc cessing, and the final yield c molybdenum determined b chemical analysis. By means c this last procedure, the forma tion of technetium-99*m* fror molybdenum-99 could be rule out with absolute certainty, prc vided the isotopic exchange be tween irradiated and non-irrad ated molybdenum carrier wa complete.

Of twelve samples examine thus far, six gave positive result and two gave negative results in the remaining four cases th identification was uncertain. summary of the results is give in Table 1; a typical deca curve is shown in Fig. 1. Th data presented in Table 1 sho that: (*a*) in all cases a contaminating activit such as zinc-69 or arsenic-76 formed through neu tron capture by impurities from the resin and/c reagents makes a contribution to the countinç rate in the 140-keV. channel of the scintillatio spectrometer; (*b*) contamination with molybdenur 99 makes a contribution to the observed technetiur 99*m* activity in several experiments; but th contaminant was absent in five samples in whic technetium-99*m* activity was definitely identifiec and was not enough to account for all the tech netium-99*m* observed in a sixth sample.

The latter statement depends upon the assumptio that any molybdenum contamination present i these six runs behaved in the same manner a molybdenum tracer employed in experiments pe formed to check procedures *A*, *B* and *C*; th assumption is supported by the results in exper ments 396 and 410. The levels of the other cor taminating activities were generally sufficiently lo to avoid any serious difficulty in the resolution c the composite decay curves.

In the first phase of this work it had to be estal lished whether or not technetium-99*m* is produce by neutron activation of samples expected to contai technetium-98. The results obtained thus far hav proved this beyond doubt, for both radiation an

Table 1. SUMMARY OF NEUTRON ACTIVATION RESULTS

| No. | Mineral and locality | Total activity in 140-keV. channel (counts/min.) | Technetium-99*m* observed (counts/min.) | Chemical procedure* | Growth from molybdenum-99 | Conclusions |
|---|---|---|---|---|---|---|
| 390 | Columbite, Kal. Digrin, Somaliland | 40 | (< 4) | *A* | No | ? |
| 391 | Columbite, British Guiana | 56 | 10 ± 2 | *A* | No | + |
| 396 | Columbite, Mtoko Dist., S. Rhodesia | 7 | 5 | *B* | Yes | − |
| 397 | Columbite, Galoleh, Henweina, Somaliland Prot. | 12·9 | 10 | *B* | No | + |
| 402 | Yttrotantalite, McCreedy's Tin Mine, Swaziland | 56 | 7 ± 1 | *A* | No | + |
| 403 | Yttrotantalite, Kelly's Tin Mine, Swaziland | 77 | 21 ± 2 | *A* | No | + |
| 409 | ,, ,, ,, ,, | 52 | 33 | *B* | No | + |
| 425 | ,, ,, ,, ,, | 204 | (22) | *C* | No | ? |
| 429 | ,, ,, ,, ,, | 122 | (< 20) | *C* | No | − |
| 440 | Thortveitite, Norway | 249 | 48 | *C* | No | + |
| 442 | Yttrotantalite, Swaziland | 122 | 78 | *C* | ? | ? |
| 443 | Chromite, Gold Coast | 71 | 33 | *C* | ? | ? |
| 410 | Blank | 3·9 | 2·2 | *B* | Yes | |

* Chemical procedures used after irradiation: (*A*) no separation of molybdenum and technetium carried out after irradiation; (*B*) moly denum and technetium separated by anion exchange after irradiation; molybdenum recovered by copper sulphide precipitation; (*C*) moly denum and technetium separated by anion exchange after irradiation; molybdenum recovered by molybdenum sulphide precipitation.

decay characteristics of the short-lived activity were repeatedly determined and found to agree very closely with those for technetium-99*m*. In the second phase, however, it had to be shown that the activity was produced by the $(n,\gamma)$ reaction with technetium-98, and by no other process. We do not yet regard this phase of the work as completed, though the most plausible explanation of the internal consistency of the results suggests the presence of long-lived technetium-98. It is interesting to note that in a recent communication[6] Herr reports the detection of technetium-99*m* in the neutron activation analysis of a molybdenite; it is, however, not clear that the technetium-99*m* activity observed was formed from technetium-98; it may well have arisen from molybdenum-98 or technetium-99 contamination in the sample.

We are planning to carry out more neutron-activation analyses and to verify their results by independent methods such as mass spectrometry and emission spectroscopy. This work was supported in part by the U.S. Atomic Energy Commission. We hope to publish a detailed account of it in due course.

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# THE CONTRACTILE VACUOLE OF PARAZOA AND PROTOZOA, AND THE GOLGI APPARATUS

By PROF. J. BRONTË GATENBY
Trinity College, Dublin
AND
DRS. A. J. DALTON and M. D. FELIX
National Institutes of Health, Bethesda, Maryland

SAVILLE KENT[1] stated that "the peculiar flagellate sponge cells exhibited a very significant Protozoic feature in the possession of two or more posteriorly located, rhythmically pulsating contractile vesicles". In *Ephydatia* and *Spongilla*, Margaret Jepps[2] found contractile vacuoles in granular, hyaline, spicule-forming and collar cells, in the latter anteriorly located, however. Jepps studied various marine sponges, *Sycon*, *Grantia*, *Leuconia*, *Achinoe*, *Oscarella*, *Reniera* and *Halichondria*. She states, "In none of these sea sponges was a vacuole seen to contract in any cell whatever". Contractile vacuoles do, however, occur in some marine Protozoa.

Jan Hirschler[3], using the Kopsch and Sjövall methods (osmic acid reduction), described, as the Golgi apparatus of *Spongilla*, dictyosome-like bodies in the site of the contractile vacuole of Jepps. Hirschler did not know of the observation of Saville Kent, and thus unfortunately missed directing attention to the fact that the cortex of what seems to be the contractile vacuole in the freshwater sponge is specifically osmiophile, like the Golgi apparatus of the *Ciona* gut epithelium which he had studied at the same time by osmic methods.

It was left to D. Nassonow[4] to show that, in *Chilodon*, *Dogielella*, *Paramecium*, etc., the site of the contractile vacuole is the place of reduction of osmium tetroxide. Nassonow pointed out that in various metazoan cells (*Hydra*, *Axolotl*), a ring-form Golgi apparatus closely resembling the protozoan osmiophile ring-like surround of the contractile vacuole can be shown to exist. Nassonow considered that the cortex of the excretory apparatus of Protozoa, etc., was lipoid.

It has been shown by Dalton and Felix[5] that the metazoan Golgi apparatus typically consists of three components: (1) a group of long smooth double membranes; (2) clusters of small granules averaging about 400 A. in diameter, frequently showing an intimate association with the double membranes (these two components together form the cortical substance); and (3) a chain of large vacuoles arranged in the form of an open-sided cylinder. These vacuoles are not present in all cell types. The argentophily and osmiophily of the Golgi apparatus relate primarily to the small granules and the double membranes, although in some cells and under certain conditions the contents of the vacuoles are osmiophile.

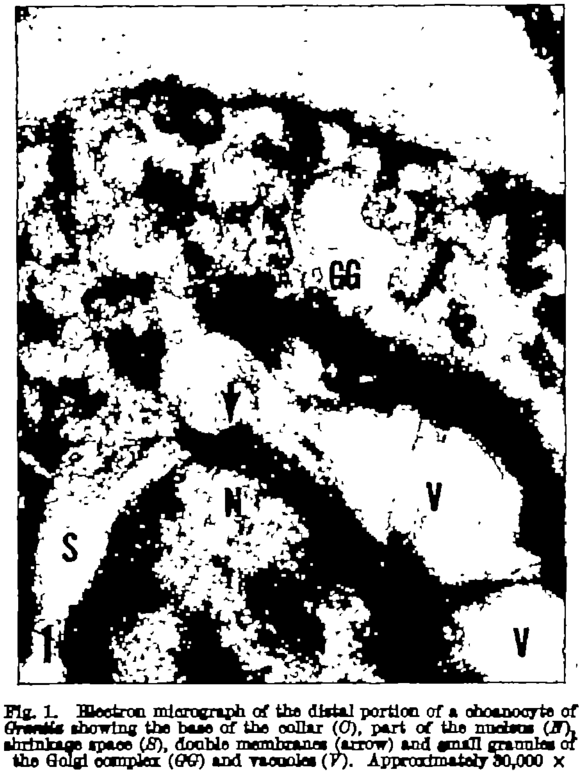
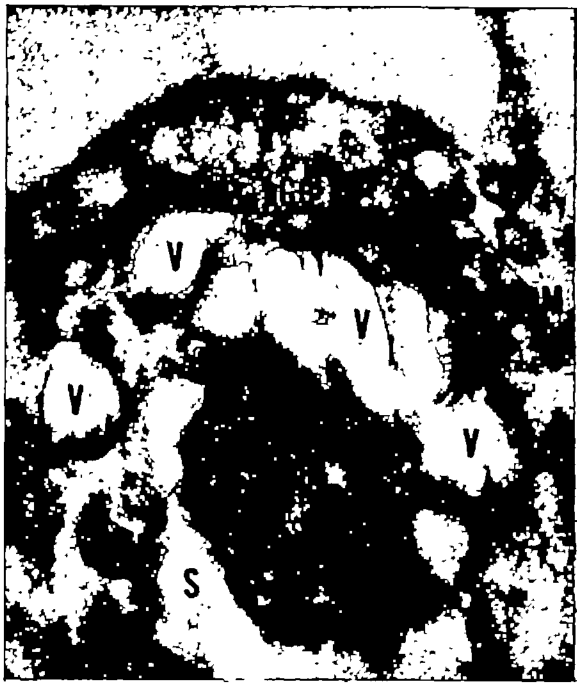


Fig. 1. Electron micrograph of the distal portion of a choanocyte of *Grantia* showing the base of the collar (*C*), part of the nucleus (*N*), shrinkage space (*S*), double membranes (arrow) and small granules of the Golgi complex (*GG*) and vacuoles (*V*). Approximately 30,000 ×



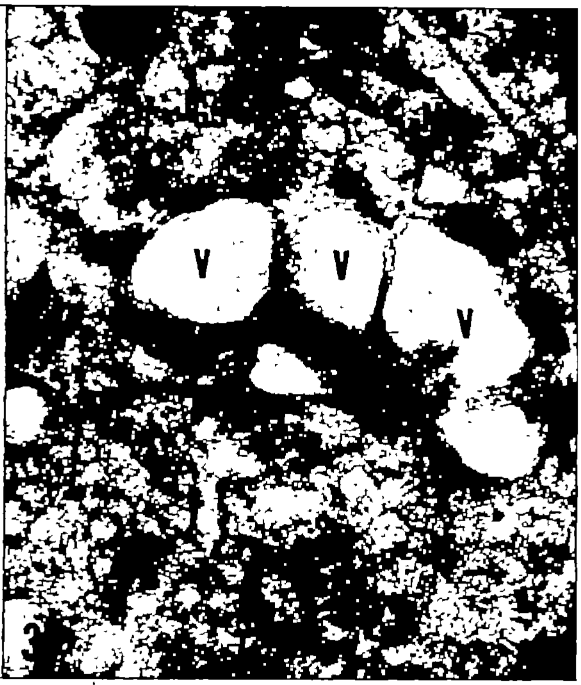


Fig. 2. Electron micrograph of a part of the same cell as in Fig. 1 at a different level, showing apparently separate vacuoles and mitochondria (*M*) with indistinct internal membranes. Other labels the same as in Fig. 1. Approximately 30,000 ×

Fig. 3. Electron micrograph of part of the Golgi zone of an epithelial cell of the epididymis of the mouse showing a marked similarity to the Golgi apparatus of the choanocyte (Fig. 1). The small granules appear to be continuous with the double membranes at some points (arrow). Labelling the same as in Fig. 2. Approximately 30,000 ×

The accompanying electron microscope photographs were made at Bethesda, Maryland (by A. J. D. and M. D. F.), from material fixed in buffered osmium tetroxide and chrome-osmium and received from Dublin (J. B. G.). Owing to the presence of spicules, the sectioning of the sponge material was very difficult. Figs. 1 and 2 of the marine sponge *Grantia compressa* show, at the outer end of the cell, the collar (*C*). The nucleus (*N*) has become shrunken on the left, leaving a space (*S*). Above the nucleus is the Golgi apparatus which, in the upper part of the photograph especially, shows a remarkable resemblance to the electron photographs of the epididymis (Fig. 3)[4,5,6]. There is a wall of double membranes and scanty Golgi granules (*GG*). In Fig. 2, we have confirmation of the observations of Jepps and Tuzet that several vacuoles can exist in this region. On the left of this figure, there is an apparently isolated vacuole (*V*) and at the lower right another partly shut off vacuole (*V*). At *GG* are examples of the scanty Golgi granules. At *M* are spherical mitochondria showing rather indistinct internal membranes. Besides the mitochondria, there are various granules of a smaller size of unknown nature. The Golgi apparatus of the choanocyte appears to have a spirally disposed inner cortical band.

We have also examined the contractile vacuoles of *Vorticella* sp. and the canals of the contractile vacuole of *Paramecium aurelia*. The osmic-reducing radiating canals are lined by a distinct, apparently single layer. Outside this, the osmiophile substance appears to be formed of a spongy branching network of short double membranes. Near the periphery of this zone are groups of small vacuoles. The cavity of the canal contains no formed material, and this also applies to the Golgi apparatus of the sponge *Grantia*. In the case of the contractile vacuole of *Vorticella* sp., the vacuole in partial systole contains a small cavity surrounded by a spongy mass of double membrane very similar to that of the cortex of the vacuol canal of *Paramecium*.

In conclusion, it can be stated that the electro photographs of the sponge Golgi apparatus closel resemble those of the metazoan cell Golgi apparatu This point of similarity is further strengthened by th osmiophily of the cortical substance on both, th presence near both of the small Golgi granules, an by the primitive form of dictyokinesis which has bee described in sponges, and in the contractile vacuol cortex of certain flagellates[7]. In 1933 Odette Tuzet showed that the acrosome of *Reniera* is formed i contact with a spherical body identical with th invertebrate dictyosome: all other types of spong cells studied with Golgi-apparatus methods by Tuze had one or more typical dictyosomes arranged i cells as the contractile vacuoles drawn by Jepp Thus from the freshwater sponge, through th marine sponge, we can link up the contractile vacuol and Golgi apparatus in metazoan cells. While th spongy cortical short branching material of th vorticellid contractile vacuole does not at first appea to resemble closely the lamellated membrane of th sponge, the substance of the cortical material i *Vorticella* is formed of double membranes; more wor on other Protozoa may supply the necessary intermed iate stages. A further account of this investigatio is being published elsewhere. [March 1

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Erosion of Surfaces by Liquid Drops

The question of erosion of aircraft surfaces due o flight at high speed in rain has for some time been he subject of study at research establishments both n Britain and in the United States.

To study the fundamental mechanics of the erosion rocess an apparatus is required which will reproduce he high-speed impact between a single drop and surface. Due to the low relative speeds at which ater drops shatter[1], difficulty is experienced in ccelerating a water drop of the size occurring in ain to the speeds at which surface erosion occurs above 400 ft./sec.). The alternative method of hooting the surface at a stationary drop has been sed in an apparatus described below which has been eveloped at the Royal Aircraft Establishment.

A projectile, the flat nose of which forms the surface o be studied, is fired from a compressed-air gun at a rop of water suspended on a fine web composed f a solution of 'Perspex' in aniline. After striking he drop the projectile is decelerated in an energy-bsorbing tube in such a way that the imprint of the rop on the surface is not damaged.

Fig. 1 is a diagram of the apparatus. The gun is red by rapidly opening a valve actuated by a large-iameter piston. It has been found that accurate ontrol of the projectile speed can be obtained by arying the air pressure in the gun, and speeds up to 00 ft./sec can be achieved. The technique of susending the droplet was suggested by Mr. W. R. ane, of the Chemical Defence Research Establishment, Porton, and provides a method of accurately placing a drop of any desired size. The energy-absorbing system comprises soft aluminium washers separated by spacers, the hole in the washers being larger in diameter than the flat impact surface of the projectile nose. The energy of the projectile is expended in passing through and deforming the washers. For some materials comprising the impact surface, such as metals, the washer system can be replaced by light pads of cotton wool, which do not damage the surface, placed at intervals along the tube.

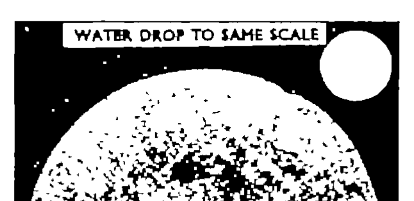

Fig. 1. Diagrammatic arrangement of apparatus. Crown copyright reserved

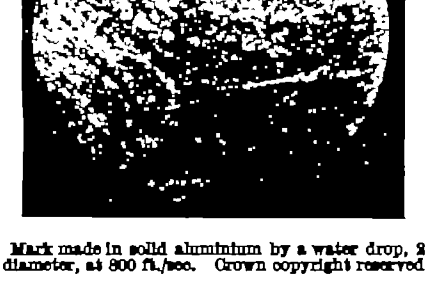

Fig. 2. Mark made in solid aluminium by a water drop, 2·5 mm. diameter, at 800 ft./sec. Crown copyright reserved

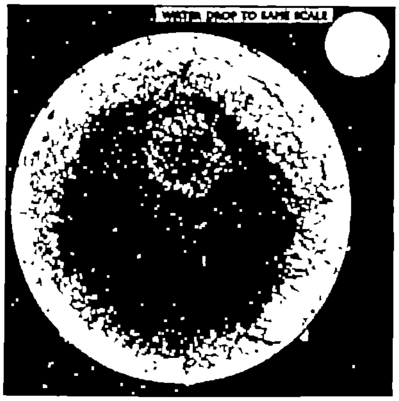

Fig. 3. Mark made in a wax layer by a water drop, 2·5 mm. diameter, at 580 ft./sec. Crown copyright reserved

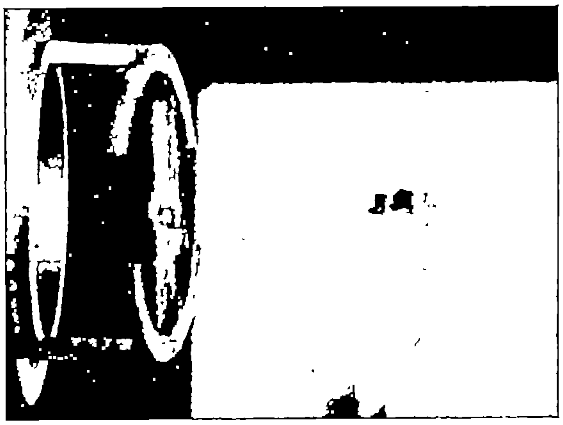

Fig. 4. Drop suspended on web. Crown copyright reserved

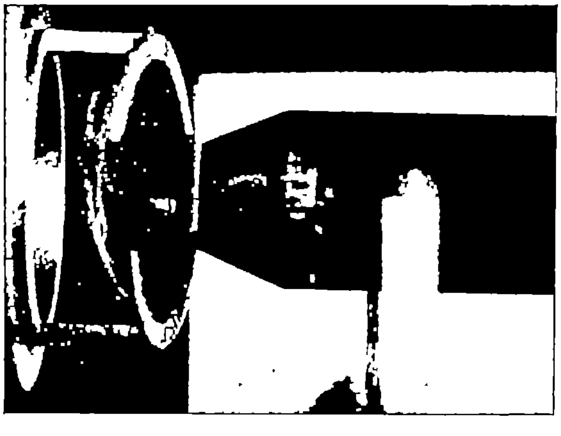

Fig. 5. Free drop before impact with projectile. Crown copyright reserved

Basic research with this apparatus is only about to start; but its possibilities are shown in the accompanying photographs, Figs. 2, 3, 4 and 5. Fig. 2 shows the impression made in solid aluminium by a 2·5 mm. diameter drop at 800 ft./sec., the depth of impression being approximately 1/1,000 in. Fig. 3 shows the annular crater made by a 2·5 mm. diameter drop in wax at 580 ft./sec.

Figs. 4 and 5 show how the air preceding the projectile blows the web away, leaving a roughly spherical drop to be struck by the projectile. Fig. 4 shows the drop suspended on the web and Fig. 5 the web being blown away. The projectile speed in this instance was 770 ft./sec.

Apart from the study of impressions of water drops on various surfaces other liquids can be tried; small drops of mercury have been successfully used. Another development proposed is to fit a piezoelectric crystal in the nose of the projectile to study impact forces and pressures. It may also be possible to study the effect of shock waves on water droplets and to investigate further the droplet break-up processes at very high speeds if the apparatus can be developed to give transonic speeds.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, with whose permission this communication has been written, and to Mr. W. C. Clothier and Mr. D. G. A. Rendel for the help and encouragement given in this work.

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## A Fluctuating Celestial Radio Source at 242 Megacycles per Second

DURING our recent radio mapping survey at 242 Mc./sec. of the region near the antigalactic centre, we have detected a fluctuating radio source. The fluctuations appear similar to the scintillations observed at lower frequencies as caused by the ionosphere[1]. No scintillation or fluctuation effect had been observed by us on any source in all our previous observing at or near 242 Mc./sec. Accordingly, this source was regarded with great interest, since it appeared likely that scintillations at this frequency and at a high altitude (about 60°) might mean that the source was of very small angular extent, or at least smaller than the sources having scintillation at lower frequencies and smaller than any other source we have detected. In other words, the source may be of stellar dimensions, that is, a true radio star. Although the fluctuations may be due to scintillations, there is also evidence that the fluctuations may represent variations in the intensity of the source itself.

Since the phenomenon may be caused by either scintillations (of ionospheric or tropospheric origin) or by true variations in intensity of the source, or both, the term 'fluctuation' will be used to describe the effect, whatever its cause. The first fluctuation record of the object was obtained on January 22, 1955. A photograph of this record is shown by the upper trace in Fig. 1. It is to be noted that the peaks of the fluctuations clearly outline the envelope of the antenna pattern. The source was again detected as a slight rise but without the marked fluctuation effect on January 23, 1955. A photograph of thi record is shown by the lower trace in Fig. 1. Th large deflexions appearing on the records at 1.00 a.m are calibrations impressed automatically once eacl hour. The marks extending below the traces a 10-min. intervals are time marks impressed auto matically from *WWV* time signals at the beginnin of each 600 c./s. tone interval. The horizonta co-ordinate is right ascension ($\alpha$) (1950.0).

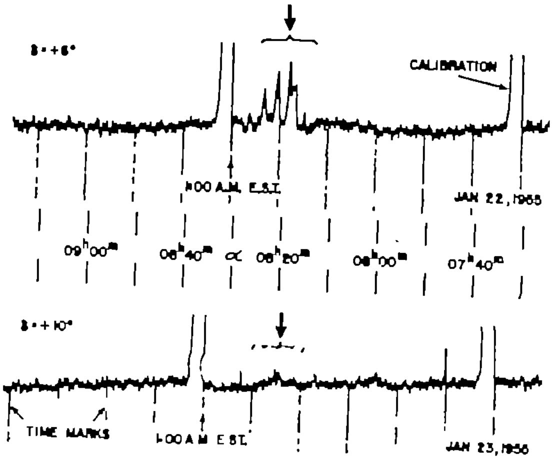

Fig. 1. Signatures obtained with the 96-helix Ohio State University radio telescope in which a source with marked fluctuations appears on January 22, 1955, but on the next night as a slight rise. The position of the source is indicated by the heavy arrows. The antenna has a fan beam 1·8° wide in right ascension by 8° in declination

Our observations of the source were interrupted afte January 23 by a routine survey, but during April anc May of this year the source has been re-observed. A total of fourteen good records of the source have now been obtained with the following results: on January 22, April 17, April 30 and May 11, 1955, the source shows marked fluctuations, whereas on December 9, 1954, January 23, April 14, 15, 16, 20, 27, and May 9, 10 and 15, 1955, the source shows only as a slight rise.

Without the fluctuations the source has an intensity of about $1 \times 10^{-26}$ W. m.$^{-2}$ (c./s.)$^{-1}$. With fluctuations the intensity increases for short periods by a factor of 6 or so. The marked fluctuations have a period of 2–3 min.

Owing to the weakness of the source and its fluctuating nature, it is difficult to determine its position accurately. Our present best position (1950.0) is: R.A. 08h. 19m. ± 1m.; Dec. +8° ±3°. This is close to the source reported in our list of 207 sources[2] as Hydra *P*.

It was mentioned that there are some factors in favour of the interpretation that the fluctuations are intrinsic variations in the source and not scintillations. These are: (1) marked fluctuations have been observed near midnight and also near sunset; this result cannot be correlated with the usual diurnal variation observed in scintillations; (2) marked fluctuations have never been observed on two consecutive days, or in fact at a more frequent interval than 11 days; (3) it has not been possible to establish any correlation between the marked fluctuations and any solar or ionospheric phenomena; (4) very occasionally, large peaks in intensity are observed that resemble solar bursts.

If the fluctuations are intrinsic variations in the source, an explanation is that the source is a star th variable radio emission having a period of hours days and also a short period of a few minutes. course, the fluctuations may be due to both ntillations and variability, in which case the short-riod fluctuations may be true scintillations that observed only when the source is at or near ximum intensity and the ionospheric conditions also suitable.

Whatever the explanation, the observations suggest at the source may be a true star or a new class of lio object. Attempts to identify the source with optical object have not yet been successful. More servations are needed to improve the accuracy of position and to follow the fluctuation periods. fortunately, this source is observable now only ring the day at times at which severe radio interence is encountered on most days. Accordingly, re detailed observations may have to wait until source is again in a favourable observing position.

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## Liquid Immiscibility in a Silicate Melt

The formation of immiscible liquids in silicate elts has been suggested as one of the possible ethods by which natural magmas may produce a riety of rock types. This theory has, however, t found much favour among petrologists, because the lack of observational and experimental idence. Bowen[1] pointed out that direct evidence this phenomenon, if it existed in rock melts, should found in glassy lavas such as obsidian; in these vas would be found discrete spheres of one glass ibedded in another glass of different composition. such phenomena have been observed. Greig[2] nducted extensive laboratory investigations on miscibility in binary and ternary silicate systems. ie areas of liquid immiscibility which he found lay ll away from those representing even abnormal ok compositions. More recently, however, Roedder[3] und an extensive region of low-temperature miscibility in the system $FeO—K_2O—Al_2O_3—SiO_2$. is new region of immiscibility fell much closer to e compositions of some abnormal rock types. rect evidence of the existence of silicate immiscibility in Nature has still been lacking, however.

In a recent study of tektites directed towards a eory of their origin, we considered the possibility at the so-called 'lechatelierite' inclusions frequently ported in these glassy bodies might really represent uid immiscibility. This idea is not original; it has en put forward, but for various reasons discarded, Barnes[4].

A series of experiments using the quenching ethod was carried out on an artificial mixture of da, lime, magnesia, alumina and silica approximating in composition to an iron-free tektite. Certain quenched charges consisted of small spheres of e glass embedded in much larger quantities of a second glass, thus giving evidence of immiscibility in the liquid state. This prompted a further test on actual tektite material sealed in a platinum envelope in a small evacuated silica tube to prevent oxidation of the ferrous iron. The quenched sample again showed the same phenomenon—small spheres of glass embedded in the greater mass of glass of slightly higher refractive index. The phase represented by the spheres made up something less than one per cent of the whole.

From this evidence we conclude that the so-called 'lechatelierite' inclusions in tektites most probably represent a state of liquid immiscibility in a silicate melt. It appears to be the only evidence of this phenomenon yet found in Nature.

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## Observations of Spiral Growth Steps in Ethylene Polymer

The role of dislocations in crystal growth has been discussed by N. F. Mott[1], and later, evidence was given by Griffin[2] to support the mechanism suggested by Frank[3]. Since that time there has been striking examples of this type of growth, described by Dawson and Vand[4], and Forty[5] along with Verma[6], to mention a few.

No report, however, seems to have appeared indicating that growth by a dislocation mechanism can take place in a polymer. All evidence of crystallization of polymers seems to be of a different character.

Recently, growth by a dislocation mechanism has been observed in 'Marlex 20*' (trade name of Phillips Petroleum Co.), a predominantly polymethylene structure with limited branching along the polymer chain. Preliminary work indicates the distribution of molecular weights to be approximately linear from 2,000 to 28,000, with a mean molecular weight of 10,000. These small crystals were grown from hot solution in xylene, were shadow cast[7] (∢ 2 : 1) and examined

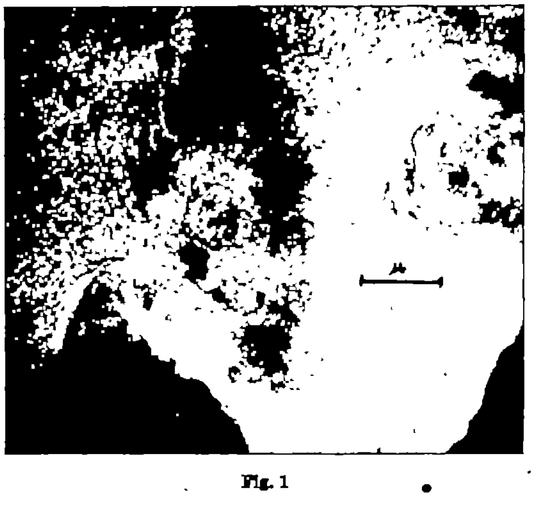

Fig. 1

in the electron microscope. Spiral growth was evident in numerous specimens obtained from both hot xylene and benzene solutions. Fig. 1 illustrates one of the simplest examples of this growth, showing growth from a single spiral. Generally, more complicated effects are observed due to the impingement of growth layers. In larger aggregates, the lozenge shape seems to persist.

I wish to thank the Phillips Petroleum Co. for their specimen.

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## Reduction in X-ray Sensitivity of Seeds by Hydration

Numerous investigators have reported that when seeds are soaked there is a parallel increase in their water content and sensitivity to X-rays[1]. These studies have been taken as strong support for the postulate that much radiation injury results 'indirectly' from the decomposition and/or ionization of water. Therefore, it was of some concern to us when it was shown there was actually an inverse relationship between the water content of dormant barley seeds and their sensitivity to X-rays[2]. For this reason it seemed desirable to re-investigate the relation between radiosensitivity and the water content of soaked seeds.

Dormant seeds, originally stored over phosphorus pentoxide until they reached weight equilibrium, were soaked at 0° C. and 22° C. for different periods of time and then subjected to X-rays. They were grown for seven days and the average heights of the seedlings compared with those of irradiated unsoaked seeds (Fig. 1).

From these results it is clear that the sensitivity of seeds to X-rays decreases after one hour of soaking at 22° C. However, after four hours soaking they are about as sensitive as dry controls. In contrast to this, when soaked at 0° C. the seeds slowly increase in resistance to X-rays, so that after four hours tl reach a point of maximum resistance comparable that obtained after one hour soaking at 22° C. Tl maintain this level of tolerance when the soak period is extended up to eight hours. Howev further soaking results in a gradual increase sensitivity and after 24 hr. they are about as sensit to X-rays as the dry control. It is significant tl the embryo rapidly absorbs water, and the wa content of embryos of seeds soaked at both te peratures for one hour equals about 40 per cent their wet weight. After 24 hr. soaking it only creased to about 60 per cent. The correspondi water content of the embryo of the dry control w 4 per cent.

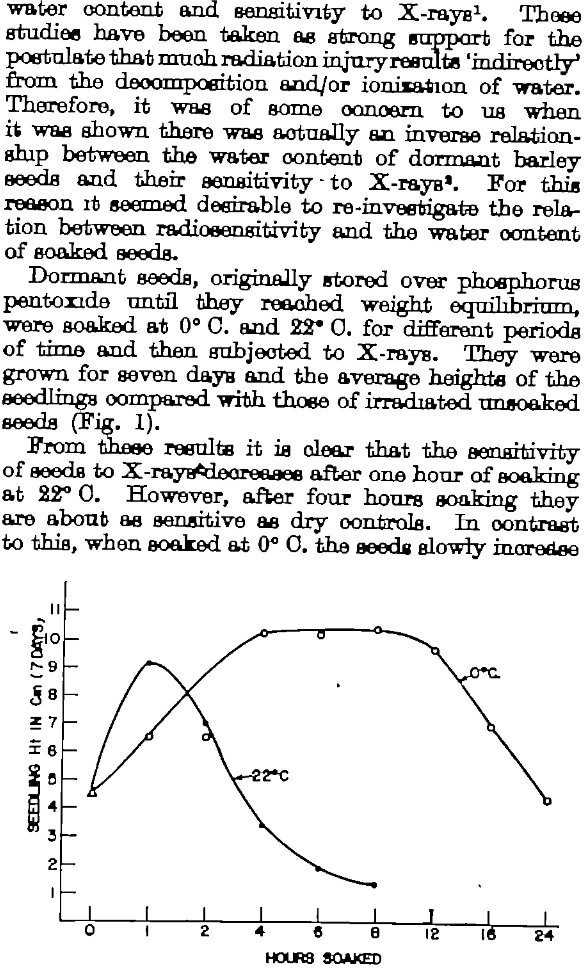

Fig. 1. Effects of soaking barley seeds at 22° C. and 0° C. on their sensitivity to 15,000 r. of X-rays

Two points seem clear from this work: (1) t X-ray sensitivity of dry seeds can actually be creased by periods of soaking at both 0° C. and 22° ( (2) the duration of the reduced sensitivity is related the temperature of the steeping water and is probal associated with increased physiological activity.

These results suggest that the radio-decompositi of water may play a less significant part in modifyi radiosensitivity than has previously been assign to it.

Part of this work was carried out at Brookhav National Laboratory under the auspices of the U. Atomic Energy Commission.

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## Distribution of Radiocarbon in Tobacco Mosaic Virus

We have made radioactive tobacco mosaic vir by exposing leaves from infected tobacco plants radioactive carbon dioxide for one day in ligh treating the homogenized leaves with buffer solutio and purifying the virus by repeated precipitation the isoelectric point[1]. The virus is determined b colour reaction, burned, and the radioactivity of tl resulting carbon dioxide measured with a gas Geig counter[2]. It has been found that the specific radi activity (activity per unit weight) of the virus decrease with increasing 'age', that is, with increasing tim interval between infection and radiophotosynthesi up to an age of about four weeks[3,4]. In addition, or sample of tobacco mosaic virus, aged two month was analysed for distribution of radioactivity. Tl nucleic acid was split off by treatment with trichlor acetic acid[5], and the protein hydrolysed and divide into the individual amino-acids by column chromat graphy[6]. A large part of the radiocarbon was foun in the nucleic acid, and the distribution of the radi carbon among the individual amino-acids was qui uneven[7].

Using the methods described, we have no determined the distribution of the radiocarbo between nucleic acid and protein as a function age of the virus. The samples of tobacco mosaic vir were the same as those used in the previous work The seeds had been sown in March, the plants tran ferred to the open field in May, and infected (fir series; *A*) early in July, or (second series; *B*) la

August. For the purpose of Tables 1 and 2, all sults have been combined, as no significant differ-oes between the two series appeared. The sample arks in the first vertical column of Table 1 establish e connexion with the previous paper, where further ta on the samples are found[4]. The activity values ted in Table 1 are the actual numbers of disintegra-ns per minute. Where the sum of the activities the protein and the nucleic acid (columns 4 and 5) es not fully agree with the activity of the tobacco saic virus, as measured independently (column 3), e percentages are referred to the sum. For clarity, ean values of the percentages are given in Table 2.

ble 1. ACTIVITIES OF TOBACCO MOSAIC VIRUS PROTEIN AND NUCLEIC ACID

| Sample | Age (weeks) | Activities (disintegrations/min.) | | |
|---|---|---|---|---|
| | | Tobacco mosaic virus | Protein component | Nucleic acid component |
| *A* 1 | 1 | 2,050 | 400 (20 per cent) | 1,650 (80 per cent) |
| *A* 2 | 1 | 2,900 | 300 (14 ,, ) | 1,850 (86 ,, ) |
| *A* 4 | 2 | 13,800 | 5,550 (37 ,, ) | 9,550 (63 ,, ) |
| *B* 1 | 2 | 1,950 | 500 (25 ,, ) | 1,550 (75 ,, ) |
| *B* 2 | 2 | 9,400 | 3,600 (42 ,, ) | 5,050 (58 ,, ) |
| *A* 5 | 3 | 3,700 | 2,200 (60 ,, ) | 1,500 (40 ,, ) |
| *B* 3 | 3 | 2,900 | 1,850 (55 ,, ) | 1,550 (45 ,, ) |
| *B* 4 | 3 | 8,800 | 5,100 (65 ,, ) | 2,750 (35 ,, ) |
| *A* 7 | 4 | 3,850 | 1,600 (39 ,, ) | 2,450 (61 ,, ) |
| *B* 8 | 5 | 59,500 | 17,000 (32 ,, ) | 35,200 (68 ,, ) |
| *A* 11 | 6 | 7,700 | 4,650 (69 ,, ) | 2,100 (31 ,, ) |
| *A* 12 | 6 | 2,950 | 1,400 (48 ,, ) | 1,500 (52 ,, ) |
| *A* 13 | 9 | 15,600 | 9,150 (65 ,, ) | 4,950 (35 ,, ) |
| *A* 21 | 11 | 34,600 | 24,000 (66 ,, ) | 12,100 (34 ,, ) |
| *A* 22 | 11 | 24,700 | 15,700 (65 ,, ) | 8,550 (35 ,, ) |

Table 2. MEAN VALUES

| Age (weeks) | Per cent activity in | |
|---|---|---|
| | Protein | Nucleic acid |
| 1 | 17 | 83 |
| 2 | 35 | 65 |
| 3–4 | 55 | 45 |
| 5–6 | 50 | 50 |
| 9–11 | 65 | 35 |

In spite of the large fluctuations of individual lues (Table 1) it is clear from Table 2 that, in neral, the fractional radiocarbon content of protein creases greatly with age of the virus. Thus young rus, which is still growing rapidly, directs radio-rbon (that is, carbon newly introduced into the af) relatively more efficiently into the nucleic acid an does old virus.

Tobacco mosaic virus contains 50 per cent carbon; t its nucleic acid (5·6 per cent of the weight of rus) has 36 per cent carbon only[6]. Hence the antity of carbon in the protein is 24 times greater an that in the nucleic acid. Applying this figure the data of Table 2, one finds that in tobacco saic virus one week old the specific activity of e nucleic acid carbon is about 115 times larger than at of the protein carbon, but in virus about ten eks old only 13 times larger.

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# Inhibition by Cyanide of the Photochemical Activity of Isolated Chloroplasts

CYANIDE is an effective inhibitor of the photosynthesis of most plants. Photosynthesis in weak light is relatively insensitive to cyanide, whereas studies with flashing light show that cyanide does not affect the yield of oxygen from each light flash if the dark time between flashes is made long enough. Experiments of this type, together with other lines of evidence, all indicate that the cyanide-sensitive phase of photosynthesis is the primary reaction in the fixation of carbon dioxide[1]. It should not be concluded, however, that all the other reactions in photosynthesis are insensitive to cyanide. The apparent lack of sensitivity of other reactions may result simply from a low concentration of the carboxylating enzyme system relative to other enzymes. Under such conditions, cyanide would appear to be selective for the carbon dioxide fixation process[1].

It was not possible to examine directly the effect of cyanide on any of the other reactions of photosynthesis until the discovery by R. Hill[2] that isolated chloroplasts could split water with the formation of hydrogen ions and oxygen gas upon illumination in the presence of a suitable electron acceptor (oxidant). This reaction (the Hill reaction) is generally regarded as representing the oxygen-evolution part of photosynthesis. The Hill reaction, in confirmation of the picture based on studies of photosynthesis, has been reported to be insensitive to cyanide[3], although Macdowall[4] observed 15–20 per cent inhibition with 0·01 *M* potassium cyanide. Recent

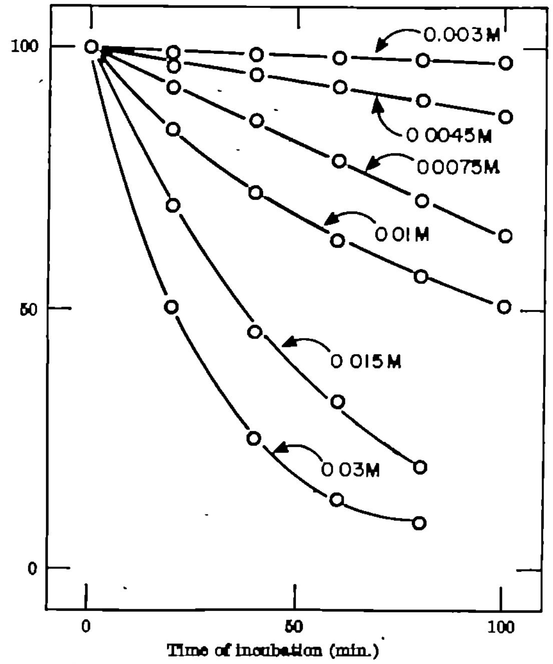

Fig. 1. Progressive inhibition of the Hill reaction by potassium cyanide. Rates are relative to uninhibited controls. Isolated chloroplast fragments were incubated with cyanide in sealed tubes at 2° C. and Hill reaction activities were measured potentiometrically (ref. 5) at the times shown at 10° C., with 0 0005 *M* potassium ferricyanide as the oxidant

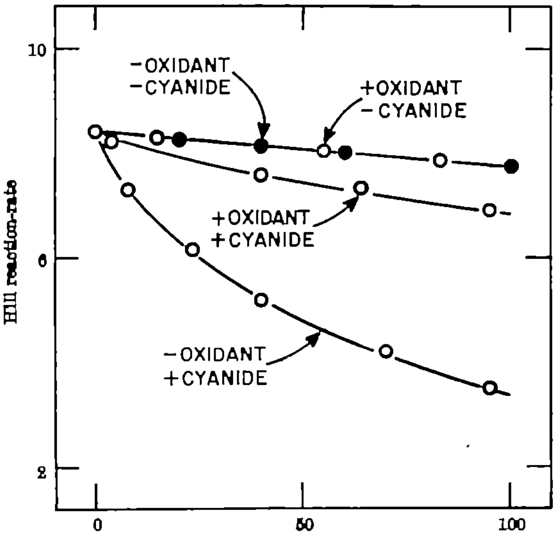

Fig. 2. Effect of oxidant (0·0015 *M* potassium ferricyanide) on the inhibition of the Hill reaction by 0·01 *M* potassium cyanide. General reaction conditions were the same as in Fig. 1. Rates are expressed as m.moles ferricyanide reduced/hr./mgm. chlorophyll

work in this laboratory, however, indicates that the Hill reaction is more sensitive to cyanide than has been previously reported if examined under certain conditions.

Chloroplast fragments from rhubarb chard and sugar beet (*Beta vulgaris*), prepared and stored in a potassium chloride – sucrose medium as previously described[5], were incubated at 2° C. in sealed tubes at *p*H 6·8 in the presence of different concentrations of potassium cyanide. At intervals, 1-ml. samples were removed and the Hill reaction activity was measured at 10° C. by a potentiometric method[6]. Similar results were obtained with the usual manometric technique. The results from a typical experiment of this type are given in Fig. 1. As the curves show, cyanide is a rather effective inhibitor. It demonstrates a very definite progressive effect, however, in that the degree of inhibition increases with time. Maximum inhibition is attained only after prolonged contact with the chloroplast fragments.

These results were contrary to earlier studies made in this laboratory using a standard technique in which the oxidant and the inhibitor (cyanide) were mixed before the chloroplasts were added. Under these conditions, cyanide produced only slight inhibition even at concentrations greater than 0·01 *M*. This indicated that the oxidant had some effect on the inhibitory action of the cyanide. Cyanide inhibition was then studied with and without the presence of oxidant during the incubation period. The results of a typical experiment of this type are given in Fig. 2. The curves clearly show that no appreciable inhibition by cyanide develops in the presence of the oxidant. These observations, together with the progressive time-effect described above, might very well account for the lack of inhibition of the Hill reaction by cyanide reported by other workers.

The mechanism by which cyanide inhibits the Hil reaction activity of chloroplast fragments is no known. Experiments now in progress indicate tha both the light and the dark rate-limiting processes are affected by cyanide. However, the light-reactio appears to be considerably more sensitive than th dark-reaction. It should be pointed out that th apparent cyanide inhibition described above could b interpreted in terms of an acceleration of the chloroplast inactivation reactions by the cyanide.

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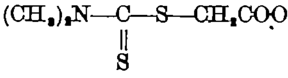
## A New Type of Plant Growth-regulating Substances

IN the course of systematic investigations of th dithiocarbamates, the compound S-(carboxymethyl) dimethyldithiocarbamate,



$$(CH_3)_2N—\underset{\displaystyle S}{\overset{}{\underset{\|}{C}}}—S—CH_2COOH$$

(I)

obtained by the reaction of sodium dimethyldithio carbamate with monochloroacetic acid, was found t exhibit distinct plant growth-regulating activity Tomato plants, about 20 cm. high, from which th tip was replaced by a glass tube containing a 1,00 p.p.m. solution of this compound showed very clea epinastic curvature and leaf deformations (Fig. 1

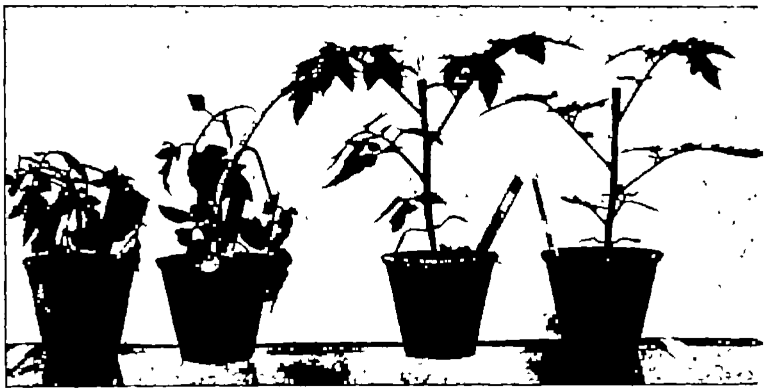


Fig. 1. *Left:* Two tomato plants the stem tips of which have been replaced by a glass tube containing a 1,000 p.p.m. solution of S-(carboxymethyl)-dimethyldithiocarbamate (compound I). Photographed after one day.

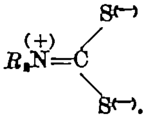
*Right:* Two tomato plants which were treated in the same way with water ich were of the same type as those caused by -dichlorophenoxyacetic acid.

Growth responses, especially curvatures, and ght deformations of leaves resembling those ought about by synthetic growth substances were o found after application of the compound to cumber and pea plants. When applied to the soil potted plants a similar picture was obtained, licating a translocation of the active substance thin the plants. Activity could also be shown on ot initiation of tomato and *Phaseolus*.

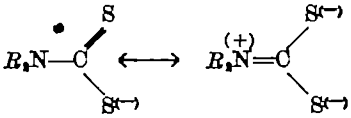
In the Went pea test, the compound had an tivity of 1 per cent, in the *Avena* cylinder test and o in the sunflower stem test[1] the activity was about er cent of that of indole-3-acetic acid. Its activity the classical *Avena* curvature test was very weak.

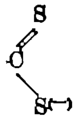
These observations seem to conflict with the first the now generally recognized structural requirements for plant growth-regulating activity, namely, e presence in an active compound of a basal ring stem with high surface activity (cf. ref. 2).

Some years ago, when investigating the relation tween chemical structure and antifungal activity the series of the dialkyl dithiocarbamates[3], arguments were brought forward for the view that the gh and specific antifungal activity of the lower alkyldithiocarbamates depends on the occurrence the chemical structure

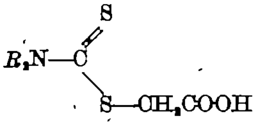


was assumed that this structure can only be rmed if in the system



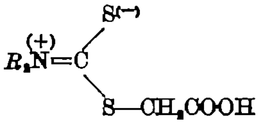
e nitrogen atom in the dialkyldithiocarbamate ion aided in its mesomeric electron release to the  group. This aiding effect is maximal for e methyl group and quickly diminishes if $R$ is placed by higher alkyl groups. Thus, what happens that the N—C bond in the dialkyldithiocarbamate n acquires a certain amount of double-bond charter under the influence of electron-releasing subituents $R$.

Returning to the plant growth-regulating prorties of compound I, it is tempting to suggest that tivity in the series



(II)

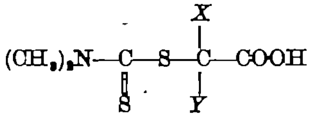
again connected with the possibility that the N—C nd acquires a double-bond character as a conquence of similar internal electron shifts :



In this way a 'ring' system bearing a polar side-chain in a distinct spatial position as required for growth-regulating activity is formed.

In view of the earlier work outlined above, it might be expected that replacement of $R$ = methyl in compound (II) by higher alkyl groups would quickly lead to compounds without plant growth-regulating activity. In fact it was found that already S-(carboxymethyl)-diethyldithiocarbamate ($R = C_2H_5$) is much less active.

In connexion with the observations of Wain[4] regarding the influence of side-chain substitution on growth-regulating activity in the series of the aryloxyalkylcarboxylic acids, the effect of replacement by alkyl groups of one or both hydrogen atoms in the $CH_2$-group of compound I was investigated. In accordance with his results, it was found that growth-regulating activity in the series

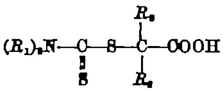
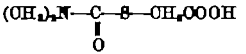
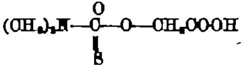


$$(CH_3)_2N-\underset{\underset{S}{\|}}{C}-S-\overset{\overset{X}{|}}{\underset{\underset{Y}{|}}{C}}-COOH$$

is observed only if at least one of the substituting groups $X$ and $Y$ is hydrogen. Further, it has been observed that replacement of C=S in compound I by C=O results in loss of growth-regulating activity. Activity is maintained, however, if the sulphur atom in the group C—S—C is replaced by oxygen.

Table 1 summarizes our observations on the growth-regulating properties of the dithiocarbamate derivatives under consideration.

Table 1. PLANT GROWTH-REGULATING PROPERTIES OF A NUMBER OF DITHIOCARBAMATE DERIVATIVES

|  $(R_1)_2N-\underset{\underset{S}{\|}}{C}-S-\overset{\overset{R_2}{|}}{\underset{\underset{R_3}{|}}{C}}-COOH$ | Results obtained in the tomato leaf epinasty test, the Went pea test, the *Avena* cylinder test and in the sunflower stem test |
|---|---|
| $R_1 = CH_3$ $R_2 = R_3 = H$ | Active |
| $R_1 = C_2H_5$ or higher alkyl groups $R_2 = R_3 = H$ | Slightly active or inactive |
| $R_1 = CH_3$ $R_2 = CH_3$ $R_3 = H$ | Active |
| $R_1 = CH_3$ $R_2 = C_2H_5$ $R_3 = H$ | Active |
| $R_1 = CH_3$ $R_2 = R_3 = CH_3$ | Inactive |
|  $(CH_3)_2N-\underset{\underset{O}{\|}}{C}-S-CH_2COOH$ | Slightly active or inactive |
|  $(CH_3)_2N-\underset{\underset{S}{\|}}{C}-O-CH_2COOH$ | Active |

With regard to the side-chain bearing the polar group, the compounds listed follow the activity pattern already known for other synthetic growth-regulating substances. The interesting new feature observed with these compounds seems to be that the electron shifts caused by simple substitutions in the remaining part of the molecule may, or may not, lead to the specific spatial arrangements required for growth-regulating activity.

The activity of the ethyl esters followed the same line as that of the corresponding free acids.

A fuller account of this work will be published elsewhere.

We are indebted to C. W. Pluygers for synthesizing the chemical compounds, and to G. Meyer for carrying out a number of biological tests.

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## Basophilia and High Ribonucleic Acid Content of Dividing *E. coli* Cells

IN a previous communication[1], a staining technique was described for demonstrating the wide difference in basophilia of growing and non-growing cells of *E. coli*. The high basophilia of growing *E. coli* cells has been attributed by Belozersky[2] to the presence of pentose nucleic acid which is not attached to protein. Apart from the work of Belozersky and his collaborators, the nature of the additional ribonucleic acid has received little attention, although it has been known for some years that rapidly growing and dividing cells of bacteria have a substantially higher concentration of ribonucleic acid than resting cells, and there is ample evidence of the heterogeneity of ribonucleic acid in metazoan cells[3].

To characterize the additional ribonucleic acid in dividing cells of *E. coli* (N.C.T.C. No. 1100) and to determine whether or not it reflects a general increase in the existing complement of constituents containing ribonucleic acid of the cell, the ribonucleic acid of rapidly dividing cells and resting cells of this bacterium were subjected to various fractionations. Dividing cells were obtained from a casein/casein/yeast culture[4] during the phase of maximum growth and of rate of division; resting cells were obtained from a fully grown culture.

When disintegrates of these cells were fractionated by centrifugation, it was found that the basophilia of dividing cells was located in the deposit obtained between 25,000 *g* and 100,000 *g*. Chemical analyses revealed that the ribonucleic acid in this fraction exceeded that in the corresponding fraction from resting cells by the difference in the total ribonucleic acid concentration of the unfractionated dividing and resting cells. The coincidence of the additional ribonucleic acid and the basophilia in one fraction lends support to Belozersky's contention that ribonucleic acid is responsible for the high basophilia of these cells. However, the possible heterogeneity of this fraction has not been investigated, and it is not known whether the ribonucleic acid responsible is attached to protein or not. The ribonucleic acid content of the basophilic fraction was approximately 40 per cent ribonucleic acid nitrogen/total nitrog
This figure was calculated from a determination
the acid-insoluble pentose as determined by Militz
and the ribonucleotide ratio of the whole ribonucl
acid of the cell.

The finding of basophilic and ribonucleic acid-r
particles in dividing bacterial cells is of particu
interest in view of the discovery by Petermann *et al*
of similar submicroscopic particles in chick embr
regenerating liver and tumours which they detec
in the analytical centrifuge at 95,000 *g* and beli
to be rich in ribonucleic acid. In regenerating liv
Petermann[6] was able to correlate the high concent
tion of these particles with rapid cell division.

The identification of the ribonucleic acid-r
particles from dividing *E. coli* cells with those fr
dividing metazoan cells would support the suggest
made previously[8] that the additional ribonucleic a
of dividing and growing *E. coli* cells is more direc
concerned in the division process than the grow
process.

Acknowledgment is made to the Chief Scienti
Ministry of Supply, for permission to publish t
communication.

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March 25.

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## Anaerobic Metabolism of Thiocyanate by Thiobacilli

IN 1904, Beijerinck[1] first described the decom
position of ammonium thiocyanate by Thiobacil
Thirty-three years later, Happold and Key[2] report
the disappearance of thiocyanate from gas liquo
due to microbial activity. The thiocyanate-oxidizi
organism was only obtained in pure culture
Happold, Johnstone and Rogers[3] in 1952. In
subsequent publication, Happold, Johnstone, Rog
and Youatt[4] characterized the organism finally as
strict autotroph which aerobically oxidized thi
cyanate to sulphate, carbon dioxide and ammon
The organism grew with carbon dioxide as sole sou
of carbon, and could derive its energy from the oxid
tion of sulphur and thiosulphate with oxygen
oxidant. The name *Thiobacillus thiocyanoxidans* w
suggested.

The oxidation of thiocyanate by Thiobacilli und
anaerobic conditions with nitrate as oxidant was d
covered in this laboratory some months ago. It w
found that certain strains of *Thiobacillus denitrifica*
isolated from surface water and from corroded sew
concrete were capable of oxidizing thiocyanate wi
the production of gaseous nitrogen. Strains *A*3-1 a
VIb-1, two of six pure cultures examined, wh

tivated in a medium containing 0·1 per cent monium thiocyanate, 0·05 per cent ammonium oride, 0·02 per cent potassium dihydrogen phos-ate, 0·1 per cent sodium bicarbonate, 0·1 per cent assium nitrate (*p*H 7) in Struyk tubes, invariably duced gas within a period of two to three eks.

Enrichments with surface water containing 0·1 per it ammonium thiocyanate, 0·1 per cent potassium rate, 0·05 per cent ammonium chloride and per cent sodium bicarbonate similarly showed itrification with the disappearance of thiocyanate. s production was, however, much slower than in responding enrichments containing thiosulphate. e adaptation of other Thiobacilli to thiocyanate s also studied. Two locally isolated pure cultures *Thiobacillus thioparus* grew well in an autotrophic dium containing 0·05 per cent sodium thiosulphate i 0·05 per cent thiocyanate. In a medium conning 0·05 per cent ammonium thiocyanate as sole idizable source of sulphur, no macroscopically ible growth occurred, however, although the cells nained viable.

Further study of this subject is in progress and l be published elsewhere. This communication is blished by permission of the South African Council Scientific and Industrial Research.

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## Deoxyribonucleic Acid Content of the Nucleus and Nuclear Volume

T seems of interest to analyse if, in a given species, re is any relationship between the volume of the -nuclei and their deoxyribonucleic acid (DNA)-tent. Except within the same tissue, H. H. Swift[1] ies the existence of such a relationship. Recent lings by G. Marinone[2] in cells of different nature hæmatopoietic organs are in agreement with this view. C. Leuchtenberger and F. Schrader[3], however, conclude that even in the same organ—the liver of the white rat—no direct relationship exists between the nuclear volume and the DNA-content.

We have now undertaken the determination, by the histophotometric technique of L. Lison[4], of the DNA-content of the liver-cells in the white rat under different experimental conditions, to re-investigate the problem of the DNA-content/volume relationship within this tissue. The nuclei of the three classes (***2n***, ***4n***, ***8n***), of which the average DNA-content increases following a geometrical progression 2 : 4 : 8 (the average DNA-content of the lowest class (***2n***) doubling nearly that of the spermatozoa) were separated. In each of these classes the volumes of the spherical nuclei were easily calculated from their circular projection area. The average nuclear volumes for the three given classes follow exactly the same progression as the average DNA-content. Statistical computations of the results obtained in the liver of five normal rats, fixed (in alcohol 20 parts, formalin 15 parts, acetic acid 5 parts), embedded and stained by the Feulgen-reaction under the same conditions, are summarized in Table 1. It is shown that between the 'DNA-content-classes', ***2n*** and ***4n***, not only the average DNA-content but also the average nuclear volume doubles. The 1 : 2 ratio becomes more precise with an increasing number of measurements (pooled results).

The scarceness of the nuclei of the ***8n*** class (2–4 nuclei for 250 measurements) makes a statistical analysis difficult. However, it is evident that the volumes of those nuclei are ranged about the double of the average volume of the ***4n*** class. From those results one could conclude that the 'DNA-content-classes' coincide with the 'nuclear-volume-classes'.

Within one of those classes the relationship between the DNA-content and the volume is not so evident for the different individual nuclei. From correlation diagrams obtained for the five livers studied, which we shall more extensively describe in another paper, one gets, however, the impression that such a relationship exists, at least to a certain extent. Although varying largely for each DNA-content value, the volume seems to present a mean value increasing with the DNA-content.

One might speculate that in the case of the rat liver the coinciding 2 : 4 : 8 ratios between the average volumes and between the average DNA-contents of the three nuclear classes depend on a common reduplicating factor (possibly polyploidy or polyteny), and within one class the DNA-content could be at least one factor acting upon the volume of individual

Table 1

| Animals | Nuclear DNA-content class | Mean DNA-content of nuclei in arbitrary units | | | Mean nuclear volume in $\mu^3$ | | |
|---|---|---|---|---|---|---|---|
| | | $n$ | $\bar{x} \pm s\bar{x}$ | $S$ | $n$ | $\bar{x} \pm s\bar{x}$ | $S$ |
| 224 | ***2n*** | 54 | 1,062·34 ± 16·7 | 122·7 | 54 | 116·7 ± 2 64 | 19·3 |
| | ***4n*** | 193 | 2,127·45 ± 15·9 | 221·8 | 193 | 223·2 ± 2·59 | 36·0 |
| 225 | ***2n*** | 57 | 1,003·20 ± 24·7 | 186·5 | 57 | 123·7 ± 5·80 | 44·0 |
| | ***4n*** | 188 | 2,071·70 ± 20·5 | 281·1 | 188 | 227 1 ± 2·96 | 40·6 |
| 226 | ***2n*** | 68 | 1,081 12 ± 16·0 | 132·5 | 68 | 105·9 ± 2·24 | 18·5 |
| | ***4n*** | 177 | 2,166·39 ± 20·2 | 269·4 | 177 | 233 2 ± 1·92 | 25·6 |
| 227 | ***2n*** | 83 | 1,044·36 ± 16·1 | 147·4 | 83 | 123·0 ± 3·08 | 27·3 |
| | ***4n*** | 167 | 2,089·51 ± 20 0 | 258 5 | 167 | 243·9 ± 2·55 | 32·9 |
| 228 | ***2n*** | 51 | 1,000·24 ± 18·9 | 135·0 | 51 | 108·1 ± 1·73 | 12·3 |
| | ***4n*** | 193 | 2,120·17 ± 18·9 | 263·4 | 193 | 226·3 ± 1·91 | 26·6 |
| Pool | ***2n*** | 313 | 1,038·25 ± 8·5 | 150·5 | 313 | 117·9 ± 1 61 | 28·4 |
| | ***4n*** | 918 | 2,116 04 ± 8·6 | 262·8 | 918 | 229 7 ± 1·12 | 34·1 |

$n$ = Number of measurements; $\bar{x}$ = mean value; $s\bar{x}$ = deviation of the mean; $S$ = standard deviation.

chromosomes and also indirectly upon the nuclear volume.

These investigations were carried out with a grant from the Fonds National de la Recherche Scientifique.

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## Growth-promoting Activity for Pigs of Inactivated Penicillin

It has been shown by many workers that the regular administration of very small doses of most antibiotics, including penicillin, will significantly increase the rate of growth of many species of animals. Extensive investigation, however, has not clearly demonstrated the mechanism or mechanisms by which such a benefit is derived, although it is generally considered that the mode or modes of action are entirely dependent upon the antibacterial activity of the antibiotic employed[1]. It has been suggested, however, that autoclaved penicillin when given by daily injection, but not by mouth, will increase the growth-rate of chicks[2].

The results of two experiments reported here show that part of the benefit derived from a supplement of penicillin is due to one or more of its degradation products, probably the amino-acid penicillamine, and that inactivated penicillin, showing no antibacterial activity whatever, significantly increased the growth-rate of pigs, when given either by mouth or by injection.

The first experiment involved five groups of pigs, each group containing eight animals, which were maintained from weaning to 200 lb. live-weight. Procaine penicillin *G* was added to the diet at the rate of 15 gm. per ton of food, and groups receiving penicillin which had been inactivated by heat, by the action of penicillinase and by contact with heavy metals, were compared with a group receiving active penicillin, and a control group receiving no penicillin. It can be seen from Table 1 that each group receiving inactivated penicillin showed an increase in growth-rate and a reduction in food conversion ratio.

Table 1

| Antibiotic | State | Growth-rate (lb /day) | Increase over control (per cent) | Food conversion ratio | Food saved (per cent) |
|---|---|---|---|---|---|
| None | — | 1·14 | — | 3 61 | — |
| Penicillin | Active | 1·25 | 9·7 | 3·56 | 6 6 |
| Penicillin | Inactivated by heat | 1 20 | 5·8 | 3 72 | 2 4 |
| Penicillin | Inactivated by penicillinase | 1·20 | 5·3 } 5·9 | 3·76 | 1·3 } 3 0 |
| Penicillin | Inactivated by salts of heavy metals | 1 22 | 7·0 | 3 61 | 5 3 |

Table 2

| Antibiotic | State | Route of administration | Growth-rate (lb./day) | Increase over control (per cent) | Food conversion ratio | Fo sa (p ce |
|---|---|---|---|---|---|---|
| | | | First replicate | | | |
| None | — | — | 0·91 | — | 3·11 | – |
| Penicillin | Active | Oral | 1·10 | 20·9 | 2·87 | 7 |
| Penicillin | Inactive | Oral | 1·04 | 14·3 | 3 03 | 2 |
| None | — | — | 0·85 | — | 3 23 | – |
| Penicillin | Active | Parenteral | 1·06 | 24·7 | 2·96 | 9 |
| Penicillin | Inactive | Parenteral | 0·98 | 15·3 | 2·99 | 8 |
| | | | Second replicate | | | |
| None | — | — | 1·01 | — | 4·20 | – |
| Penicillin | Active | Oral | 1·20 | 18·8 | 3·57 | 15 |
| Penicillin | Inactive | Oral | 1·17 | 15·8 | 3·71 | 11 |
| None | — | — | 1·07 | — | 4 03 | – |
| Penicillin | Active | Parenteral | 1·19 | 11·2 | 3·65 | 9 |
| Penicillin | Inactive | Parenteral | 1·13 | 5·6 | 3·67 | 8 |

Table 3

| Experiment | Growth-rate (lb./day) | | | Food conversion ra | | |
|---|---|---|---|---|---|---|
| | Control | Active | Inactive | Control | Active | In-acti |
| 1 | 1·14 | 1·25 | 1 21 | 3·81 | 3·56 | 3·7 |
| 2 (first replicate | 0·88 | 1·08 | 1 01 | 3·19 | 2·92 | 3 0 |
| 2 (second replicate) | 1·04 | 1·20 | 1·15 | 4·11 | 3·61 | 3·6 |
| Mean increase over controls | — | 14·3 per cent | 9·4 per cent | — | 9·2 per cent (food saved) | 5·5 pe cent (food save |
| Significance (deviation from controls) | | $p<0.01$ | $p<0.05$ | | | |

The second experiment compared active and inactive penicillin when given by mouth and by injection. The experiment was replicated twice and involved 120 pigs. The animals were maintained
the experiment from weaning until they reac
120 lb. live-weight and were fed a recommen
ration[3]. Procaine penicillin was inactivated w
penicillinase and was administered at the rate
15 gm. per ton of food, or 0·5 mgm. per kilo bo
weight daily by intramuscular injection. Both rou
of administration supplied approximately the sa
total daily intake of antibiotics. It can be seen fr
Table 2 that in every case the inactive mate
produced an increase in growth-rate and a reduct
in food conversion ratio, irrespective of the route
administration. In a comparable experiment,
activated aureomycin hydrochloride was found
produce no growth response.

The results of both experiments are summari
in Table 3. Active penicillin produced a signific
mean increase in growth-rate of 14·3 per cent,
inactive material produced a significant mean incre
in growth-rate of 9·4 per cent. The inactive mate
thus produced 66 per cent of the growth respo
achieved with active penicillin. The difference
tween the effect of the active and inactive mate
was not significant.

The inactive material showed no activity *in v*
against a range of test organisms, and no penic
could be detected in the digestive tract, serum
urine of animals receiving the inactivated mater
It seems likely that the only relatively stable e
product common to each of the three methods
inactivation employed is the thiol amino-acid pe

llamine (E. L. Smith, personal communication), hich has already been shown to be capable of creasing the growth-rate of chicks when given by aily injection[4]. Further work is being undertaken sewhere to evaluate the nutritional significance of is material.

We are grateful to Dr. R. C. Campbell for statistical nalysis of the experimental results, to Mr. R. Long Glaxo Laboratories, Ltd., for preparation of the activated penicillin, and to Glaxo Laboratories, td., for supplying the penicillin used in these periments.

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## A New Rare Blood-Group Antigen, $Chr^a$

During recent years, many rare blood-group ntigens, so-called 'private' or 'family' antigens, have een discovered. A survey of eleven of these was ecently made by van Loghem and his associates, ho described two new antigens. Most of the antiens were found exclusively in the members of one amily; but as suggested by Dunsford, who studied he Wright system, some of these antigens may be rdinary blood-group factors with a very low freuency. Most of the corresponding antibodies were he results of iso-immunization during pregnancy or y blood transfusion, but a few of them were naturally ccurring antibodies.

Through routine screening for blood-group antiodies we found a hitherto unknown antibody, which t 37° C. agglutinated trypsinized red cells from one of he test-cell donors, who happened to be the present riter. The serum donor was a nineteen-year-old nmarried woman, who had never received transsions and had never been pregnant. Serological vestigations showed that the antibody was most ctive in albumin at 37° (titre 8). It was less active saline and by the trypsin technique, and it gave o reaction by the indirect Coombs technique. he antibody was weakly active at 20°. The test rum has since been tested against the red cells om 311 persons selected at random; but so far has been found to react with the red cells from nly one more person.

Investigations of the blood-group genotypes of the st-serum donor and of the two persons whose red ells had reacted with the test serum gave the followg results:

B. Chr. (test-serum donor): *A*, *CDe/c e*, *MNs*, *e(a+)*, *P*, *k/k*.

F. K.-N.: *O cde/cde*, *MNs*, *Le(a−)*, *P*, *k/k*, *u(a−)*, *Fy(a−)*, *Jk(a+)*.

S. S.: *O cde/cde*, *MNs*, *K*, *Le(a−)*, *p/p*.

Studies of the families of F. K.-N. and S. S. have ot revealed other persons giving positive reactions with the test serum; but unfortunately it has been impossible to draw any conclusions concerning inheritance from the results obtained in the available family material. Seven relatives of F. K.-N., including two brothers, one sister and the mother, and three relatives of S. S., two brothers and one sister, have been investigated.

The test serum has been investigated by Miss Mia van der Hart and Dr. J. J. van Loghem, who found that the antibody was different from antibodies reacting with the following 'private' blood-group antigens: *Vw* (Verweyst), *Rm* (Romunde) and *Vis* (Wright). Testing against 150 blood samples chosen at random gave negative results. The test serum was also investigated by Dr. A. E. Mourant, of the Lister Institute, London. He stated that the antiserum was not identical with those from Berrens, Graydon, Wright and two other 'family' antisera which are as yet unpublished. Dr. E. Freiesleben has tested the serum against thirty-nine random blood samples, also with negative results. Thus, including my own investigations, the serum has been tested against a total of five hundred random blood samples, of which only two gave positive reactions, which gives a frequency of 0·4 per cent. The antibody has been named anti-$Chr^a$ on the supposition that an anti-$Chr^b$ reacting with a very common blood-group antigen may exist.

I wish to thank Dr. A. E. Mourant and Dr. Dorothy M. Parkin, of the Lister Institute, London, Miss Mia van der Hart and Dr. J. J. van Loghem, Amsterdam, and Dr. E. Freiesleben, of Statens Seruminstitut, Copenhagen, who all assisted me in the serological investigations.

This work was aided by grants from the Anders Hasselbalch Anti-Leukæmia Foundation and C. P. Schepler and Wife's Bequest, the Irma Foundation.

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[2] van der Hart, M., Bosman, H., and van Loghem, J. J., *Vox Sang.*, 4, 108 (1954).

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## Some Notably High Acuities of Taste for Phenylthiocarbamide

In the course of a recent study of the thresholds of taste for phenylthiocarbamide (phenylthiourea) of members of a division of the Malayan Negritos, some extraordinarily high acuities were encountered.

The Negritos under study belonged to the Kintak Bong division, most of the few remaining members of which are at present living in the Baling district of the State of Kedah, Federation of Malaya. They are probably the 'purest' of the Negritos still living in the Malay Peninsula. The phenylthiocarbamide solutions employed in the work comprised a series numbered 0, 1, 2, . . . 18, the concentration of the substance being $2{\cdot}60 \times 2^{-n}$ gm. per litre, where $n$ is the solution number.

Three of the youths, aged seventeen, eighteen and fifteen years, were able successfully to distinguish in sorting trials between the solvent (distilled water) and solutions numbered 18, 17 and 16, respectively, the chance of success by guesswork being 0·125 in each case. Assuming that guesswork actually played no part in the trials, we may accept the respective solution as having set an upper limit to the threshold concentration in each case. These concentrations are lower than the lowest that appear to have been used by other workers elsewhere[1–3], and I wish to direct attention to the high acuities of taste for phenylthiocarbamide possessed by these subjects, the first-mentioned in particular.

Bitterness appears to be the taste sensation most readily evoked by appropriate substances, of which brucine, strychnine and quinine are among the most potent, brucine being accepted (apparently) as the most potent known and, on a weight basis, some twelve times more effective than quinine and four times more effective than strychnine[4]. Thresholds for quinine have been investigated fairly extensively. Recent upper-limit values obtained by Harris and Kalmus[2] for thirty-eight subjects range from $2 \cdot 4 \times 10^{-6}$ to $5 \cdot 7 \times 10^{-6}$ molar, calculated as quinine from the quinine sulphate (anhydrous ?) they used, and were obtained by sorting trials requiring discrimination between solvent and solution. Moncrieff[4] has discussed results varying from $4 \times 10^{-5}$ to $1 \cdot 5 \times 10^{-6}$ molar. A result reported by Kiesow[5] (quoted by Fulton[6]) corresponds with $1 \cdot 3 \times 10^{-6}$ molar quinine solution, calculated from the quinine sulphate (dihydrate ?) employed. A value, $1 \cdot 5 \times 10^{-7}$ molar, quoted by Dethier and Chadwick[7] and by Jahn and Wulff[8], appears to have arisen from a mistake in calculation. Thus, $1 \cdot 3 \times 10^{-6}$ molar appears to be the lowest recorded threshold concentration for quinine and, on the basis of the weight ratios mentioned above, a threshold concentration of $1 \times 10^{-7}$ molar might be expected for a very acute taster of brucine.

Phenylthiocarbamide belongs to a group of substances the threshold concentration of each of which covers a very wide range in a human population and is distributed bimodally. It is normally classed as 'bitter'; but it is well known that in the neighbourhood of their thresholds subjects may be inclined to characterize the taste as other than bitter, though usually describing it as 'bitter' at somewhat higher concentrations. Thus, the first-mentioned subject described the taste of solution 18 as 'sour', as did the second describe the taste of solution 17, and the third the taste of solution 16. The third described the taste of solution 14 as 'bitter and sweet'.

As the concentration of solution 18 is $9 \cdot 9$ μgm. of phenylthiocarbamide per litre, namely, $6 \cdot 5 \times 10^{-8}$ molar, the first-mentioned subject seems to enjoy the distinction of possessing for phenylthiocarbamide a higher acuity of taste than has been recorded for any other subject tasting any substance.

The volume of solution transferred to these subjects' mouths for tasting purposes was only $2 \cdot 5$ ml. on any one occasion. It contained, therefore, in the particular case under discussion, only $0 \cdot 025$ μgm. of phenylthiocarbamide (namely, $1 \cdot 6 \times 10^{-13}$ mole or about $4 \times 10^{11}$ molecules), and it is unlikely that even all this small amount was involved in reactions at the taste-buds. If Moncrieff's[4] estimate, that $0 \cdot 05$ ml. of solution properly applied should be sufficient for taste-testing, is correct, then this subject may have been able to detect a quantity of phenylthiocarbamide as minute as $8 \times 10^{9}$ molecules.

In passing, it is of interest to record that, in contradistinction to this high acuity, two female members of the same ethnic group were unable to distinguish even solution 0 from the solvent. It is the widest range of acuities we have encountered in any of the six Malaya-domiciled ethnic groups th we have examined.

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## A New Form of Male Sterility in *Nicotian tabacum* L.

MALE sterility in tobacco has been reporte previously by Clayton[1] in advanced back-cro generations of two interspecific crosses betwee *Nicotiana debneyi* and *N. megalosiphon* as fema parents, and *N. tabacum* as pollen parent. E suggested that the cause may be incompatibilit

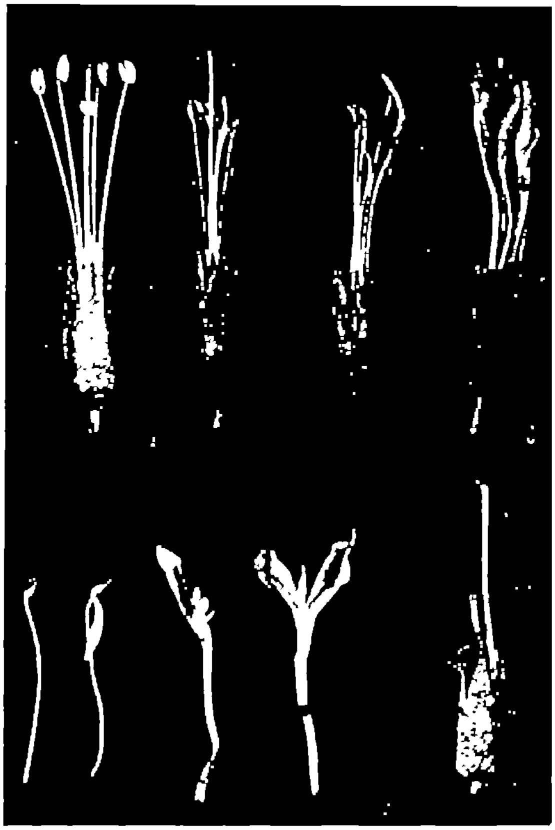

Fig. 1. Normal anthers observed in variety American Joiner and first-generation progeny of the new male sterile form (*a*) are compared with types of dissected flowers of the new male sterile form (*b*), individual petaloid stamens of the new male sterile form (*c*), and a dissected flower of variety Male Sterile 402 (*d*). The latter was derived from an *N. debneyi* × *N. tabacum* hybrid and generally contains one or more aborted stamens which may be fused in groups of two or more or with the stigma

tween the cytoplasmic constituents of the former d the nuclear constituents of the latter.

A new form of male sterility was observed here ring the 1953–54 season, which may be conditioned genetic rather than cytoplasmic factors. It peared spontaneously in plants of flue-cured riety American Joiner grown from seed several ars old. Plants from the same seed this current ason again exhibited one male sterile to about twelve rmal plants. Male sterile flowers are characterized petalody of the stamens, slightly reduced corolla e and lighter coloration (see Fig. 1). Even where dimentary anther-like structures were present, no llen was detected. In a small proportion of flowers e corolla was four-lobed and accompanied by four orted stamens.

This new male sterile form was crossed with normal ants of American Joiner, and the $F_1$ generation oduced only normal fertile flowers. A study of the ode of inheritance and possible linkage relationships s been initiated.

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layton, E. E., *J. Hered.*, 41, 170 (1950).

## Size Variations of Septate Wood Fibres in *Pithecolobium dulce* Benth.

In a recent abstract, Spackman and Swamy[1] ate that septate wood fibres "exhibit considerable riation in size, structure and contents. In most stances these elements are considerably longer than e cambial initials from which they were derived. some forms, however, the elongation has been ght and in others no elongation has taken place d the elements are essentially cambiform". It is edless to say that the above statements were of a sual nature and were not substantiated by actual monstration.

The septate fibre is an unusual cell type in two portant ways. First, it illustrates that lignification not a necessary concomitant of the death of the otoplast, but that the protoplast continues to hibit dynamic activities even after the comete lignification of the secondary wall. Secondly, is is a cell type modified to perform a dual function, mely, affording mechanical strength, on which the nction of storage has become superimposed. The ailable information on the origin, distribution and haviour of this important category of cells of the condary xylem is admittedly meagre.

Exploratory investigations indicate that this cell pe occurs sporadically in many (about a hundred) of e dicotyledonous families and that the proportion this cell type to others of the secondary xylem is riable not only among genera and species but also ithin a single individual. There are also instances here the septate fibres are confined only to a particlar sector of the stem or branch, or occur only in the rly or later formed parts of the secondary xylem. uch more extensive and intensive investigations this remarkable cell type are necessary in order understand clearly its exact morphological and nctional features.

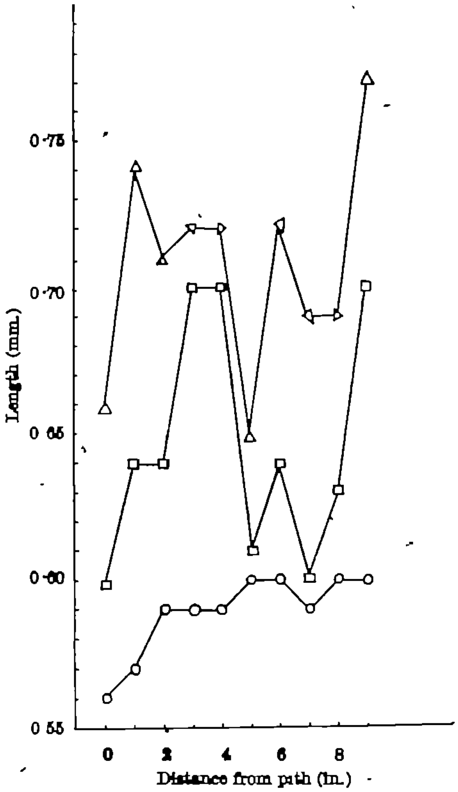

Fig. 1. Length-on-age curves illustrating variations of vessels (bottom), non-septate (middle) and septate fibres (top)

In *Pithecolobium dulce* Benth., the septate fibres are intermixed with the non-septate ones throughout the secondary xylem. A disk of 9-in. radius from two feet above ground-level was available for investigation. Measurements of tracheal elements were taken at every successive inch from the centre along the radius, and the data thus obtained were statistically analysed. The results may be summarized as follows (Fig. 1): The vessel members show a gradual increase in length in the early stages (until the second inch from the centre), but afterwards their length is subject to very little fluctuation. The non-septate fibres as well as the septate fibres in the early stages behave in a manner similar to the vessels in regard to their linear dimensions; but later their length is subject to considerable variations. The most remarkable feature that has emerged from the present study concerns the total independence of the septate and non-septate fibres in regard to their respective linear dimensions. The length-on-age curves for these two cell types are more or less parallel. However, it is significant that the septate fibres are not only longer than the non-septate ones from the initial stages, but also that the same relative linear values are maintained throughout ontogeny.

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# An Apparent Change from Cytoplasmic to Nuclear Control of a Form of Chlorophyll Deficiency in *Gossypium arboreum* L.

THE occasional occurrence of variegated plants in *Gossypium herbaceum* race *Wightianum* has been reported by Gopalratnam[1], and in *Gossypium arboreum* race *sinense* by Feng[2], who also reported typical maternal inheritance.

Variegated plants have frequently been observed at this Institute in *G. arboreum* race *bengalense*. On one of these plants a bud from a chlorophyll-deficient area was forced into growth by appropriate pruning, giving rise to two flowers with chlorophyll-deficient boll, calyx, bracts and pedicel. These two flowers were selfed and the pollen also used for pollinating several types of normal green.

Selfing resulted in two progenies with twelve and thirteen yellow seedlings which died shortly after germination.

The crosses of normal green × deficient gave sixteen plants all of which were green.

From the sixteen $F_1$ plants, sixteen $F_2$ families were raised. The $F_2$ families exhibited two types of behaviour.

(1) *Normal Mendelian segregation.* Family *B*6 gave eighty-six plants of which sixty-seven were green and nineteen yellow deficient—a close approximation to the usual 3 : 1 ratio. The results of $F_3$, $F_4$ and $F_5$ confirmed the mode of inheritance as monogenic. Chlorophyll deficiency, however, showed a progressive increase in viability, and in $F_5$ and subsequent generations it was possible to grow deficient plants to maturity. They flowered well in pots, the first year's growth producing yellow-green leaves, while the leaves in the second year were almost full green, with only the growing-point yellow-green. Crosses were then made reciprocally between the new type of viable deficient and normal green. In $F_1$ green was fully dominant with 3 : 1 segregation of green to deficient in $F_2$, thus: green × deficient, 80 : 19; deficient × green, 108 : 29. A slight excess of green plants is found.

(2) *Maternal inheritance.* The $F_2$ families from the other fifteen crosses threw only greens—a total of 1,879 plants being recorded. This absence of segregation conforms to the usual type of cytoplasmically determined inheritance.

Therefore, out of sixteen crosses between female green and male chlorophyll-deficient from a deficient region of a variegated cotton plant, fifteen exhibited maternal (cytoplasmic) inheritance, while in the remaining family inheritance was nuclear and monogenic, with mutation from green to deficient in one locus as a possible explanation. This transition from cytoplasmic to nuclear control has apparently not been recorded in other plants. The improvement in viability of deficients from lethality to the condition of fertility is possibly due to progressive reverse plastid mutation.

I am indebted to Prof. S. C. Harland for his help in writing this communication, and to Mr. R. B. Sethi, director of the Indore Institute of Plant Industry, for permission to publish it.

BHOLA NATH

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April 6.

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# Synthesis and Properties of S-Alanyl Coenzyme *A*

S-ALANYL coenzyme *A* has been prepared l aqueous transfer of the alanyl residue from S-alan thiophenol hydrochloride to coenzyme *A* (Co*A*—SH in a manner similar to that used for the synthes of S-alanyl glutathione[1], and other S-acyl com pounds[2-4]:

$$\mathrm{PhSCOCH(CH_3)NH_3^+Cl^-} + \mathrm{Co}A\mathrm{{-}SH} \rightarrow$$
$$\mathrm{PhSH} + \mathrm{Co}A\mathrm{{-}SCOCH(CH_3)NH_3^+Cl^-}$$

Due to the small quantities of Co*A*—SH availab and the lability of S-alanyl coenzyme *A*, the produ could not be isolated by classical methods, that i as a metal salt. However, S-alanyl coenzyme *A* w successfully isolated in the pure state by pap electrophoresis (50 V./cm.), as it migrates at a slow rate than Co*A*—SH.

50 mgm. (70 per cent pure) Co*A*—SH and 25 mgm of S-alanyl thiophenol hydrochloride were dissolve in 0·2 ml. of water. The *p*H of the solution wa adjusted to 5–6 by means of the dropwise additio of 2 *N* sodium hydroxide solution. The reactio solution was then placed in a cold room at 4° C. f three days. The product was separated and purifie by paper electrophoresis in a neutral buffer (pyridine acetic acid : water, 10 : 1 : 89). (It was found necessar to use several 35-cm. wide paper sheets, owing t the low capacity of the paper.) The buffer solutio was removed from the electropherogram by freez drying, and the area which contained S-alan coenzyme *A* was cut out and eluted at low tempera ture with water. The water solution of S-alan coenzyme *A* was then freeze-dried. The yield wa 20 mgm.

A fresh solution of S-alanyl coenzyme *A*, subjecte to paper electrophoresis, exhibited one identica spot when developed with ninhydrin, in ultra-viole light, and with nitroprusside ammonia. The nitr prusside spot was slightly delayed, appearing withi 1–2 min. The paper electropherogram of an age solution also contained a positive ninhydrin spot fo alanine.

When a sample of S-alanyl coenzyme *A* was in cubated for 2–3 hr. with an excess of glutamic aci at *p*H 8 in a sodium bicarbonate buffer solution a 20° C., a new ninhydrin reactive compound arose This compound we believe to be alanyl-glutamic aci (Fig. 1). In the presence of pigeon-liver homogenate

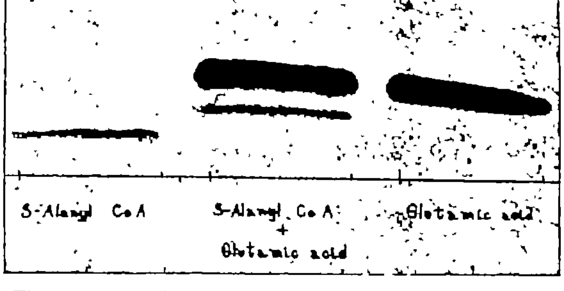

Fig. 1. Electropherogram of S-alanyl coenzyme *A* – glutamic acid incubation mixture. The formation of alanyl-glutamic acid is shown in the middle column where it has migrated at a slower rate than glutamic acid (right column), but faster than S-alanyl coenzyme *A* (left column). Composition of incubation mixture: 0·1 ml. of 0·5 *M* sodium bicarbonate, 0·05 ml. of 0·1 *M* glutamic acid, 0·05 ml. of 2 mgm./ml. S-alanyl coenzyme *A*

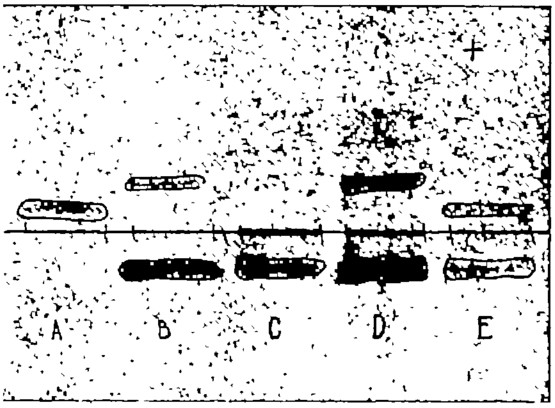

Fig. 2. Action of S-alanyl coenzyme *A* deacylase. *A*, S-alanyl coenzyme *A*; *B*, S-alanyl glutathione, lower spot (traces glutathione upper spot); *C*, S-alanyl coenzyme *A* + deacylase, spot: alanine; *D*, S-alanyl glutathione + S-alanyl coenzyme *A* deacylase; *E*, S-alanyl coenzyme *A* + glyoxalase II. Composition of incubation mixtures: 0·05 ml. Sorensen phosphate buffer *p*H 5·4, 0·05 ml. enzyme solution, 0·05 S-alanyl compound (2 mgm./ml.). Time, 15 min. at 20° C.

rapid enzymatic hydrolysis of S-alanyl coenzyme *A* ) alanine and Co*A*—SH takes place. The active eacylase is not identical with glyoxalase II [5]. A pure mple of glyoxalase II rapidly cleaves S-alanyl lutathione[1]; however, it does not, or only very owly, hydrolyse S-alanyl coenzyme *A* (Fig. 2).

S-Alanyl coenzyme *A* deacylase is present mainly the mitochondria and microsome fractions of liver. owever, it is also present in smaller concentration the plasma fraction of the liver homogenate.

Attempts to demonstrate an enzymatic acyl transr of the alanyl group to other amino-acids or to the H group of cysteine have been unsuccessful thus far, ecause of the rapid, possibly competing, enzymatic ydrolysis of S-alanyl coenzyme *A*.

Coenzyme *A* was kindly given to us for experiental purposes by C. H. Boehringer Sohn, ngelheim.

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## Meaning of 'Turnover' in Biochemistry

In a recent communication, Kleiber[1] has discussed wo different definitions of the term 'turnover-rate'. ome workers, particularly those associated with haikoff, regard the turnover-rate as the rate at hich a substance is replaced in the tissue cells lefinition 1). This is essentially the concentration of e substance in the tissue divided by the turnoverme. Others, including Kleiber, consider it to be the te at which the whole 'pool' of the substance, howver large or small, is replaced in the tissue, given y the reciprocal of the turnover-time (definition 2). oth groups agree that the turnover-time is the biological 'average life', given by 1·44 × biological half-life.

These concepts are each valuable; but the turnover-rate as defined by Kleiber tells no more about physiological events than does the turnover-time. Two tissues could have the same turnover-time and yet contain very different concentrations of the substance under consideration. They would have the same turnover-rate according to Kleiber, yet unit weight of the one tissue would metabolize the substance much more rapidly than unit weight of the other.

The dorsolateral prostate of the rat contains more than ten times as much zinc as the ventral prostate[2] per unit weight. The results of turnover experiments with these tissues, using zinc-65, are given in Table 1. The data are taken from a paper which is being prepared in collaboration with Miss M. I. Fischer and Dr. B. E. Riedel. The turnover-rate of zinc in the dorsolateral prostate is nearly ten times as great as in the ventral prostate according to definition 1; but by definition 2 the turnover-rate of the ventral prostate is actually greater than that of the dorsolateral prostate.

Table 1. Turnover of Zinc in the Prostate Glands of the Rat

| | Ventral prostate | Dorsolateral prostate |
|---|---|---|
| Mean zinc content (µgm./gm.) | 13 5 | 168 |
| Biological half-life ($T_{1/2}$) (days) | 7 6 | 9·9 |
| Turnover-time ($T_{1/2}$ × 1·44) (days) | 10 9 | 14·3 |
| Turnover-rate (1)* (µgm. Zn/gm./day) | 1 24 | 11·8 |
| Turnover-rate (2)* (fraction of pool/day) | 0 092 | 0 064 |

* Turnover-rate (1) = µgm. Zn/gm. tissue divided by turnover-time. Turnover-rate (2) = reciprocal of turnover-time.

Many tracer experiments are done without estimation of the concentration of the substance under investigation, and this applies particularly to work with trace elements, especially those which do not occur naturally in the body in measurable amounts. It may partly be for this reason that most workers have defined turnover-rate as the reciprocal of turnover-time. However, the Chaikoff concept of turnover-rate is of such physiological significance that it should have a name. In Table 1, turnover-rate (1) could be described as the zinc turnover-rate, and (2) as the zinc pool turnover-rate; but these terms are sufficiently similar to lead to confusion. It is suggested that the Chaikoff turnover-rate (1) should be called the flux-rate, retaining 'turnover-rate' for the definition favoured by Kleiber. The word 'flux' has been used in a similar sense by Reiner[3] in a theoretical discussion of the implications of turnover-rate calculations.

Zilversmit[4] has suggested that 'turnover-rate' should continue to apply to definition 1, and has proposed an alternative term for definition 2. I believe that this would be a mistake. An extensive review of the literature has shown that 'turnover-rate' is defined according to definition 2 in the great majority of cases and any alteration would add to the confusion which we all wish to avoid.

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[1] Kleiber, M., *Nature*, 176, 342 (1955).

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Experimental Officer (with a pass degree or at least G.C.E. at advanced level) in the Plant Breeding Section—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (August 17).

Senior Psychologist in the Department of Psychological Medicine, to be responsible for the diagnostic testing of adults and children—The Clerk to the Governors, St. Thomas's Hospital, London, S.E.1 (August 17).

Lecturer in Geology, with special reference to petrology—Head of the Department of Geology, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (August 19).

Experimental Officers and Assistant Experimental Officers (with at least H.S.C. (science) or equivalent), at the Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants, for work concerned with problems of combustion, heat transfer, aerodynamics, projects and performance instrumentation and application of electronics in gas turbine research—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.146/5A (August 27).

Research Demonstrator in Physics—The Registrar, The University, Sheffield (August 27).

Assistant in Natural History—The Secretary, The University, Aberdeen (August 31).

Director of the University Gardens at Ness, Neston, Wirral—The Registrar, The University, Liverpool (August 31).

Research Assistant in the Physics Department, for work with Prof. K. G. Emeléus either in spectroscopy or on gaseous conductors—The Secretary, Queen's University, Belfast (August 31).

Research Assistant (with a degree in physics and preferably with some research experience) in the Department of Physics, to undertake wave-length measurements of high precision, using a reflecting echelon interferometer—The Registrar, King's College, Newcastle-upon-Tyne (August 31).

Research Fellow in Mathematical Physics at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Adelaide, August 31).

Lecturer in Comparative Social Administration at Victoria University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 1).

Assistant Lecturer or Lecturer in the Department of Pharmacology and Therapeutics—The Registrar, The University, Liverpool (September 3).

Assistant Lecturer in Metallurgy—The Registrar, The University, Manchester 13 (September 7).

Lecturer in the Department of Botany at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 12).

Professor of Genetics—The Registrar, University of Adelaide, South Australia (September 15).

Reader in Mechanical Engineering at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, September 15).

Lecturer (first-class honours graduate in mathematics, and preferably with special interests in some branch of applied mathematics or statistics) in Mathematics—The Registrar, College of Technology, Manchester 1 (September 19).

Lecturer in Geology at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Tasmania, September 30).

Senior Lecturer in Biochemistry at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, September 30).

Assistant Lecturer (honours graduate in chemistry, with research experience and special interests in physical or inorganic chemistry) in Chemistry—The Registrar, College of Technology, Manchester 1 (October 1).

Lecturer (with experience in some of the following subjects: X-ray crystallography, non-destructive testing, optical methods of examination, gauging methods and instrumentation of plant) in Industrial Metallurgy—The Registrar, The University, Birmingham 15 (October 15).

Assistant Biochemist (Basic grade) (with a B.Sc. degree with honours in chemistry or biochemistry, or an equivalent qualification) in the Department of Pathology—The Group Secretary, The Royal Hospital, Wolverhampton.

Biochemist (with an honours degree in chemistry or biochemistry, and with one or two years biochemical research experience), to assist in research work in the Special Unit for Juvenile Rheumatism—The Secretary, Canadian Red Cross Memorial Hospital, Taplow, near Maidenhead.

Chemical Engineers and Chemists (with an honours degree in chemistry or chemical engineering, or corporate membership of a relevant recognized professional institution or equivalent qualifications) to work in a group concerned with the industrial aspects of atomic energy—The Recruitment Officer, United Kingdom Atomic Energy Authority, Research and Development Branch, Industrial Group Headquarters, Risley, near Warrington, quoting Ref. 1,057.

Circuit Engineer (with a knowledge of pulse techniques and video and r.f. amplifiers, and a recognized technical qualification) in the Nuclear Physics Research Laboratory to work on design of electronic equipment associated with the experimental programme of the 156 in. synchrocyclotron—The Registrar, The University, Liverpool, quoting Ref. No. 220.

Experimental Officer or Assistant Experimental Officer (with a degree in geology, chemistry or physics), for work on the X-ray and differential thermal examination of clays (Soil Survey of England and Wales)—The Secretary, Rothamsted Experimenta Station, Harpenden, Herts.

Lecturer in Animal Husbandry—The Principal, Shuttlewort College, Old Warden Park, Biggleswade, Beds.

Lecturer (with a good honours degree in electrical engineerin and with experience in servomechanisms) in Electronics—Th Secretary, Royal Technical College, Glasgow.

Principal Scientific Officer (with a first- or second-class honour degree or equivalent in mathematics, physics or engineering, and wit instrument experience), at the Ministry of Supply Headquarters i London, to be in charge of a section responsible for research and development of fire-control equipment for military aircraft and ancillary equipment—The Ministry of Labour and National Service Technical and Scientific Register (K), 26 King Street, London, S.W.1 quoting A.275/5A.

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*(not included in the monthly Books Supplement)*

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# EDUCATIONAL PROBLEMS OF THE COLONIAL TERRITORIES

UST on twenty years ago, in September 1937, the Commission on Higher Education in East Africa, hich was under the chairmanship of Earl De La arr, issued its report. The Commission took as iomatic that the primary need of East Africa was e improvement of health and agriculture, and that ch improvement could best be achieved through e general education of Africans and by training in fficient numbers qualified African experts. Its first commendation, that education in East Africa ould be based upon the need of the community d should be closely related to environment, was nply endorsed two years ago by the Binns report; d the recommendations relating to education in e recent report of the East Africa Royal Comission of 1953–55 (see *Nature*, July 16, p. 87) are milarly based. It is not too much to say that lucation lies at the root of almost all the latter ommission's recommendations: they cannot be plemented effectively unless an educational policy such broad lines is formulated and executed aginatively and with vision as well as more gently and on a larger scale than has yet been done.

This is not to disparage the progress that has ready been made or to belittle the very considerle achievements of the past two decades. It is ther to emphasize that it is only through education at the African can adapt himself to use the w opportunities which are opening to him in dustry and on the land; and also gain a clearer nderstanding of the changes in traditional African ociety which are necessary to enable Africans to joy the higher standards of living they desire. ithout a vigorous and wisely concerted educational licy, the conditions encouraging the exercise of tivities favourable to progress cannot be secured, the co-operation and understanding between the ces essential for harmonious development establhed.

This point is very firmly emphasized by the Comission, which insists that the co-operation of the frican is essential for the effective development of ast Africa and that this co-operation cannot be cured without dispelling the fears and suspicions hich hinder it at present. To that end education is effective a weapon as it is in promoting the skill d knowledge the African needs for using the new pportunities which confront him. Nor is it any less nportant in assisting adaptation to the changes in aditional tribal economy which a modern and more roductive system demands.

Much that the Commission has to say on education essentially a re-statement of the findings of the inns Committee. That Committee saw in a full, comrehensive and balanced education a major solvent f the economic and social problems of East Africa, nd it emphasized that the more liberal education it ought for Africans must be based on their own frican environment and on their own way of life; nd particularly it stressed the paramount importance of agriculture and an attack on agricultural ignorance. Again, it urged that technological education should be developed to keep pace with industrial expansion, in order to enable Africans to make their maximum contribution as skilled workers in accordance with the opportunities of each area. The Binns Committee emphasized, too, the necessity for a close connexion between technical education and industry, and pointed out that successful technical education can only be based on a good general education.

The East African Commission naturally did not pursue the requirements of educational policy in any detail; but it recognizes clearly enough that education is a fundamental service, on the adequacy and efficiency of which all other services depend. For example, new industrial development in Africa requires a large contribution from Africans, even if at present they cannot provide all the managerial ability and capital required; and it is important to enable Africans to acquire the special skill required in modern industry and to create conditions which will allow Africans to exercise the greatest degree of enterprise of which they are at present capable. The difficulties are not primarily financial: they are chiefly deficiencies in knowledge and experience, and a public policy concerned to promote direct African participation in new industrial development should concentrate on removing those deficiencies.

Though education is a basic factor, it is not the only one. Much industrial training will have to be provided by industry itself, although the emergence of a foreman class among the African workers themselves clearly will depend on raising the standards of education as well as on the quality of industrial training. Moreover, the low productivity of ordinary African labour is not due merely to the lack of technical skill but also to various factors, some of which—such as under-nourishment, poor physique, endemic disease and lack of interest in ordinary economic incentives—could be modified or removed by appropriate public policy.

Specifically, the Commission advocates carrying elementary education to a stage at which it will be of permanent benefit to all growing children able to profit by it. Free universal education is, however, a long-term objective. For the present, the Commission suggests providing education for all pupils, at fees which will not exclude any, to the beginning of the intermediate stage, and in towns to the end of the intermediate stage. Secondary education should be obtainable by those prepared to pay for it, and supported by a wide and liberal system of bursaries for those unable to pay but showing clear promise and ability. The proposals of the Binns Committee for eliminating waste and ensuring that pupils complete their courses are supported, and it is suggested that priority should be given to the expansion of intermediate education, preferably as an adjunct to existing primary schools, even if this means temporarily retarding direct progress with primary education. It is emphasized that a higher standard of training in technical education can scarcely be established except on the basis of eight years primary education.

It is a little surprising, accordingly, in view of this long-established opinion as to the fundamental importance of education in Africa, to find so few references to education in the schemes made under the Colonial Development and Welfare Acts in the returns for 1954–55*. Apart from £37,116 for the expansion of education services in Zanzibar and a further £37,000 for the construction of primary schools and teachers' houses and £7,000 for the adaptation of Kampala Technical School, the only major schemes for education financed in this way are in West Africa, where £228,700 is provided for the construction of students' hostels, lecture theatre, assembly hall and gymnasium for the Nigerian College of Arts, Science and Technology. Under other schemes, £99,314 is provided for the construction of senior staff housing for the Nigerian College of Arts, Science and Technology, and £42,613 for additional accommodation for students and staff at University College, Ibadan. Out of the further £3,763,351 contributed to the development plan for Nigeria, however, £527,828 is earmarked for general education and £455,478 for technical education.

Education, moreover, receives due emphasis in the recent report on the Colonial Territories, 1954–55†, which, noting the continued expansion of educational facilities and the making of new provision for technical and higher technical education in several territories, points out that at the end of 1954 the number of students at the three universities and four university colleges in these territories exceeded four thousand. Enrolment at the Kumasi College of Technology increased to 580, of whom 62 were taking professional courses in engineering; and good progress was made towards the completion of the new buildings in Nairobi of the Royal Technical College of East Africa, for which a further grant of £107,000 was approved from Colonial Development and Welfare Funds.

It is in the context of these findings of the East Africa Commission and the general survey presented in "The Colonial Territories" that the significance of the achievements recorded by the Inter-University Council for Higher Education Overseas in its recent survey of the period 1946–54, and of the findings of the report by PEP entitled "Colonial Students in Britain"‡, are best appreciated. Indeed, "The Colonial Territories, 1954–55" contains a wealth of material which could be used for combating the complete indifference of the general British public to their own great Colonial inheritance, which was noted by PEP, and it should be for consideration whether the presentation of that annual report could be varied so as to deal more effectively with an ignoran which is both generally dismaying to Colonial studen and hinders sound judgment and wise decisions issues affecting all those territories for which Brit is still politically responsible.

To combat such ignorance is the more importa when we consider the extent to which these questio are interlocked. It is not simply a matter of pr viding more information or other effective action promote understanding between British and Colon peoples. The growth of the Colonial student popu tion from about 1,000 in 1946 to more than 10,0 in 1955 reflects the need of the Colonial territories trained men and women in order to accelerate even maintain development; and that need mu in large part be met from overseas until the n university institutions in those territories come maturity. Although only some thirty-five per cent such students are at universities, the remaind attending polytechnics, training colleges, or studyi under the auspices of such bodies as the Inns Court, they occupy places in British universi institutions to the extent of some two per cent at time when we are seriously concerned with t ability of those institutions to provide a sufficien of scientific and technical man-power for the dire needs of Britain.

Colonial education is, moreover, directly link with this question of scientific and technical ma power, as both the report of the Inter-Universit Council and the latest report from the Adviso Council on Scientific Policy (Cmd. 9537. Londo H.M.S.O. 6*d.* net) indicate. The young universiti overseas have close ties with universities in Brita and receive from them invaluable assistance, whi makes none the less heavy demands on staff. Suc special co-operation will be needed as fully in t immediate future as in the past. Much the same ca be said of research. The Advisory Council estimat that only some 450 scientists are at present engage in Colonial research, and of these less than o hundred are members of the Colonial Researc Service. This number is quite inadequate for t important problems awaiting attention, and unt the Colonial universities and research institutio have developed considerably, any expansion research must draw largely on the limited suppli of scientific and technical man-power in Britain itsel

The postgraduate scholarships recommended b the Inter-University Council in another connexio may offer some contribution here; but it is evide that in the present man-power situation the needs the Colonial territories require the most caref consideration. This factor, as well as their financi needs, should receive due weight in determini priorities and the allocation of our resources, n least when regard is had to the implications of suc new developments as that of nuclear power f Britain's own economy. The potentialities of th export trade stressed by Sir Francis Simon recent depend to some extent on the existence of traine men and women in the under-developed area and on the level of general and technical educatio there.

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* Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the concurrence of the Treasury, in the period from 1st April, 1954, to 31st March, 1955. Pp. 32. (London: H.M. Stationery Office, 1955.) 1*s.* 3*d.* net.

† Colonial Office. The Colonial Territories, 1954–55. (Cmd. 9489.) Pp. ix+186. (London: H.M. Stationery Office, 1955.) 6*s.* net.

‡ Colonial Students in Britain: a Report by PEP. Pp. ix+257. (London: PEP (Political and Economic Planning), 1955.) 21*s.*

As the PEP report on Colonial students notes, in ost territories the demand for professional and hnical skill is changing rapidly. Often the response these changes is too slow and development is peded because people with the right qualifications not available at the right time. Students arriving Britain are not always as well informed as they ould be about these changes, and PEP rightly esses the importance of systematic efforts to vise students and parents as to vocational suit- ility and opportunities.

This is one of the most important functions of the ident advisory service which PEP recommends ould be set up in each territory. Too many Colonial idents reach Britain inadequately prepared and equipped for their studies; but the student visory service should not be concerned with the itine inquiries which all educational institutions in itain are bound to make about all candidates for mission. PEP deprecates the students leaving me until they have obtained at least the minimum alifications they require for the courses they pro- se to take overseas, and urges that the maximum vantage should be taken of local facilities for gher education; nor should students proceed over- is before they have received admission to an ucational institution. The local student advisory rvice should make a continuous review of students' airs and problems, and there should be a corre- onding service in Britain to advise and help to ice Colonial students. Moreover, the British uncil facilities should no longer be restricted to idents recommended by governments but should available to all Colonial students.

There are other sensible suggestions dealing with ch matters as short preparatory courses for the s-mature students and the provision of accom- odation; but the vital issue is made abundantly in—more careful selection by the Colonial thorities and further preparation on the part of student. It is here above all that the recom- mdations are linked with the findings of the Royal mmission on East Africa and the observations of Inter-University Council for Higher Education erseas. On one hand, they imply greater local orts to provide adequate secondary and technical ucation up to sixth-form standard or its equivalent. the other, they confirm the wisdom of developing lonial universities, where ideally the sorting process ıld be effected so that mainly postgraduate students ıld be sent on for further training or specialized rk—a development itself retarded by the slow velopment of secondary education in both quality d quantity in the territories these institutions serve.

As the PEP report remarks, the increased flow of lonial students to Britain since the Second World ar reflects the fact that, although the facilities for gher education and specialized training in many lonial territories have been very greatly extended recent years, the advance has not been able to ep pace with the rapidly growing demand for ined men and women created by the accelerated npo of local political, social and economic develop- nt. Nor is it easy to see how, without grave detriment to standards or imposing excessive demands on the limited scientific man-power of Britain generally, as well as on the universities, the young institutions in the Colonies can be expanded rapidly to overtake that demand. Apart altogether from the fact that it is improbable certain types of education and training will be obtainable in these territories in the foreseeable future, the flow of students from the Colonial territories to Britain and some other countries is unlikely to diminish significantly for many years to come.

The relatively small number of Colonial students who are gaining the advantage of higher education and specialized training in Britain must thus bear early, and to a large extent, the responsibilities of leadership in the swiftly developing countries from which they come. Their attitude to, and relations with, Britain will be greatly influenced by their reception and experience as students in Britain. This is a paramount reason for attention to the sensible recommendations which the PEP report makes in regard to their welfare, and for the co-operation of the recognized professional associations and other bodies in the ways that are indicated.

But it is in the context of the expansion of the institutions of higher education in the Colonies that the Inter-University Council has some wise comments that need stressing. Noting that the progressive achievements in the provision of universities within the overseas territories during the past nine years have exceeded expectations, the Council remarks that the apparent ease with which the programme has been carried through to this point masks risks and dangers that may yet defeat or imperil the whole enterprise. One such danger—the growing signs of a demand for the establishment of more universities in the immediate future—bears particularly on this recommendation of the PEP group regarding the sorting out of students in the territory from which they come.

There may be political reasons for desiring a further university in a particular territory; but the consequence of such a step in a country where educational needs for the next decade might be better served by the provision of technical colleges could well be a dissipation of effort and resources, resulting in two starved institutions and a disastrous lowering of standards, not only in the so-called universities but equally in the public services and professions. The Inter-University Council and the PEP Group are at one in stressing the need for high standards and for resisting pressures to lower them. Political factors cannot indeed be ignored: local pride and support are vital to the success of any university, and it will always be a matter of delicate judgment to decide what weight should be given to political arguments when these conflict with technical and professional considerations.

Provided the academic issues and financial implications are fully and clearly stated, however, as the Inter-University Council seeks to ensure, there is the less risk either of a false step or of failure to keep alive the dynamic factors in the development of the overseas universities. The importance of that factor—of recognizing that the new universities are communities of men and women with pride and ambition in their subjects and in their institutions—is implicit in the PEP report and also in that from the Inter-University Council. Both reports present a great challenge, not only to all directly concerned in the enterprises which they survey but also to the body of informed opinion in Britain which already appreciates how much is at stake, and how simple are some of the measures required to avoid waste of effort and frustration. Confidence and co-operation must take the place of distrust and suspicion towards Britain that endanger the political, economic and social development of the Colonial territories, and the ultimate evolution of self-governing States within the Commonwealth, which are the declared aims of British Colonial policy. An important step to meet that challenge is offered by the material collected in "The Colonial Territories, 1954–55" and elsewhere for the creation of an informed public opinion, alive to the responsibilities of Britain in those territories and sensitive to the needs of those peoples, whether they remain in their own territories, or seek to fit themselves in Britain to serve their countrymen.

# LOW-TEMPERATURE PHYSICS

## Progress in Low Temperature Physics

Edited by Prof. C. J. Gorter. (Series in Physics.) Pp. xii+418. (Amsterdam: North-Holland Publishing Company, 1955.) 30.50 guilders; 61*s.*; 8 dollars.

DURING the past ten years or so, the commercial availability of the Collins cryostat has enabled many new laboratories, particularly in the United States, but also in France, India, Japan and elsewhere, to work at liquid-helium temperatures, previously a monopoly of only a few specialized laboratories; and there has been, in consequence, an enormous expansion of activity in low-temperature physics. The appearance of this collection of review articles—about half from laboratories which have only recently entered the field—is therefore to be welcomed. Such review articles enable the research worker specializing in any one branch of low-temperature physics to keep up with progress in others without having to read all the original literature; because many of the principles and techniques are common to all branches, this may well give him new ideas for his own special problem as well as broadening his outlook.

The best method of presenting a review article depends very much on the nature and scope of the subject. For a rather limited topic, it is possible to give a critical survey of the experimental and theoretical situation, using tables and illustrative graphs with full references to the literature, in quite a short space. An admirable example of this style of treatment is E. F. Hammel's article on liquid helium-3, which guides the reader through a very tangled situation and shows just what has been achieved. A less-successful example is C. F. Squire's article on the effect of stress on superconductivity—an even more limited topic, but not sufficiently systematically presented and lacking an adequate theoretical discussion. At the other extreme there is the mu
wider topic, such as the technique of adiaba
demagnetization and its many applications, whi
demands a much larger space if coverage in f
detail is to be achieved. This approach has be
adopted by D. de Klerk and M. J. Steenland, wh
article on adiabatic demagnetization is the long
in the book (62 pages) and almost a monograph
its own right; it can be read with profit by anyo
who wishes to learn the subject in detail from t
beginning, but is perhaps unnecessarily detailed
the low-temperature physicist to whom the book
primarily addressed. Alternatively, this kind of to
can be treated in more general terms with no attem
at a complete build-up but with a selection of ill
trative examples; this is A. H. Cooke's approach
his interesting 20-page review on paramagne
crystals in use at low temperatures. Probably t
ideal lies between the two, assuming rather m
specialized theoretical knowledge than de Klerk a
Steenland but giving a rather more detailed develo
ment than Cooke.

Nearly all the articles are reviews of alrea
published work; but R. P. Feynman's article on t
application of quantum mechanics to the liqu
helium problem deserves special mention as being n
so much a review as an original contribution, in whi
he presents important new developments of
recent ideas, in a form assimilable by the expe
mental physicist. These new ideas stress t
importance of turbulence in the flow of liquid heliu
and are particularly suggestive for new experimen

The eighteen articles cover a wide variety
subjects; about half are concerned with the propert
of liquid helium and superconductors, and t
remainder deal with paramagnetism, antifer
magnetism, ferromagnetism, propagation of sou
and transport properties of gases. There is so
overlapping (between B. Serin's article on sup
conducting critical fields and J. G. Daunt's on el
tronic specific heats of metals, which might well ha
been combined) and the choice of detailed top
seems a little haphazard. It is, however, explain
in the editorial preface that this choice has be
governed partly by expediency (where the compete
authority was not available to deal with a particu
topic at the time) and partly by the existence
recent review articles on some topics which it seem
unnecessary to treat again for a while.

On the whole, the articles are successful
achieving their object, and it is to be hoped that t
valuable service rendered by this collection
articles will be continued in at least a second volun
Perhaps, however, in such a second volume the edi
might aim at rather greater uniformity in the sc
and level of treatment of the articles.

D. Shoenberg

# FRUIT PRODUCTION

## The Fruit Year Book, 1955

(No. 8.) Edited by P. M. Synge and Lanning Rop
Pp. 142+30 plates. (London: Royal Horticultu
Society, 1954.) 10*s.*; 1.65 dollars.

ALTHOUGH the cultivation of fruit trees in t
specialized sense began early in the past centu
so much new knowledge of its problems and pote
tialities comes with each year that a year-book
necessary to record the progress. The complexit
of the situation are well portrayed in the pres

ume in a paper on the maintenance of healthy it clones, by R. V. Harris. Dealing particularly h a nuclear stock organization for the propagation tested healthy material, he shows that many fruit es and plants harbour 'latent' viruses without wing symptoms. Strawberries have a high degree tolerance in that they show little diminution of our when viruses are carried without causing nptoms. Raspberries and probably some tree its, on the other hand, often make but poor wth when 'latent' viruses are present—a pre- usly unsuspected cause of lack of vigour. Absence symptoms makes it impossible to maintain health roguing alone; hence the necessity for a care- ly controlled system of virus testing, the assess- nt of varietal reactions, and propagation under iditions where virus cannot be re-introduced.

). W. Greenham describes several types of soil nagement for the fruit grower, from clean culti- ion to permanent grass. He concludes that a table stand of grass and clover, mown frequently h a gang-machine, is in most cases the best form soil management for English orchards. Straw lches for soft fruit are also discussed; they are tively non-absorbent, and appear to act as 'non- rn valves' for the rainfall, and thereby conserve moisture, with considerable practical benefit.

'ree fruit yields fluctuate notoriously; A. P. ston finds that thinning the fruits to one per nty leaves gives good and regular crops. L. C. kwill shows that thinning on the large scale can accomplished by spraying with α-naphthalene tic acid in concentrations ranging from 5 to 50 ts per million, depending on the variety, the time r petal-fall, the degree of thinning required, the perature, and the nutritional status of the tree. also discusses the now well-established use of the e substance for reducing fruit drops at various es. Changes in the orchard insect fauna during present century are reviewed by A. M. Massee, o makes a plea for their ecological study as a ole. There are several other articles of more eral or regional interest, and the excellent plates l lustre to a well-produced volume.

John Grainger

# HUMAN BIOLOGY FOR THE MASSES

, the Great Adventure

Jean Rostand. (Discussions with Paul Bodin.) nslated by Alan Houghton Brodrick. Pp. 258. ndon: Hutchinson's Scientific and Technical blications, 1955.) 12s. 6d. net.

HIS book is an account of a series of conversa- tions on the French broadcasting system, which k place between Jean Rostand, a well-known nch biologist and, like his famous father, a man letters, and Paul Bodin, a distinguished poet, elist, journalist and man of science. In the talks, din played the part of a devil's advocate who was ill-informed on matters which excite public rest, while Rostand attempted to put the point view of a modern biologist-philosopher on topics cerned with heredity, sex, health and the future nankind. The radio talks were listened to by a e audience and have now been expanded by tand and Bodin into a book which is an admirable guide for those who wish to explore some of the broader paths in the field of current biology. Translation from the French has been made by A. H. Brodrick, himself well known for his contributions to the popularizing of science.

With Rostand's general point of view few modern biologists would quarrel, although his explanation of reasons for superfluous hair in the male is nonsense. Nor is he to be commended for the most obvious side-stepping of a question from Bodin dealing with birth control; perhaps, in France, the question should never have been put. This may also explain why a subject like miscegenation is dismissed in a sentence, although possibly here the translation may be at fault.

These, however, are trivial criticisms of a book which could reach many readers. Many of them will be shocked to learn that, in days of popular education and in a country like France, whose people are so proud of their ability to behave rationally, there are still about 3,460 astrologer-palmists in Paris alone. Here the man of science has cause to regret that the spread of scientific knowledge may even increase the credulity of those who possess a little scientific learning. One of the lessons from this book is that the mass of people are still prepared to believe anything, particularly if the new cult is served persuasively with the right amount of scientific jargon. Rostand and Bodin deserve praise for their efforts to remove some of the superstitions of 1955.

T. H. Hawkins

# HISTORY OF ASTRONOMY

The History of Astronomy

By Prof. Giorgio Abetti. (Translated from the Italian "Storia dell' Astronomia" by Betty Burr Abetti.) Pp. xviii + 345 + 34 plates. (London: Sidgwick and Jackson, Ltd., 1954.) 25s. net.

IN this book of more than three hundred pages Prof. G. Abetti gives the reader a straightforward summary of the history of astronomy. As he remarks in the preface, a book of this size "can be nothing but a summary of the vast amount of material which only a complete history could adequately present". He considers (Chapter 2) that the subject "may be arranged into three great periods corresponding to the history and civilization of the peoples of the Earth". First we have ancient astronomy, which can be traced back to about forty centuries before Christ and which can be considered to have ended with the decline of the Alexandrian school at about A.D. 650. Then comes medieval astronomy, which is mainly the astronomy of the Arabs and, to a small extent, that of the Romans. "But," comments Prof. Abetti, "the astronomy of these peoples, as also of the western Latins until Copernicus, is essentially nothing but a repetition of the Almagest of Ptolemy." Medieval astronomy is regarded by the author as extending up to about A.D. 1500. Between it and modern astronomy there is a transitional period of reformation, represented by the work of Copernicus, Tycho Brahe, Kepler, Galileo and Newton: "Through the work of these great men astronomy was launched on new and unthought-of paths to numerous and important conquests".

The modern era is considered to begin directly after Newton, and the book proceeds forward right up to the present day, Chapter 19 dealing with the developments of the twentieth century. It is always extremely difficult to include contemporary developments in writing a history of anything, and the author has wisely stated explicitly that his aim here is "to give an over-all glance at the results obtained in relatively recent times up to the present, without pretending to give the complete picture either of the subject matter or of the persons". Most readers will agree that Prof. Abetti has discharged this part of his task competently and fairly, and that the book would not have been so good, as it undoubtedly is, if Chapter 19 had been omitted. Any would-be critic will be well advised to ask himself whether he could do the job better.

In the chapters dealing with ancient astronomy, many readers will select Chapter 5 as the most interesting. This chapter gives an account of the school of Alexandria. A valuable feature is an earlier chapter, "Ancient Astronomers other than Greek", which deals successively with the astronomy of the Mesopotamians, the peoples of Central America, the Egyptians, the Jews, the Phœnicians, the Hindus and the Chinese. The last two come in for some courteous but definite 'debunking'.

The author explains in the preface that this "History", now translated for English-speaking readers, was written originally in Italian and that he has "lingered more, in the course of its development, on the Italian personalities and on their contributions to astronomical progress". I consider that Prof. Abetti's 'lingerings' have enhanced the value of the book. I particularly enjoyed the author's 'lingerings' over the work and careers of Toscanelli and of Secchi. The author is probably correct in claiming that the first period of the rise and development of astrophysics closed with the death of Ricco in 1910. The fact is that the contributions of Italians to astronomy are not so well known as they ought to be, and the 'lingerings' come as a useful corrective to English-speaking readers.

The book is excellently illustrated. There is a foreword by the Astronomer Royal, Sir Harold Spencer Jones, and an appendix dealing with the development and aims of the astronomical observatories of the world.

W. M. H. Greaves

## "INDEX GENERALIS"

**Index Generalis**

Vingt-et-unième Année, 1954–1955. (Annuaire Général des Universités et des Grandes Écoles—Académies — Archives — Bibliothèques — Instituts Scientifiques—Jardins Botaniques et Zoologiques—Musées—Observatoires—Sociétés Savantes.) Pp. xvi+2108+xx. (Paris: Dunod, 1955.) 9,500 francs.

THE "Index Generalis" first appeared in 1920 and by 1939 was a well-established work of reference, having run through a number of editions. Naturally, the Second World War seriously interrupted its publication, and it was not until 1953 that a new edition could be produced. This latest edition is based on the 1953 one with considerable corrections and additions, which make two hundred and fifty pages more of material to the already formidable total of two thousand.

The work is divided into six sections: universities and other major teaching establishments; observatories; libraries and archives; scientific institutes and research centres; academic and learned societ
and indexes. The section on universities is by
the largest, comprising more than a thousand pa
It is arranged alphabetically by countries, and wi
each country by the capital city followed by o
cities and towns in alphabetical order. (The princ
exception to this lay-out is the entry for the Un
States, where the sequence is by name of univer
institution.) For each university a list is give
professorial staff and similar persons holding se
appointments.

The section on observatories is a comparati
small one of sixty-five pages, the entries for e
observatory indicating its exact geographical posit
staff, publications, instruments and work. The
tion on libraries comprises 171 pages, sub-divide
countries. To economize in space, twenty-five c
letters, or combination of letters, are used for sp
fying particular items—for example, the numbe
books held—in the details given for each libr
The section on scientific institutes, 114 pages l
has a similar but much smaller code; but this co
not often used as the type of information given va
very much from one institute to another.
section on learned societies, which has 91 page
different from all the others in that it is grouped
subjects rather than by nations. Thus, u
"Generalités", defined as societies with more t
two subjects of study, are to be found the R
Society and the British Academy, while in a c
pletely different part of the section, under "Scie
(generalités)" are to be found the Royal Institut
the British Association and a host of other socie
such as the Royal Aeronautical Society and
Institute of Petroleum. This only serves to a
that science cannot be divided into watert
compartments, and scientific societies less
the arrangement by nations, as in all the o
sections of the book, would have been much n
preferable.

Then there are the two indexes. That dealing
names has more than a hundred thousand entries
can only be described as a 'monumental' c
pilation. Following each page reference is a num
ranging from one to eight, which indicates the
of the page in which the name is to be found;
is a great convenience, because many pages h
dozens of names scattered over them. For s
reason best known to the compilers, the lists
names beginning with *A*, *B* and *C* have short sup
mentary lists added at the end. The geograph
index, a mere thirty-four pages compared with
three hundred and fifty pages of names, is arran
alphabetically by place-names, and then under e
place are the various bodies to be found there.
main criticism to be made is that it is someti
difficult to find a particular institution, especiall
it is an American one; one has to take the var
cities in turn—New York, Chicago, etc.—and se
through the numerous entries thereunder. Fin
mention must be made of the sixty-four pages at
end of the book, on coloured paper and separa
numbered, which contain material that was sen
to the publishers after the main body of the b
had gone to press.

The whole work is primarily in French; but
should present no difficulty to the English-spea
reader with a smattering of French. In genera
can be said that in the past this book has bee
useful work of reference, and the present edi
worthily carries on that tradition.

# STRUCTURE OF VITAMIN $B_{12}$

## he Crystal Structure of the Hexacarboxylic Acid derived from $B_{12}$ and the Molecular Structure of the Vitamin

THE hexacarboxylic acid isolated from vitamin $B_{12}$ by Cannon, Johnson and Todd[1,2] has proved markably amenable to direct X-ray analysis. hrough a series of calculations of successive degrees f approximation to the correct electron density istribution, we have reached a solution of the ystal structure of this product which appears to rovide the solution also of a large part of the emical structure of vitamin $B_{12}$.

The rapid progress which we have made has een possible through the use of the National ureau of Standards western automatic comuter (SWAC) in Los Angeles, to calculate the ecessary structure factors and three-dimenonal Fourier syntheses[3]. Our general method as been to compute structure factors for all bserved X-ray reflexions based on gradually creasing groups of acceptable atomic posiions, to assign phases to the observed structure ctors after each set of calculations and to e the rephased terms to recalculate the ree-dimensional electron density distribution. his in turn was employed to revise or add tomic positions.

The starting point of the present calculaons was the recognition, described earlier[3], the first electron density maps calculated r this material (using phases based on nown cobalt atom contributions alone) of n internal nucleus surrounding the cobalt atom milar to that found in vitamin $B_{12}$ itself. Structure factors were next calculated based on 62 atoms belonging to this nucleus and to the rest of the cobalt co-ordination group. In the resulting electron density distribution there was an enormous improvement in the character of the peak pattern. In addition to the 26 atoms placed by calculation, which had peak heights from 7·5 e./A.$^{3}$ upwards, 91 independent peaks appeared with heights varying from 1·6 to 4·5 e./A.$^{3}$. All those greater than 2·5 e./A.$^{3}$, 28 in number, were in chemically reasonable sites to be assigned to atoms of side-chains attached to the main nucleus. A further ten atoms in additional side-chains were readily recognized in two following rounds of calculation. In one side-chain alone the selection of the positions of the atoms has not been straightforward and still presents certain difficulties. Since we have little doubt from other evidence of the chemical nature of these remaining atoms, we have included them with the rest of the molecule in Figs. 1 and 2, which show the most recently derived atomic positions projected on to the crystallographic a and c planes. At the latest stage of structure factor calculations based on 73 atoms in the crystal unit the agreement factor was 28·7 per cent. This figure, while it provides no guarantee that our solution is quite correct, compares not unfavourably with values often obtained for far simpler crystals built of molecules of chemically well-established structure. Interatomic distances conform with accepted values within 0·2 A., electron densities within about 1·5 e./A.$^{3}$.

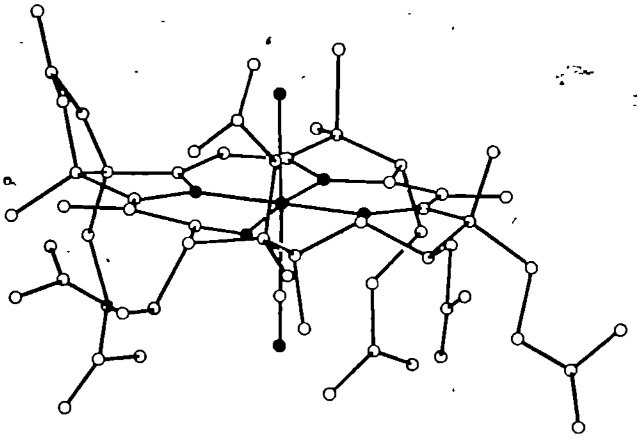


Fig. 2. Atomic positions found in the hexacarboxylic acid projected on the *c* plane. The chemical bonding deduced is outlined to emphasize the stereochemical form of the molecule

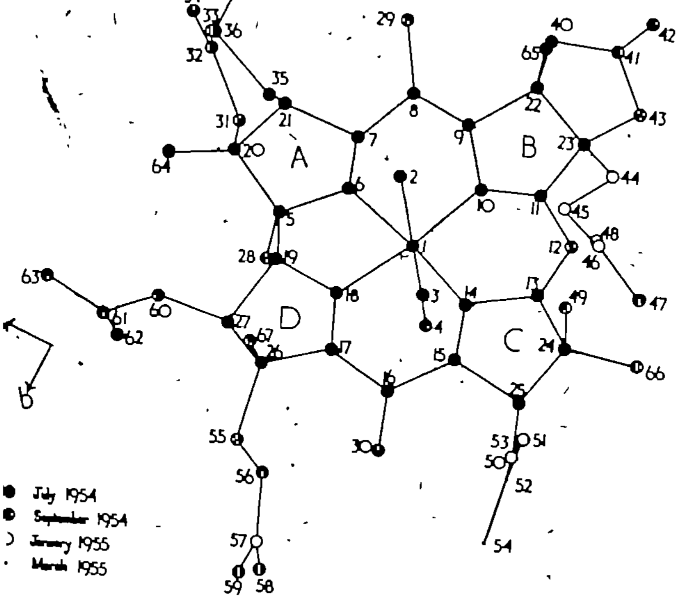
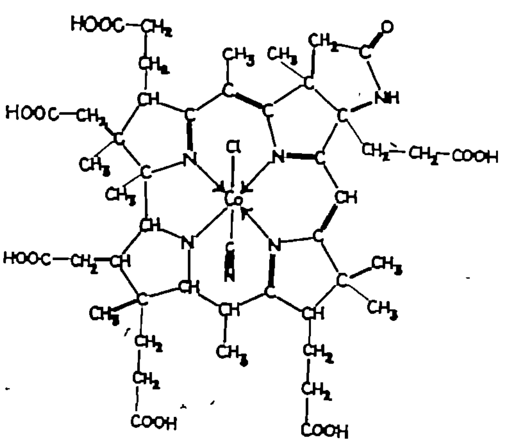


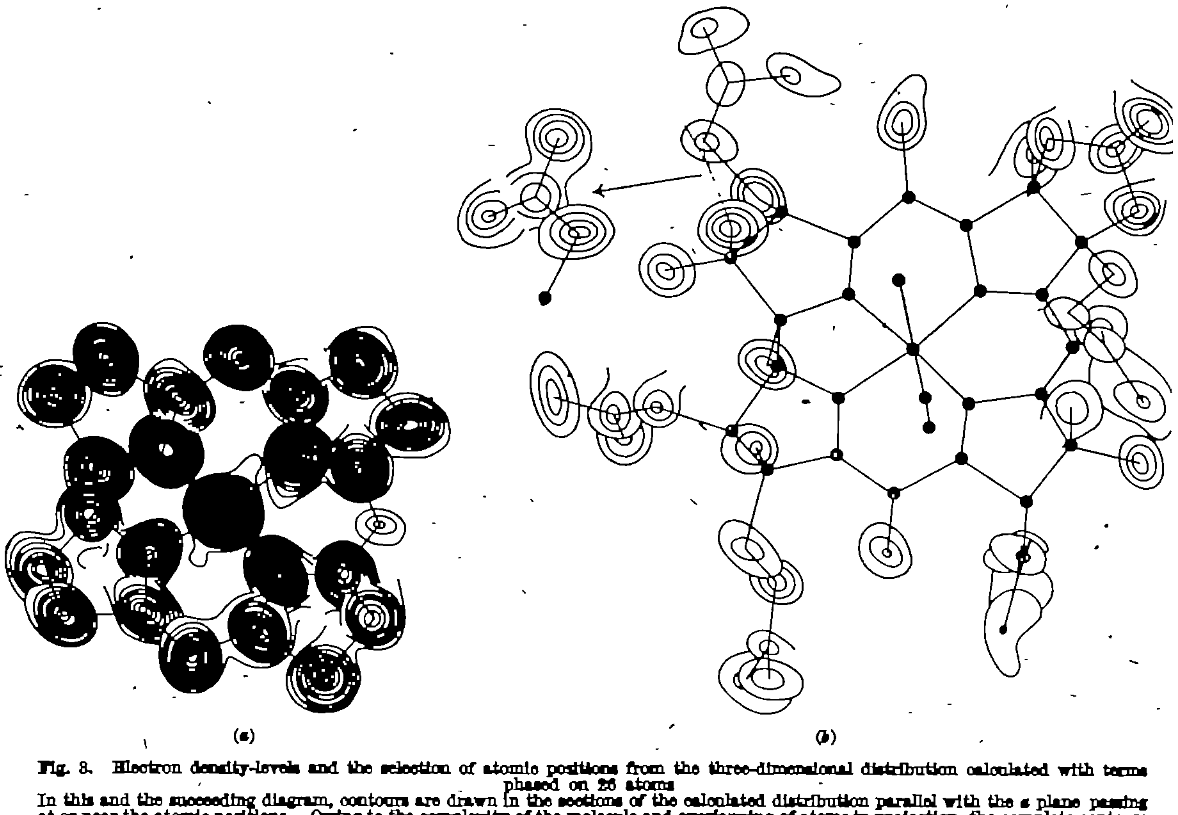
Fig. 1. Atomic positions found in the hexacarboxylic acid derived from vitamin $B_{12}$ projected on the *a* plane. The shading illustrates the course of the crystallographic study; the dates show approximately when each group of atoms was selected

The projected atomic positions of Figs. 1 and 2 correspond with a molecule having cobalt as its centre, attached to chlorine on one side and a cyanide group on the other, and surrounded by a nucleus of 63 atoms, not counting hydrogen. Two water molecules and one acetone molecule also appear in the crystal asymmetric unit. We earlier described the inner nucleus of atoms surrounding the cobalt atom, which consists of four five-membered rings, two of which are directly linked. The geometrical form of this nucleus is now much clearer. The inner ring of atoms, from 6 to 17 in Fig. 1, lie closely in one plane, suggesting that they are linked by a system of double bonds. At the direct link *C*5 is tetrahedral and bears a single substituent atom. The outer ring of atoms, the β-positions of the five-membered rings, lie alternately above and below the plane of the inner ring. They are clearly reduced and carry substituent side-chains conforming in outline with substituted acetic and propionic acid side-chains, in the order characteristic of porphyrins of Type III, together with other single substituent atoms. All the acetic acid residues project on the same side of the ring as the chlorine atom; all the propionic acid chains on the other (Fig. 2). Even without the apparent porphyrin relationship, it would be reasonable to write the chemical nature of the atoms N, C and O in a major part of the skeleton formula I, following evidence of the geometrical distribution in space of the side-chain atoms and the relatively heavy electron density of the four inner nitrogen atoms and of many of the carboxyl oxygen atoms, as shown by Figs. 3 and 4. The chemical character of the single substituent atoms at different points on the nucleus is less certain from crystallographic evidence alone. Interatomic distances and relative weights are consistent with their all being methyl groups as suggested by the analytical evidence; but neither measurement is sufficiently precise by itself to exclude the possibility that one or other (and particularly perhaps 28 or 30) is a hydroxyl- or amino-group. The one exception is atom 43, which is combined in a ring. This atom from its electron density must be oxygen or nitrogen (as NH), the ring being either a lactone or lacta ring. Neither the position nor number of the doub bonds is certain; the system shown in formula perhaps extended by one double bond, seems mo likely; but the alternative, formula III, is also possibl



(I)

To be able to write down a chemical structure ve largely from purely crystallographic evidence on th arrangement of atoms in space—and the chemic structure of a quite formidably large molecule that—is for any crystallographer something of dream-like situation. We realize that our metho do not permit us to be dogmatic about any particul detail of our proposal formula, however much w may believe that it does as a whole correspond wit reality. Our conclusions are strengthened by chemic



(*a*) (*b*)

Fig. 3. Electron density-levels and the selection of atomic positions from the three-dimensional distribution calculated with terms phased on 26 atoms

In this and the succeeding diagram, contours are drawn in the sections of the calculated distribution parallel with the *a* plane passing at or near the atomic positions. Owing to the complexity of the molecule and overlapping of atoms in projection, the complete contours for every atom are not shown. Interval of contours, 1e./Å.³. The figures are divided into two parts to show the atoms of (*a*) the nucleus, (*b*) the side-chains. The acetic acid residue inset in Fig. 4 is viewed along the *b* axis

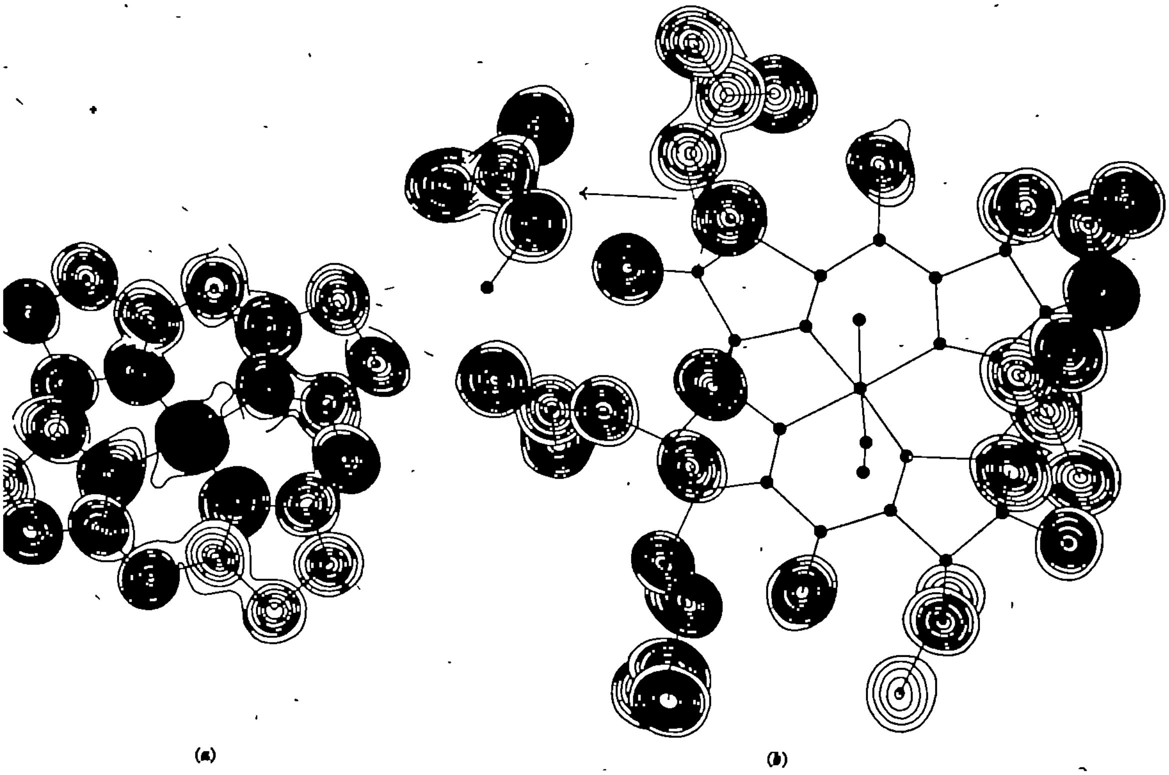
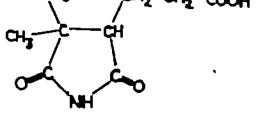


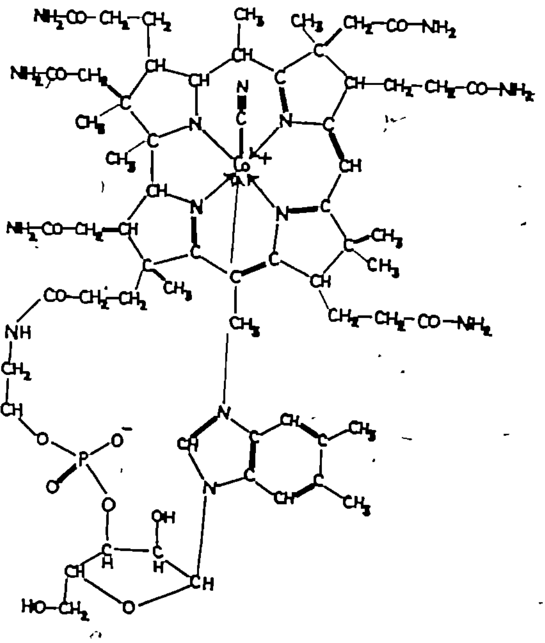
Fig. 4. Electron density-levels in the three-dimensional distribution calculated with terms phased on 68 atoms. In this and the preceding diagram it is noticeable that electron densities are usually lowest over the terminal atoms of the propionic acid side-chains owing to the greater freedom of displacement of the longer chains from their mean positions in the crystal. The effects are most marked over the side-chain on ring *C*

idence on the nature of the degradation products eady isolated from vitamin $B_{12}$[4] and discussed in tail below, and by our own parallel work on the amin itself. This additional evidence, and parularly the isolation of the succinimide, II, in the rck Laboratories[5], was most useful in deciding the ture of the only side-chain of which the atomic itions were not immediately clear from the crystal ucture of the hexacarboxylic acid.

The X-ray analysis of the different $B_{12}$ crystals is as far advanced as that of this degradation duct, and full results on these must come later. t already we have substantial confirmation for the sence of a nucleus of the above form in $B_{12}$ pro-ed that an exchange reaction has occurred in the mation of the degradation product; the nucleotide $B_{12}$ occupies the site of the CN group in the fragnt. We can also trace the positions of the atoms the propanolamine group linking the phosphate up in $B_{12}$ to the propionic acid side-chain of ring bove; only this group and the ribose molecule are ectly attached to the phosphate[6]. We can observe $B_{12}$ no evidence of an atom at the site of atom 43 the hexacarboxylic acid; instead, there is low tron density corresponding to a free acetamide up[7]. We conclude that the lactone or lactam ring ormed during degradation. These results make it possible to put forward a tentative complete structure for vitamin $B_{12}$ (III). This structure corresponds to the empirical formula $C_{63}H_{90}N_{14}O_{14}PCo$ in excellent agreement with reported analyses[7] which give figures within the limits $C_{61-64}H_{84-92}N_{14}O_{13-14}PCo$. Again, the exact number and position of the double bonds are uncertain.



(II)



(III)

We are very grateful for grants from the Nuffield Foundation and the Department of Scientific and Industrial Research and for technical assistance from Mrs. U. K. Ledwith and Mrs. H. M. Oliver. We also acknowledge the support of the computer in Los Angeles by the United States Office of Naval Research and Office of Ordnance Research.

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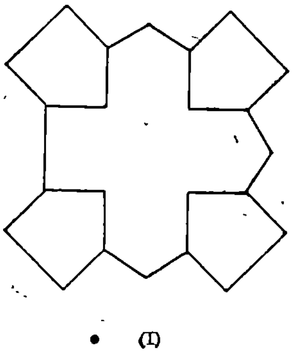
# The Structure of Vitamin $B_{12}$ and its Hexacarboxylic Acid Degradation Product

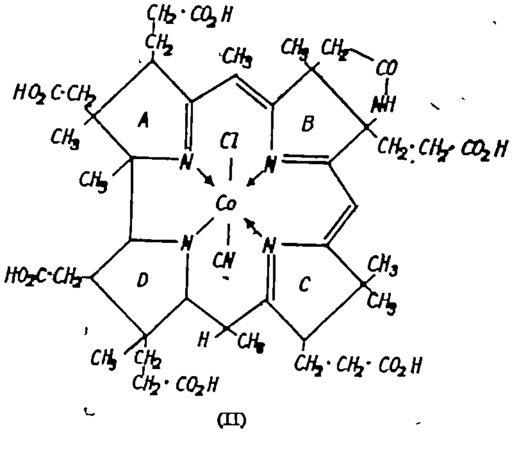
THE isolation of a crystalline nucleotide-free hexacarboxylic acid from alkaline hydrolysates of vitamin $B_{12}$ was described in an earlier communication[1], and the detailed X-ray examination of this product by our colleagues in Oxford[2] led to the recognition of the general nature of the cyclic system (I) surrounding the cobalt atom. Since that time, as described above, the relative positions of all the atoms (excluding hydrogen) in the molecule have been determined through the calculation of the full three-dimensional electron density distribution in the hexacarboxylic acid. These results, taken together with chemical evidence, have led to the proposal of the formula (II).

The crystallographic data by themselves leave open a number of details in the molecular structure of the hexacarboxylic acid, particularly the chemical nature of the single substituent atoms, the nature the ring attached to ring *B* of the nucleus, and th exact position of the double bonds in the molecul These can be partly resolved from chemical dat The sample of the hexacarboxylic acid subjected t chemical analysis was dried at 54°/0·05 mm. If is assumed that the residue still contained two mol cules of water of crystallization, then the formul $C_{46}H_{60}O_{13}N_6CoCl.2H_2O$ (C, 53·35; H, 6·2; N, 8 per cent) is in agreement with the values (C, 52·8 H, 6·3; N, 7·9 per cent) obtained from the el mentary analysis. This formula differs slightly fro that provisionally quoted in our previous com munication[1]; but the difference is clearly within th margin of experimental error. The figures ca best be accounted for by assuming that all eig single substituent atoms are present as carbon methyl groups; it seems unlikely that any of the are oxygen or nitrogen since the mode of formati of the hexacarboxylic acid (action of 30 per ce aqueous sodium hydroxide on the vitamin at 150 precludes the existence in it of any inherently unstab or labile groups. Independent evidence for t existence of ring *C* as now formulated was provid by the isolation and identification of the appropria succinimide (III), from a chromic acid oxidation a crude vitamin $B_{12}$ hydrolysate by the Merck grou and we have since obtained (III) from the chrom acid oxidation of the pure hexacarboxylic acid.

The nature of the five-membered ring attached ring *B* is the next point of ambiguity. The X-ra examination of vitamin $B_{12}$ itself reveals that t five-membered ring, which occurs fused to ring *B* the hexacarboxylic acid, is not present in the vitami which appears to contain an acetamide and a meth group as β-substituents in ring *B* and a propionami group as a β′-substituent. The extra ring in t hexacarboxylic acid is therefore produced by cycliz tion of the acetamide or acetic acid side-chain, pr sumably subsequent to hydroxylation at the remai ing β′-position, which is activated by a carbo nitrogen double bond, and the ring is therefore lactam or a lactone. The hexacarboxylic acid do not acquire an additional negative charge even high as *p*H 11, and this fact, coupled with its infr red spectrum and with the analytical figures, has l us to adopt the lactam formulation as is shown structure (II). This aspect of the problem and bearing on the structures of the tetra-, penta- a hepta-carboxylic acid degradation products[4] will discussed in detail in a later paper; but it should stressed that degradation of vitamin $B_{12}$ to a hep



(I)



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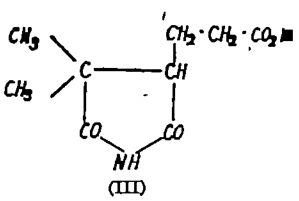
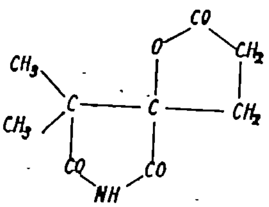


(III)

rboxylic acid without cyclization involving amide ups has only been observed in hydrolysis under d conditions.

Hydroxylation in the activated β-positions of rroline rings is well established in chlorophyll rivatives[5] and occurs with ease in the vitamin $B_{12}$ ies. When vitamin $B_{12}$ is subjected to short atment with alkali in presence of air it is con- rted into a biologically inactive crystalline sub- nce very similar to the original vitamin[6]. The idation involved in this conversion is, in our view, ring-hydroxylation of the type under discussion. support of this contention we find that the new bstance, unlike vitamin $B_{12}$, gives no heptacarb- ylic acid on acid hydrolysis, yielding instead only nixture of penta- and hexa-carboxylic acids ; on caline hydrolysis it is indistinguishable from the amin. Presumably hydroxylation will occur more dily under alkaline than acid conditions, although a hydroxyl is already present cyclization occurs der either. It may be observed that hydroxylation ring *C* can occur at least to some extent under d conditions, since the Merck group isolated the tically inactive lactone (IV) from chromic acid idations of acid hydrolysates of vitamin $B_{12}$.

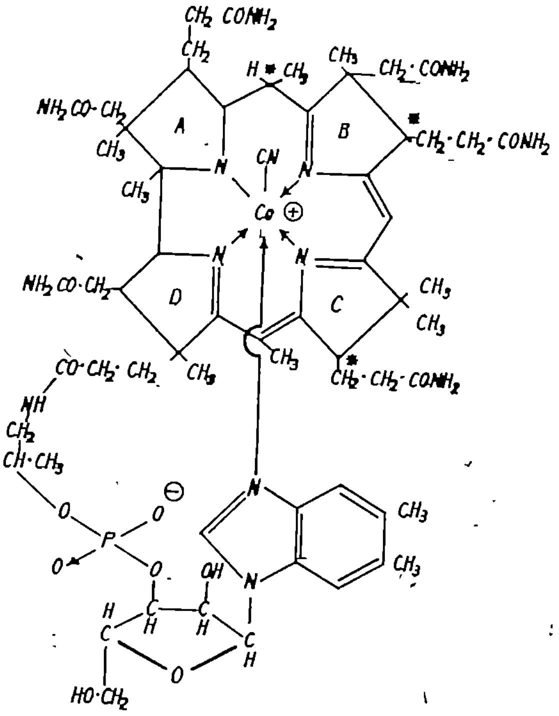


(IV)

Each of the rings *A*, *B*, *C* and *D* contains at least e tetra-substituted β-carbon atom, and conse- ently no pyrrole rings are present in the hexa- boxylic acid. It is therefore not surprising that re are many outstanding differences, both physical l chemical, between the vitamin $B_{12}$ and the phyrin series. Mention has been made elsewhere differences in the visible spectra and of the failure obtain maleimides from oxidations of the vitamin. om a vigorous hydrogen peroxide oxidation of the cacarboxylic acid (II) we have isolated oxamic d, in amounts greater than one mole per mole of amin. This observation lends support to structure ) in so far as the nitrogen of the oxamic acid must ginate in the nitrogen of the central partially uced pyrrole rings. It is of interest that, whereas mic acid has never been reported from the dation of a porphyrin, it has been isolated from dations of hydrogenated prodigiosin[7].

he conjugated double-bond system in the hexa- boxylic acid (II) was originally proposed on the unds that these constituent atoms of the macro- lic ring were effectively planar on X-ray evidence. ile there is as yet no definite chemical evidence the precise location of the conjugated system, the angement in (II) provides an adequate explanation, only for the production of (III) and of oxamic d on oxidation, but also for the behaviour of the cacarboxylic acid on chlorination, which is dis- sed below together with the chlorination of amin $B_{12}$ itself.

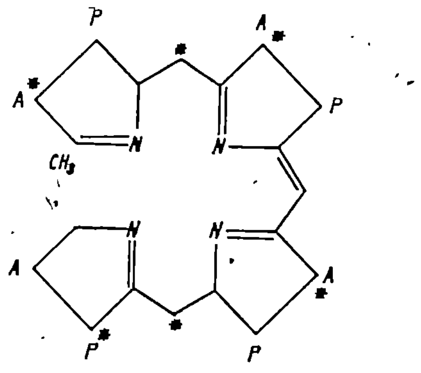
rom the X-ray studies on the hexacarboxylic acid l on the different $B_{12}$ crystals, together with con- erations of its chemical behaviour, structure (V), $H_{88}O_{14}N_{14}PCo$, is advanced for the vitamin.



(V)

According to structure (V) the vitamin contains six primary amide groups and one secondary amide joining the aminopropanol residue to the propionic acid grouping in ring *D*. It will also be observed that the vitamin is formulated as a diester of phosphoric acid, the free-acid group of the phosphate being neutralized by a positive charge on the cobalt atom. This not only accounts for the relative stability of the phosphate grouping but also for the electrophoretic behaviour of factor *B*, that is, vitamin $B_{12}$ lacking only the nucleotide, which in contrast to the parent vitamin behaves as a mono-acid base[4].

The location of the conjugated system in structure (V), although by no means proved, rests in part on the X-ray data and in part on the behaviour of the vitamin towards chlorination. On treatment of vitamin $B_{12}$ with N-chloroamides, three moles of reagent are consumed before a stable product is formed[8], and this appears to be a dichloro compound with a visible spectrum displaced into the red. Chlorination of structure (V) would be expected to result in substitution at each of the three activated positions marked with asterisks, and only one of the chlorine atoms in the product (that on the meso-carbon between rings *A* and *B*) could be eliminated as hydrogen chloride with a consequent extension of the conjugated system ; further extension of conjugation by this means is impossible. Chlorination of the hydroxylated vitamin $B_{12}$ obtained by aerial oxidation in alkaline solution consumes, as expected, only two moles of N-chloroamide with the same change in absorption spectrum. An alteration in the location of the conjugated system in passing from vitamin $B_{12}$ to the hexacarboxylic acid (II) apparently occurs, since the latter shows on chlorination the same behaviour as the vitamin—a fact most readily explained on the double-bond distribution shown in (II).



(VI)

Our confidence in structure (V) for vitamin B$_{12}$ is strengthened by biogenetic considerations. It is now widely accepted that porphobilinogen, the self-condensation product of δ-aminolævulic acid, is the precursor of many porphyrins in Nature, and indeed it yields mainly uroporphyrin III on mild acid treatment. A simple scheme for the biogenesis of the vitamin B$_{12}$ chromophore can be developed on similar lines, involving the initial formation of the tetracyclic, partially reduced, intermediate (VI; $A = CH_2COOH$, $P = CH_2CH_2COOH$). In such a molecule there are six positions (marked by asterisks) which should be susceptible to C-alkylation, and it is noteworthy that these are precisely the positions in which methyl groups occur in vitamin B$_{12}$. The ring-closure of the methylated (VI) to yield the chromophore we assume to occur by a dehydrogenation in the presence of cobalt; the appearance of a pyrrolidine ring in the final product is thus readily understood, as is also the double-bond arrangement. That rings *A* and *D* become linked directly rather than through the α-substituent of ring *A* (shown arbitrarily as methyl in (VI)) is probably due to steric considerations enforced by the non-planarity of the system. The introduction of the amide groups and the nucleotide portion as well as the necessary decarboxylation in ring *C* are regarded as secondary features.

Full details of the work described in this paper will be published elsewhere.

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# JUBILEE OF RELATIVITY THEOR

## CONFERENCE AT BERNE

ALBERT EINSTEIN published his famous fir paper on relativity theory in 1905, during th time when he was employed in the Swiss Pate Office in Berne. In celebration of the jubilee of th event, a conference was held at Berne during Ju 11–16 this year. It was organized by a special con mittee of professors in the Swiss universities und the chairmanship of Prof. Wolfgang Pauli (Zuric and with Prof. André Mercier (Berne) as secretary Prof. Pauli also presided over the conference itse Almost one hundred mathematicians, astronome and physicists from some twenty different countri were present as guests of the organizing committe They included a number of official representatives national academies, who conveyed to their hosts th salutations of these academies on the occasion th was being celebrated. Among the guests were son who had made classical contributions to relativi theory in its earliest days and whose reputations we legendary to the younger visitors. It is only natur to make special mention of the revered personality Prof. Max von Laue, since he was the spontaneo choice of all the other guests as the one to expre their thanks at the final meeting. There were prese also several of those who had been associated wi Einstein in various phases of his work at Princeton.

An account of the background of the conferen has already been given in *Nature* by Prof. Mercie The scientific programme was carried through in t form originally planned before Einstein's death April of this year. The conference was official opened by Dr. Virgile Moine, directeur de l'instructi publique (Berne), and by Prof. Pauli, who recall Einstein's singular affection for the place where l early great work had been done. The subseque proceedings comprised ten principal lectures, different speakers, reviewing various departments the subject, and about twenty short papers of a mo specialized character. The committee has arrang to publish the proceedings and discussion in bo form.

A programme of this nature does not lend itself easy summarizing. However, borrowing some of t headings used by Prof. Pauli in his concludi résumé, I may record a few of my impressions.

*Observational tests of general relativity.* Doubts these matters are nowadays mainly confined to t optical tests concerning the gravitational deflexion light and the gravitational red-shift of spectral lin The difficulties in the way of making these tests e better appreciated now than when they were fi attempted. A few participants were inclined interpret the results as establishing a defin divergence from the predictions of the theory. B the majority were prepared to accept the eviden which was re-analysed and reviewed with due cauti by Dr. R. J. Trumpler, as not contradicting t theory.

*Cosmology.* Much recent evidence concerning t red-shift in the spectra of external galaxies and t distance-scale of the universe was reviewed by I W. Baade. This all tends to yield a value ab $5{\cdot}4 \times 10^9$ years for the reciprocal of 'Hubbl constant', that is, three times the value origina estimated by Hubble; but Baade considers t uncertainty in the value to be still perhaps 20 p cent. Other speakers on various aspects of cosmolo particularly Prof. H. P. Robertson and Mr. F. Hoyle, also discussed a wide range of observational results and astrophysical inferences that must be taken into account by the theory. Special reference was made to ways in which radio-astronomy may soon provide crucial information. Discussion on this level, as contrasted with abstract arguments about, say, cosmological principles, showed how cosmology has 'grown up' in recent years, as Prof. H. Bondi remarked. There was no violent conflict of views arising from theories depending upon unique or upon continuing creation of matter. Apparently the general attitude was that a verdict must await the outcome of further evidence of the kinds considered. But, indispensable as present theories are for giving direction to the work, certain of us expect that fresh concepts will sooner or later be needed.

*Mathematical methods.* Workers on relativity have gradually become aware of a number of fundamental problems involved in any mathematically adequate formulation of the subject. These are mainly boundary-value problems, topological problems and problems concerning 'global' properties of the geometries employed. It is, however, only recently that many of these problems have been given a precise formulation and solution, above all by A. Lichnerowicz[2] and his school. Prof. Lichnerowicz gave a most valuable outline of this work. Its extension to the mathematics of 'unitary' theories is in part closely related to work by Prof. P. Jordan[3], who also described his somewhat different treatment.

*Extensions of relativity theory.* General relativity is primarily a theory of gravitation. Ever since its invention, attempts have been made to extend it so as to deal with other phenomena and thereby to discover their physical relationship with gravitation. These attempts have followed one or other of two main ideas. The first is that general relativity, so far as it goes, is a 'geometrization' of physics, so that it ought to be possible to extend its physical scope by suitably generalizing the geometry employed. Einstein's own efforts to obtain a unified field-theory belong to this category; but he assigned a more profound significance[4] to them than do, probably, most other workers in this branch. The second idea is that any extension of the physical scope of relativity ought to depend upon relating gravitation to quantum-phenomena, and that an essential first step in this direction is to 'quantize' the gravitational field-equations. Both these approaches reduce in practice to making trial of formal mathematical procedures in the hope that relations will emerge which either admit significant physical interpretations or suggest the general character of the desired physical relations.

Much work along these lines was described by Prof. P. Bergmann, Dr. Harris-Kaufmann, Prof. O. Klein and others; but there seemed to be no claim that it has so far produced any advance in physical theory. While no one can assert that such exploration of mathematical possibilities will never suggest any physically interesting relationships, the majority of those present were pessimistic about the prospects.

At the conclusion of an address on relativistic invariance of quantum-mechanical equations, Prof. E. Wigner briefly and tentatively suggested a much more fundamental approach. He recalled that general relativity is based on the concept that only coincidences in space-time are observable and on the principle of equivalence. From the fact that the concept of coincidences is not applicable on the atomic scale, Wigner was led to suggest that the use of co-ordinates would have to be renounced in the basic formulation of a more comprehensive theory. From the fact that the principle of equivalence gives a priority to gravitational interaction which it does not possess in atomic systems, he suggested that the simplicity of gravitational interaction may be realized only in the later stages of such a theory. Wigner thus foreshadowed a theory that would not look at all like general relativity in its initial formulation but in which familiar relativistic features would emerge in the final development. His arguments carried considerable conviction and reinforced the doubts about the feasibility of proceeding in the opposite direction, that is, from relativity to something more general. However, Wigner did not try to formulate such a new theory, beyond offering a suggestion that its equations might involve derivatives of fields with respect to fields instead of derivatives with respect to co-ordinates.

In view of Einstein's death, there were appropriately added to the conference some features of a more personal and commemorative nature. Calling upon many recollections and intimate details of academic history, Prof. Max Born gave an illuminating account of Einstein's career and its impact upon the physics of its times. Also at the 'Jubiläumsfeier' in the University of Berne at the end of the conference, Prof. Louis Kollros (Zurich), in an address read by Prof. Mercier, gave memories of Einstein's time in Switzerland, with numerous little-known particulars.

It is remarkable that this was probably the first international conference ever to be devoted to relativity. As the foregoing notes should show, its attention was concentrated upon current, and often tentative, developments rather than upon established 'text-book' theory. The exchange of ideas that took place is certain to play a large part in future progress, and Prof. Pauli, Prof. Mercier and their colleagues have done a great service to the advancement of the subject.

W. H. McCrea

[1] Mercier, A., *Nature*, 176, 919 (1955).

[2] Lichnerowicz, A., "Théories relativistes de la gravitation et de l'électromagnétisme" (Paris, 1955).

[3] Jordan, P., "Schwerkraft und Weltall" (Braunschweig, 1952).

[4] McCrea, W. H., *Nature*, 176, 925 (1955).

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# THE UNIVERSITY MUSEUM, OXFORD

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THE year 1850 might formally be regarded as marking the beginning of modern science in Oxford, for it was then that there was first established a School of Natural Science, capable of conducting its own examinations, and of awarding honours degrees.

But the year 1855 marked a more substantial advance, for in that year was laid the foundation stone of the new University Museum; in this building there were, for the first time, facilities such that the teaching of undergraduates could keep pace with the growth of science.

The University Museum has always meant more to Oxford than just an establishment in which collections are maintained; it has been, from its foundation to the present day, the centre of all scientific research and teaching in the University. Before it was built, the fruits of collectors' enthusiasm had accumulated in several university buildings; as the collections grew in size they became less accessible, and more difficult to preserve. The records are probably not exact enough to reveal the extent of the losses that the collections suffered before the building of the new Museum. One disaster is, however, recorded and well known; it took place in 1755, when a decaying specimen, thought to be useless, was put on the bonfire. It was the last example of the dodo.

With the development of the Honour School of Natural Science it was found that the collections were essential for the teaching of undergraduates, and that they were ineffective for this purpose as they were, at that time, distributed. We should honour the men who realized that a change was necessary, and took steps to bring it about. In 1847 Daubeny, Duncan, Walker and Acland drew up a 'memorial' addressed to the University. They said: "We . . . being officially connected with various institutions for the advancement of Natural Knowledge in this University, are of opinion that the several collections . . . are deposited in rooms of inadequate dimension and inconvenient arrangement, and that their present efficiency and future progress are by these means retarded. . . . we are desirous of furthering such steps as may tend to the erection of an edifice within the precincts of the University for the better display of materials illustrative of the facts and laws of the Natural world".

There were some men of science in Oxford who saw no hope for the development of their subject: William Buckland, the geologist, was one of those who refused to subscribe to the memorandum which Daubeny and his colleagues had drafted; he wrote: "Some years ago I was sanguine, as you are now, as to the possibility of Natural History making some progress in Oxford, but I have long come to the conclusion that it is utterly hopeless—the idle part of the young men will do nothing, and the studious portion will throw their attention into the channel of honours and profits which can alone be gained by the staple subjects". The manuscript of this letter was to be seen among a collection of documents, many of them of the greatest rarity, arranged by Mr. H. F. Alexander in an exhibition in the Radcliffe Science Library, during the period of the recent centenary celebrations.

Many in Oxford appreciated the urgency of the situation, and the more optimistic view prevailed. In 1849 a body called the Oxford Museum Committee was set up, and appealed for subscriptions towards the cost of building a new Museum. In 1850 it told of what it had collected in a letter to members of the Convocation of the University: not a great deal had been subscribed. In 1852 a tremendous help came in the report of the Royal Commission: it recommended that the University should proceed with the plan for building a "Great Museum" and that the trustees of the collections of various kinds should be empowered to transfer their collections to this Museum.

The University proposed to act: the University Press had in its account a balance of £60,000, and it was moved that this should be transferred from the Press account to the General Account of the University. The money was to be used to cover several expenses beyond those of the Museum. It was an amusing and healthy habit, in those days, for senior members of the University to express their views in privately printed pamphlets, when they objected to proposals by the Hebdomadal Council. Such a pamphlet appeared on this occasion: "the proposed Museum, Lecture Rooms, and various other apartments, exceed greatly in number, and some in magnitude, the needful requirements. . . ."

The University established a body, called "The Delegates of the New University Museum", in 1854. The Delegates were empowered to invite architects to submit plans for a building; in December of that year Acland invited the University to a conversazione in the Radcliffe Library, to meet the delegates, and to see the fruits of this invitation. Thirty-two designs had been submitted by twenty-nine architects. The delegates had selected six as possibles, the styles of which were said to be: Italian, Jacobean, Palladian, Rhenish Gothic, Roman, and Belgian Gothic. The short list was Palladian and Rhenish Gothic.

Opposition was not silenced by the delegates' hospitality. "The Babylon of a new Museum is again before us. Have we any Students in Natural Science? No! Do we require this new Museum? No!" wrote one pamphleteer. Other attacks were on the final choice of design, which was for the Rhenish Gothic. Another pamphlet, thought to be by Acland himself, explained what was wrong with the Palladian: among many objections, he pointed out that it was of three floors, one of them in a basement, and that the laboratory and yard of the Physiological Department were placed within the mass of the building. In the Rhenish Gothic, on the other hand, the use of detached buildings around a central court allowed for expansion.

The Rhenish Gothic design, which was by B Woodward, included a great deal of decorative work for which it seems that the University was disinclined to pay. For in 1856 a circular had again to be sent round, asking for private subscriptions Shafts of different kinds of rocks were required, 124 of them at £5 each; these would be useful, as illustrations of geology; they would also be ornamental Most expensive of the items which individuals were asked to buy were the statues of the great founders and improvers of natural philosophy. These were likely to cost £70 each in Caen stone. Her Majesty the Queen had already promised several; John Ruskin, of Denmark Hill, had offered to purchase Hippocrates, Dr. Hope the statue of Linnæus, and the bachelors and undergraduates of the University Aristotle and Cuvier.

The foundation stone of the new Museum was laid on June 20, 1855, being the day of the annual Encænia; on this occasion honorary degrees were to be conferred on Tennyson and Gladstone, among others. The night before the ceremony the Chancellor of the University, Lord Derby, spoke on the subject of the new Museum at a reception in the Radcliffe Library. This is the building now known as the Radcliffe Camera, for Dr. Radcliffe's medical and scientific library was transferred to a room in the Museum as soon as it was built. A contemporary Oxford lady said[1]: "It was long and uninteresting and not delivered with spirit".

On the day of the ceremony there was lunch at All Souls, and *The Times* wrote: "After a very hurried luncheon . . . visitors proceeded . . . to the open ground known as 'The Parks'. The Old Hundredth Psalm was sung, Lord Derby laid the stone, and addressed the meeting at some length going over most of the ground which he had gone over at the Radcliffe".

On June 20, 1955, the centenary was celebrated at the same hour—by the sun's time. With equal piety but greater wit, Sir Gavin de Beer, director of the British Museum (Natural History), at the invitation of the University, gave a lecture within the walls of the Museum, to mark the occasion[2]. It was heard, with great appreciation, by the Vice-Chancellor and a large body of senior members of the University. Having surveyed the events which led to the occasion he was commemorating, Sir Gavin spoke of the growth of Oxford science in the hundred years, in the spreading group of laboratories centred on the Museum court. He named some who, working there, had made outstanding contributions: Brodie, Perkin and Sidgwick; Rolleston, Burdon Sanderson, Haldane and Sherrington; Sollas, Poulton, Geoffrey Smith, Jenkinson and Goodrich. "These masters of research set a standard of which we may justifiably be proud; and the remarkable thing is that their successors, who are fortunately still with us, have not only equalled it but surpassed it."

Looking to the future, Sir Gavin noted that the centenary by chance marks also a reorganization in the control of the collections, this change having taken place in the present year; it came about as follows.

The original building contained accommodation for seven scientific departments, as well as for Radcliffe's library. With the growth of the science faculties, new buildings were needed, and these were built at the periphery of the Museum area, on land taken from the University Parks. Since the Museum collections were useful to the teaching of science only n certain of its branches, it was inevitable that the ooms immediately adjoining the Museum court came o be reserved entirely for Departments such as those f Geology and Zoology. The collections were eniched by Dr. Hope's entomological specimens, and when, in 1861, he endowed the Hope chair of zoology entomology) the new professor moved into the building as one concerned with material which lready occupied a good deal of space. In 1883 the ethnological collection made by General Pitt-Rivers was deposited in the Museum, an annexe being built on the eastern side to accommodate it; this part of the Museum is unique, for it has its own curator. For the rest there has been no curator since 1902, and the collections have been in the care of the professors whose Departments were concerned with them. This arrangement was satisfactory so long as the professors and the members of their Departments had the time and interest necessary for them to act as 'spare-time' curators. But as the scope of science broadened, and when the time-table and the laboratories became congested, few could find time even to look after the specimens used in teaching—those which, in the Zoology Department, for example, are necessary to display the variety of animal form.

The University has this year resolved to remedy this unsatisfactory state of affairs. One member of the staff of each Department concerned with the collections has been nominated as a curator, and will serve, with representatives of the delegates of the Museum, on a committee concerned only with the collections. This committee will have the power to make independent application for funds for its work; it is to be hoped that they will be forthcoming, for much needs urgently to be done.

The new arrangement is likely to be fruitful, too, in encouraging research on the rich store of material available. In zoology, for example, it is not possible for Oxford to maintain experts on the systematics of every group of the animal kingdom. But since the appointed curator in the Zoology Department is also the lecturer in taxonomy he will be able to advise postgraduate students and visiting research workers on what can be gained from the study of the Oxford material. Also, since the most exciting progress in systematics comes now from the study of the evolutionary significance of variation, he may find, and lead others to find, new scope for experiment from the study of the material in his charge.

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[1] Gifford, M. J. (ed.), "Pages from the Diary of an Oxford Lady" (Blackwell, Oxford, 1932).

[2] de Beer, Sir Gavin, "The Centenary of the Oxford University Museum with Thoughts on the Teaching of Science" (Oxford University Press, 1955).

# NEWS and VIEWS

## ast African Agriculture and Forestry Research Organization:

### Dr. H. H. Storey, C.M.G., F.R.S

Dr. H. H. Storey has retired from the Colonial service on reaching the age limit. He joined the newly opened East African Agricultural Research nstitute at Amani, Tanganyika, as plant pathologist n 1928, after some years of service with the South African Department of Agriculture. During 1941–46 he was occupied with war supplies, and served as hairman of the East African Industrial Research Board. During this period, important work was done n the development of a phosphatic fertilizer from he extensive rock deposits at Tororo in Uganda. In 946 he was appointed secretary for Colonial agriultural research, and was closely connected with the ormation of the Colonial Research Service. In 1948 e returned to East Africa as deputy director of the East African Agriculture and Forestry Research Organization, where his administrative ability was of much value in building up this new inter-territorial venture.

Dr. Storey has made notable contributions to agricultural research and practice. He was instrumental in identifying the devastating tea 'yellows' in Nyasaland as a sulphur deficiency, and in its spectacular cure by the simple expedient of using fertilizers, for example, sulphate of ammonia, containing sulphur. His work on the interspecific hybridization of cassava to obtain virus-resistant types is probably the most extensive piece of plant-breeding yet done on a tropical food crop. More recently, his swift organization of co-operative work on breeding rust-resistant varieties of maize is likely to protect East Africa from the ravages experienced in West Africa. Dr. Storey's outstanding contribution to virus research is undoubtedly his work on the transmission processes. His original techniques for inoculating a virus into small insects, and for transferring body fluids from one insect to another, are now used by workers on both plant and animal virus diseases. It is gratifying to learn that Dr. Storey's research work will not cease on his retirement, as he has accepted a special-appointment post at the East African Agriculture and Forestry Research Organization, and pending the arrival of Dr. E. W. Russell (see *Nature*, June 18, p. 1065) he will continue as acting director.

### Dr. H. C. Pereira

DR. Pereira, who has been appointed deputy director of the East African Agriculture and Forestry Research Organization in succession to Dr. H. H. Storey, is head of the Soil Physics Department of the Organization. After completing a research on cultivation, in association with Rothamsted Experimental Station, he joined the Colonial Agricultural Service in 1946 as a member of the Kenya coffee research team. In Kenya he studied the water relationships of coffee soils with special reference to the functions of cultivation and organic mulches in maintaining the structure and permeability of the soils and, from 1949, he took an active part in co-operative work, prior to his transfer to the East African Agriculture and Forestry Research Organization in 1952. Since then he has worked on dry-farming methods applicable to East African conditions, and has paid special attention to hydrological problems in forest, arable and ranching areas. He has successfully developed soil physical methods for laboratory and field use, in tropical conditions, and has established close relations with all territorial departments concerned in hydrology.

### Applied Electricity at Bangor: Prof. M. R. Gavin, M.B.E.

DR. M. R. GAVIN, who has been appointed to the chair of applied electricity at the University College of North Wales, goes to Bangor with a valuable and varied scientific and educational experience. He graduated in mathematics and natural philosophy in the University of Glasgow in 1929, and after some years as a mathematics master in Motherwell, he joined the Research Laboratories of the General Electric Co., Ltd., in 1936. Here much of his work was concerned with high-frequency valves and circuits, which earned for him the degree of D.Sc. from Glasgow; he was also made M.B.E. in 1945 for his research work during the Second World War. In 1947 Dr. Gavin returned to educational work as H.M. Inspector in technical education with the Scottish Education Department. In 1950 he was appointed head of the Department of Physics and Mathematics in the Birmingham College of Technology, and since 1953 he has also been vice-principal. Despite difficulties, Dr. Gavin has moulded a flourishing research group in Birmingham working mainly on problems in the fields of electronics and semiconductors, and has introduced new postgraduate courses on such topics as electronics, transistors, vacuum technique, X-ray technology and gamma-radiography. The Department of Applied Electricity in Bangor is concerned with the lighter branches of electrical engineering. Although the Department is independent, the relationship with physics is a close one, since there are no other engineering departments in Bangor. Dr. Gavin's blend of experience thus fits him well for this new appointment.

### Nuclear Research and Development

UNDER the title "The Commonwealth and Nuclear Development", the Central Office of Information has produced as Reference Pamphlet No. 2 the account of the British contribution to nuclear research which the Prime Minister on June 16 promised the House of Commons would be available in time for the International Conference on the Peaceful Uses of Nuclear Energy (pp. iv+52. London: H.M.S.O. 2s. net). In five well-written chapters, to which are appended the United States proposals of March 19, 1954, for an international atomic energy agency, the United Nations draft resolution on co-operation in developing peaceful uses of atomic energy and a brief bibliography of Government publications, it gives a clear account in non-technical language of the development of nuclear physical theory to 1939 and the present position. There are also accounts of the development of nuclear weapons, the United Kingdom nuclear energy project, progress in other Commonwealth countries, particularly the Canadian programme and the position in Australia, and international co-operation in this field, leading to the European Organization for Nuclear Research, the European Atomic Energy Society and the latest agreements (June 15, 1955) between the United Kingdom and the United States.

Most of the information is summarized from officia documents; but among interesting new points the pamphlet emphasizes that an important factor in Britain's growing export of radioisotopes has been their reasonable price—and it may be noted that the price of some have been recently further reduced (see below). The average value of each of the 10,257 dispatches from Amersham last year was £20, and some useful items cost only £5. Export between October 1953 and September 1954 went to forty-one countries, and to help prospective purchasers, catalogues of radioactive materials and labelled compounds giving technical details and prices are available. Some further information i provided regarding the new experimental nuclea reactors. The zero energy fast reactor ZEPHYR which went into operation at Harwell in February 1954, will supply operating and design information of major importance for the fast breeder reacto under construction at Dounreay, while a deuterium-moderated low-energy reactor, known as DIMPLE which started operation in August 1954, has bee used for experimental work for a new and mor powerful heavy-water reactor which is being built a Harwell to provide the high-neutron flux essentia for some research purposes. This reactor, which should be operating in 1957, will be a powerfu source of radioactive isotopes as well as testin materials. The pamphlet includes Mr. Geoffre Lloyd's announcement of June 13 regarding the additional reactors to be built at Calder Hall and near Annam, and summarizes some details of industrial co-operation and of the training programme.

### Prices of British-produced Radioisotopes

REDUCTIONS in the prices of iodine-131 an colloidal gold-198, which are distributed from th Radiochemical Centre, Amersham, are announced b the United Kingdom Atomic Energy Authority. These isotopes are used extensively for treating disorders of the thyroid gland and of the lymphatic system. The concession has been made possible b a continuing growth in demand and by improve manufacturing efficiency at Amersham. The saving o the average isotope user will be about 20 per cent. Both these isotopes are in ample supply. Although hey are short lived—iodine loses half its activity in ight days and the gold loses half its activity in three days—they can be delivered by air to any part of he world at short notice; the Radiochemical Centre provides sufficient activity to compensate for that oss during transit. Among the more distant countries lready using this service are Australia, New Zealand, Argentine, Uruguay, South Africa and Japan. The new prices are: iodine-131, in carrier-free solution— minimum charge of £1 for 1 millicurie and 3s. 6d. per millicurie thereafter; iodine-131 in sterile olution—a minimum charge of £2 for 1 millicurie nd 3s. 6d. per millicurie thereafter; gold-198, in a colloidal solution—a minimum charge of £5 for 50 millicuries and 6d. per millicurie thereafter.

## Academy of Zoology, India, and *Annals of Zoology*

IN 1954 a new society, the Academy of Zoology, was founded in India, with headquarters in Agra, under the presidency of Prof. B. C. Mahendra. Its ims are to further all branches of zoology and to ncourage research, not only in India, but in countries n the East in general, with as international an appeal s possible. This is indeed an ambitious project. The Academy has started a new journal, the *Annals f Zoology*, each part of which will in general consist f a single memoir; supplements containing short otes, reviews, etc., will be issued from time to time, nd special volumes may also be issued. The first part, which appeared in January this year (1, No. 1 1955); pp. 22; Rs. 15 or 30s. for each volume of pproximately 240 pp.), is a paper by Surendra Sharmer and P. N. Tiku on the venous system of *Rana tigrina* Daud, a frog widely used in the universities of northern India, for which no detailed account f the veins is available. The paper is a straightforward piece of work carefully done and based upon he classical account in Gaupp's "Anatomie des Froches", which is a good model. The authors have ollowed Gaupp in his incorrect account of the interpretation of the relationship of the abdominal vein and hepatic portal vein. The block-making and printing are well done upon good paper, and the text s remarkably free from errors. The editor, authors nd printers are to be congratulated on a satisfactory production. Inside the cover, it is stated that the Academy intends to continue the well-known series f "Indian Zoological Memoirs" established by the late Prof. K. N. Bahl, which have come to an end with his much regretted death. This would be a valuable service to zoology and to Indian zoology in particular. Information regarding the Academy and he *Annals* can be obtained from the Secretary, Academy of Zoology, 164 Civil Lines, Agra.

## Air Pollution in Britain

THE Clean Air Bill published on July 27 is intended o implement the principal recommendations of the eport of the Beaver Committee on air pollution in Britain (London: H.M.S.O. 1s. net). It applies to Great Britain only, and four of its clauses prohibit he emission of dark smoke from chimneys, railway ngines and vessels, subject to exemption by the Minister for specified periods to cover soot-blowing, he raking of boiler fires and other necessary operations which unavoidably cause smoke for a few minutes. It will be a defence to prove that mission of dark smoke was due solely to the lighting up of a furnace from cold, an unpreventable mechanical failure, the impracticability of obtaining suitable fuel, or (for the first seven years only) the unsatisfactory nature of the furnace and the impracticability of modifying it at reasonable cost. Clause 3 prohibits the installation of new industrial furnaces unless they are capable, so far as practicable, of being operated continuously without emitting smoke. Clauses 4–7 require the emission of grit and dust from existing industrial furnaces to be minimized, and new furnaces burning pulverized coal or large amounts of other solid fuel to be provided with grit-arresting equipment. Clause 8 empowers local authorities by Order (subject to confirmation by the Minister) to designate 'smoke-control areas' in which the emission of smoke from any chimney will constitute an offence. In such areas, grants covering at least 70 per cent of the cost of adapting or replacing grates and stoves to enable smokeless fuel to be used will be payable to owners or occupiers of private dwellings, of which 40 per cent will be paid by the Government and at least 30 per cent by the local authority. The cost of these clauses to the Exchequer is not expected to exceed £3 million a year, but expenditure up to £40,000 will be incurred by the appointment of additional staff by the Ministry of Housing and Local Government and the Department of Health for Scotland.

## Forestry in Malaya

IN spite of all the troubles in Malaya, which must have made forestry working exceptionally difficult during the past few years, the *Malayan Forester* (17, No. 1; January 1955) maintains its high character. The number includes several papers presented to the Fourth World Forestry Congress held last December in Dehra Dun, India. One, on Malayan tropical rain forest, by F. H. Landon, is of exceptional interest. An important note is struck in the editorial on the housing question, which is as vital in many parts of Malaya as in Britain. In the past, the houses were built mainly of unseasoned timber and classified as 'temporary' or 'semi-permanent'. Only unseasoned wood was obtainable, and the timber trade made no effort to provide the public with seasoned wood. Now houses are built of brick and cement, tiles and metal windows, though there is an abundance of timber in the forests of the country which only requires the introduction of modern methods of seasoning to make available houses at a cheaper rate. It is scarcely a matter for surprise, then, that the Government is losing money on its forestry working.

## Evidence of Translocated Antibiotics in Expressed Plant Sap

DETAILS have been given by S. H. Crowdy and D. Pramer (*Ann. Bot.*, N.S., 19, 79; 1955) of a convenient and efficient press for extracting laboratory samples of plant sap. The pressing procedure is stated to release 53–74 per cent of the total water as expressed sap. They have also described briefly some preliminary experiments on the uptake and translocation of antibiotics. They have shown that the assay of expressed sap provides a measure of the griseofulvin and chloramphenicol concentrations in leaves of plants grown in solutions of these antibiotics, that is, in good agreement with the values obtained by the assay of water extracts. By using organic solvents, however, the authors have extracted considerably greater amounts of antibiotics than is indicated by the assay of expressed sap. To explain this difference they have postulated the existence of a 'free' antibiotic fraction, which is obtained in water extracts or in expressed sap, and a 'bound' fraction which can be recovered from the leaf only by using suitable organic solvents.

## C. L. Herrick

THE whole of a recent issue of the *Transactions of the American Philosophical Society* is devoted to an account of the astonishing life of the famous American naturalist and psychobiologist, Clarence Luther Herrick (45, Part 1; 1955). The author is his younger brother, Prof. C. J. Herrick, who writes with great pride and affection of his brother's career when holding chairs at Denison University and the Universities of Cincinnati and Chicago, his posts as United States deputy mineral surveyor and president of the University of New Mexico, and manager of the Cat Mountain Mine in New Mexico which soon became bankrupt. All this was crowded into a life of forty-six years, the last eleven of which consisted of a struggle against pulmonary tuberculosis. His brother describes him as a precocious genius "whose pioneering was in areas of remarkable diversity—in natural history surveys, in geology and paleontology, in general biology and ecology, in comparative neurology and psychology, in rare proficiency as an inspiring teacher and educational administrator, in the rejuvenation and successful reorganization of a great university, in naturalistic philosophy, and in the founding of two great scientific journals".

## Abstracts of New Zealand Scientific Papers

LAST year a new feature was started in the *New Zealand Science Review*, the official journal of the New Zealand Association of Scientists, whereby abstracts were prepared of scientific papers published in New Zealand since September 1, 1953, and, where possible, of papers published in Britain or North America which were based on work in New Zealand. By the end of the year, 502 such abstracts, covering the period up to October 30, 1954, had been printed, and in the November–December number of the *Review* (12, Nos. 11–12; 1954) are to be found author and subject indexes for all these abstracts; the subject index is particularly full and contains nearly two thousand entries. The abstracts are arranged under subject headings, and biological and agricultural subjects, as befits a country like New Zealand, greatly predominate, though entries under physical and technological subjects, etc., are to be found. It should be borne in mind, however, as a preparatory note to the subject index explains, that very little of the work in physics, chemistry or mathematics that is done in New Zealand is published in that country, and the compilers of the abstracts are fully aware that they have not covered extensively overseas journals. The onus of directing attention to their work must always rest on the authors of papers themselves.

## Ramsay Memorial Fellowships for 1955–56

RAMSAY Memorial fellowships for research in chemistry have been awarded for 1955–56 to the following: B. R. Hammond and E. Haslam, general British fellowships at the University of Cambridge; H. Inokuchi, a Japanese fellowship at the University of Nottingham; Dr. R. V. Jordana, Dr. A. Esteve and Dr. Garcia-Moliner, Spanish fellowships at the University of Cambridge; and T. Cohen, a United States fellowship at the University of Glasgow. The following fellowships have been renewed: Dr. J. A. Davies, Canadian fellowship at the University of Leeds; Dr. L. H. Ruiter, Netherlands fellowship at the University of Bristol; and Dr. C. Alfonso, Spanish fellowship at the University of Birmingham.

## Polish Medal Awards for Scientific Work

THE following medal awards have recently been made in Poland. *Biological Sciences:* Prof. J. Dembowski, for general scientific work; Prof. E. Mikulaszek, for his work entitled "Immunologically Active Polysaccharoses". *Mathematical and Physical Sciences:* Prof. K. Borsuk, for distinguished work in topology; Prof. L. Infeld, for outstanding achievements in theoretical physics and, in particular, for work on the theory of gravitation and non-linear electrodynamics; Prof. S. Pawlowski, for the discovery of sulphur deposits of great economic importance; Prof. J. Samsonowicz, for research into depth structures of the Polish Plain.

## Announcements

WE regret to announce the following deaths.—Prof. R. W. Wood, For.Mem.R.S., research professor of experimental physics in Johns Hopkins University, on August 11, aged eighty-seven; Prof. J. B. Sumner recently professor of biochemistry and director of the Enzyme Research Laboratory in Cornell University in 1946, on August 12, aged sixty-seven.

MR. SIDNEY JOHN WORSLEY, principal of the College of Estate Management, Kensington, has been appointed by the Secretary of State for the Colonies to be secretary of the Inter-University Council for Higher Education Overseas and of the Colonial University Grants Advisory Committee. Mr. Worsley succeeds Dr. Walter Adams, who has been appointed director of planning and principal-designate of the University College of Rhodesia and Nyasaland (see *Nature*, January 29, p. 193).

THE ninth General Assembly of the International Astronomical Union will be held in Dublin during August 29–September 5.

DR. N. B. CHAPMAN, senior lecturer in organic chemistry in the University of Southampton, has been appointed a reader in respect of that post.

THE College of Physicians of Philadelphia has awarded the Alvarenga Prize for 1955 to Dr. C. H. Rammelkamp for his outstanding work in the field of streptococcic infections, particularly in relation to rheumatic fever and nephritis.

THE following appointments in the University of London have been announced: Dr. Roger Warwick lecturer in anatomy in the University of Manchester to the University chair of anatomy tenable at Guy's Hospital Medical School. Dr. R. H. Gorrill, senior lecturer in bacteriology at St. Mary's Hospital Medical School, to the University readership in bacteriology tenable at Guy's Hospital Medical School.

THE ninth annual conference of the Stress Analysis Group of the Institute of Physics will be held during September 28–30 in the Stephenson Hall, University of Sheffield, and will deal with applications of stress analysis. Enrolment forms and further information can be obtained from the Secretary of the Institute, 47 Belgrave Square, London, S.W.1.

# BUILDING RESEARCH STATION, GARSTON, WATFORD

## OPEN DAYS FOR ENGINEERS

THE purpose of the display of engineering and soil mechanics work of the Building Research Station (Department of Scientific and Industrial Research) at Garston, Watford, during July 15–19, was not so much to give a general account of work in progress as to stimulate the application of the results of research by practising civil and structural engineers. To this end, special emphasis was laid on five lines of research: those concerned with reinforced concrete, steel-framed structures, load-bearing walls, bridges and foundations.

One important contribution to research was mentioned by Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, in opening the exhibition. Referring to the expert advice and guidance on building research given by the Building Research Board under the chairmanship of Sir Herbert Manzoni, Sir Ben said: "This Board, consisting of people of great ability, achievement and experience in the many and varied aspects of building, give us their time voluntarily and do us a service we could not obtain in any other way. All our D.S.I.R. Stations enjoy this advantage, and it is not generally known how much scientific research owes to the public-spirited men and women who serve on our Boards".

The central theme of the presentation was that the older methods of design lead to under-estimations of the strengths of structures, that more exact methods of design are being made available, and that provision is increasingly being made, in building regulations and codes of practice, for their use.

The safety factors used in structural engineering have to take into account a number of variables, such as the mechanical properties of building materials, quality of workmanship and the knowledge of designers. On the other hand, there are many ameliorative effects, such as rigidity at joints in frames, stiffening by concrete encasing steelwork, stiffening by panel fillings, and 'composite action' generally, that cannot be taken into account until a quantitative assessment of them is possible. Display panels and testing equipment were used to illustrate the Station's work on both aspects of this general design problem.

Research on reinforced concrete has led to the inclusion in the relevant code of practice (*CP* 114) of recommendations for a new method of design—the load-factor method. The principle behind this method is that the load that will just cause failure of a structure is sufficiently greater than the working load to bring the probability of failure during the working life below a specified limit. Several exhibits illustrated research to provide data enabling designers to use the load-factor method of design with safety and economy—research on the control of quality of concrete as well as on the behaviour of walls, beams and other structural components at the point of failure.

With steel-framed buildings, three main lines of investigation are leading to more economic methods of design. Mathematical analysis has been made of a large number of idealized frames with fully rigid joints, to enable the bending moments in the neighbourhood of such joints to be assessed accurately. Secondly, an attack is being made on the problem of what happens in a steel structure when some of the steel is deformed beyond its elastic limit and passes into the plastic range. Formerly, this point was regarded as marking the limit of strength of the structure; in fact, it marks the onset of a redistribution of stresses that may result in a considerable margin of safety before actual collapse occurs. Thirdly, there is the question of how much allowance can be made for the effects of composite action, in a complete building, between the steel frame and floors and panel infillings, and between the steel members and concrete encasements provided primarily for fire protection.

A major difficulty here is that of embodying this more accurate knowledge of structural behaviour in design procedures that are not too complicated for adoption by the profession as a whole. The aim, therefore, is to express the results of mathematical analysis, once their validity has been confirmed by measurement, in simple design charts that can be used with confidence by a designer even though he may not feel at home with the analytical methods that have gone into their preparation.

The thickness of load-bearing walls has in the past been largely determined by rules-of-thumb that have been shown by experience to be safe. Such rules are often wasteful. Examples were shown of work devoted to determinations of the strength of walls under various conditions of loading, so that design recommendations on a calculated-stress basis could be formulated. The results of this work, mainly on walls and piers built with bricks and blocks, largely shaped the recommendations of the code of practice (*CP* 111) for the design of load-bearing walls—recommendations that can lead to important economies in material.

Research on bridges has naturally been pursued in close liaison with the Ministry of Transport. Perhaps the most important outcome of this work has been, in a sense, an invisible one. Throughout Great Britain there are some thousands of old bridges, carrying traffic much heavier than was envisaged at the time they were built. It was thought that many of these bridges might have to be rebuilt. The Station was asked to investigate, with the view of formulating more accurate ways of assessing the strength of such bridges. From 1936 onwards more than fifty cast-iron girder and masonry arch bridges were tested, some of them being loaded to destruction. Two important conclusions emerged: first, with the girder bridges, a load applied over one girder is partially supported by other girders; secondly, with both girder and masonry arch bridges, the fill and road-surfacing material gradually becomes consolidated and acts structurally in combination with the girders or arch so as to give a total strength considerably greater than that forecast from consideration of the basic structure alone. Many suspected bridges were thereby reprieved—a matter of immense and immediate importance when, during the Second World War, it became necessary to send heavy military vehicles up and down the country. This work on old bridges alone saved the country many millions of pounds.

Since the War, research on bridges has been concerned mainly with modern steel-and-concrete bridge decks. The most striking feature of measurements on bridges has been the low values for the strains measured in the girders, even with heavy traffic. Laboratory tests on scale-models have helped to explain this, particularly on the basis of composite action between the girders and the concrete and of the lateral distribution of load among the girders. Several possible new methods of design are being investigated, with the view of gaining all possible advantage from this structural interaction, which previously was ignored.

A working model was used in the exhibition to illustrate a series of tests that measured the dynamic effects of traffic. The impact factor (the ratio of the strain due to a load applied dynamically to that due to the same load applied statically) varied in most cases between 0·8 and 1·3, the commonest values being about unity. In the past, it has been usual to assume an impact factor of 1·5 or more for design purposes; but the tests show that such a value is unduly high and that a more economical design can be made on the safe basis of an impact factor of 1·25 or even less.

The work on bridges demonstrates *in parvo* nearly all the principles characterizing the present-day approach to the problems of designing structures above ground. Formerly the approach, in very general terms, was to reduce a structure to the simplest components that could be considered to lead an independent structural existence—joists, girders, columns, walls, slabs; the loading each component could sustain without permanent deformation was then calculated according to simple rules based on tests on such components in isolation; finally, each component was assumed to be similarly loaded in the complete structure, needing to be strong enough to support the worst probable load distribution. Any component not designed for strength was assumed to make no contribution. Nowadays, the tendency is to consider the behaviour of the complete structure, to measure stresses at critical points in buildings under construction and after completion, to account for these results by more refined theories of stress–strain pattern, and finally to interpret these theories in terms of convenient rules for design. The important thing is that investigation starts with what actually happens in actual structures.

The Building Research Station's work on foundations engineering, since it is carried on chiefly in the field, had to be demonstrated mainly by photographs. Two model-scale investigations were exhibited: in one, a glass-sided tank is used for studying the effect of seepage under hydrostatic pressure at the base of a sheet pile cofferdam; in the other, the effect is examined of proximity between piles in a group on the bearing capacity of each.

Another exhibit included part of the equipment used for measuring pore-water pressures during the construction of earth dams. Pore-water pressure tends to reduce the shear strength of the soil, with a consequent risk of instability as the height of earth fill is increased. Piezometers, incorporating a rigid porous membrane that supports the stresses due to solid material while transmitting hydrostatic pressure, are buried in the dam as work proceeds, permitting direct measurement of pore-water pressures to be made afterwards at a distance. This enables appropriate precautions to be taken if the pore-water pressure threatens to mount too high in relation to the factors contributing to stability.

# LAND USE IN BRITAIN

A CONFERENCE on "Land Use in Britain" was held in the University College of the South-West at Exeter during July 15–16. It was organized by the Division for Social and International Relations of Science of the British Association, under the chairmanship of the president of the Division, Mr. P. Ritchie Calder. The Division in this way revived its pre-war function of holding occasional meetings in different parts of the country to discuss problems in which both scientific and social questions are involved. The excellence of the prepared papers and of the discussion, and the success of the conference as a whole, fully justified this initiative.

The theme of the conference was particularly appropriate at a time when most of the local planning authorities in Britain have completed their development plans, as they were charged to do under the Town and Country Planning Act of 1947.

The first speaker was Sir George Pepler, who was chief technical adviser to the Ministry of Town and Country Planning during 1943–46 and planning adviser to the Government of Singapore during 1950–54. His theme was the administrative arrangements necessary to reconcile the demands for land for many different purposes—agriculture, housing, forestry, recreation, military training, roads, airfields, etc. Sir George emphasized that at present the framing of a national policy of land use is greatly hampered by the number of government departments involved—just as at local government level planning is hampered by the number of local committees. He urged that there should be more co-operation at both central and local government levels. As soon as possible the Minister should summarize statistically the information contained in the first batch of development plans; the summaries should be reviewed and brought up to date every five years, thus producing a periodic 'balance sheet' of the land use of Great Britain.

Mr. Geoffery Clark, planning officer for Devon, then described some of the planning problems of local authorities from his own experience. Above all, he said, it was important to "take the public with you". Plans should not be imposed from above. He had found scale-models particularly helpful in explaining planning schemes to the public.

The second session of the conference considered the need of land for agriculture and forestry. Prof. L. Dudley Stamp, professor of social geography in the University of London, discussing competing uses for land, said that while in the United States there are about thirteen acres of land, including 4–5 acres of productive land, per head of population, in Great Britain there is about 0·8 acre per head, which includes about half an acre of productive farmland. The full use of our present farmland could support a little over half our population. Some 35,000 acres a year of agricultural land would probably be needed for housing, industry and other purposes during the next twenty or so years. Industry must have first priority in an industrial nation, especially as its choice of site was often determined by natural factors such as the location of mineral workings. Housing came next, and here there was considerable controversy as to desirable housing densities. It should not be forgotten that only about a fifth of the agricultural land taken for housing remained potentially productive. Further, the quality of land used should be taken into consideration. If an acre of average and represented one 'potential production unit', then an acre of poor land would represent 0·1 unit, while one of good land would represent two units. The value of a piece of land lost to agriculture could thus vary by a factor of 20. It was therefore most mportant to ensure that the right land was used for the right purpose.

Sir James Turner, president of the National Farmers Union, then enlarged upon the importance of agriculture to the country. It was an unfortunate fact that the best farmland was very often also the most suitable for other purposes. Farming represented one-twentieth of the national income, and its output was now 153 per cent of the pre-war average, although the total labour force had decreased. Pursuing the question of the productivity of back gardens, Sir James said that while it might be true o say that garden produce was worth £66 per acre while farm produce was only worth £45 per acre, one must not lose sight of the fact that building houses meant building roads, schools, factories and shops as well. If this were taken into account, the value of garden produce averaged over the whole built-up area was about £20 per acre. What is more, gardens were not really replacing agricultural produce, and he proper comparison to make was with hortiultural holdings, which produced about £350 per acre. The land was our only irreplaceable national sset, and once built upon was lost for ever. A oherent national policy for land use which bore this n mind was urgently required.

In the discussion, Mr. F. J. Osborne, chairman of he Town and Country Planning Association, said hat increasing housing densities would not save much agricultural land. If we were to build three million houses, at fifteen houses per acre, over the next twenty years, this would use about half a million acres, or 1–1½ per cent of the remaining agriultural land of Great Britain. Increasing this density to eighteen houses per acre would not save more than 25,000 acres. To save one acre of land y building flats would cost about £20,000 in additional building costs.

The third session of the conference considered three special aspects of land use. Mr. Langley Taylor, eputy chairman of the Council for the Preservation f Rural England, said that the Cinderella of planning was amenity—not appreciated until lost; since it cannot be valued in money, it was too seldom taken into consideration. The National Parks were a step orward of great importance. Good management of orests and farmland was essential to the amenity value of the land, and here efficiency was more valuable than sentiment. We still had a long way to o before our development enhanced and did not destroy the beauty of the land.

Major L. E. Andrews from the War Office discussed he Army's needs for land for training purposes. National Service, with its greater turnover in men, modern weapons with their greater firing and manœuvring area, and modern battle training techiques had all increased the amount of land needed. About 600,000 acres of land was required for Army training; but only about 8 per cent of this land would be lost to agriculture. The Army was not n a position simply to grab land, as reports in the ress sometimes seemed to imply. The planning and agricultural authorities were always consulted, under n agreed procedure, as was the Council for the Preservation of Rural England. Usually agreement was reached; but if it was not, a public local inquiry was held, which the Army could, and sometimes did, lose.

Prof. S. H. Beaver, University College of North Staffordshire, discussed the need of land for mineral exploitation. Some 5,500 acres a year were used for this purpose at present, but by no means all of it was permanently lost to agriculture, and some of it could also be built on afterwards. Lower-value minerals like chalk, clay and gravel, which were widespread in occurrence, had to be mined where demand and transport costs made it most economic. There had been much progress recently in land reclamation methods, which meant that the sites of many old mineral workings could be built on, afforested or returned to agriculture.

During the fourth session, three papers were read to the conference on the need of land for urban and industrial development. Sir Herbert Manzoni, chairman of the Building Research Board (Department of Scientific and Industrial Research), said that production lines and mechanical handling had tended to increase the amount of space required by industry, and the majority of new factories were single-story. This trend might be reversed by developing vertical production lines and building upwards. Numerically, the population of Britain was very nearly housed, although housing is unevenly distributed; nevertheless, we already had nearly one house to three people. The real problem was the dreadful congestion of some of the urban areas. We were tending to forget the art of urban living, and in solving congestion problems we should not forget that some people like to live in towns. Current development plans would probably mean that a further half a million acres would be needed for urban development in addition to the two million acres at present occupied by housing, schools and industry. This was quite a small proportion of the total amount of land available.

Mr. P. A. Macrory, chairman of the Location of Industry Committee of the Federation of British Industries, produced three criticisms of the impact of land planning over the past three years. First, it was often far too difficult to find out exactly what the planning policy for any particular area was. Secondly, an industrialist who learns that he will be 'non-conforming' in five, ten or twenty years time often cannot discover when he will have to move, nor how much compensation he can expect. Lastly, planning control was carried down to quite unnecessary detail, and there tended to be a general negative attitude towards the industrial developer. These points all tended to get planning a bad name, but they could be remedied by more consultation and a more constructive attitude.

Prof. J. Sykes, of University College, Exeter, examined the effect planning has had on the location of industries in the past ten years. It appeared that it had so far been fairly successful in combating industrial congestion. One loophole was the fact that industrial premises vacated by non-conforming firms would be immediately filled by new firms. The local authority should supervise the change of use of premises and have the duty to offer alternatives to firms.

Summing up the conference as a whole, the chairman emphasized that this subject must be seen in relation to national and international economy. The increase in world population, and the industrialization of food-exporting countries, meant that if we wanted to import food we should only be able to do it by producing goods at a very high level of scientific and industrial achievement. In deciding the best way to divide the very limited amount of land available so that it was used to the best advantage for the whole of Britain, it was essential to know exactly what one had to divide.

This brought the conference back to the point made by Sir George Pepler at the beginning of the conference, and which came up repeatedly in discussion, namely, the need for more accurate information about how land is actually being used in Great Britain—for, as Dr. Wibberly, of Wye College, pointed out at one point, even the figures of urban acreage are in dispute.

The conference therefore concluded by agreeing to forward the following resolution to the Council of the British Association: "That the British Association for the Advancement of Science represent to Her Majesty's Government the importance of arranging for the collection and publication of comprehensive statistics of the present use of all land in this country and to prepare an analysis on a national basis of the development plans now being submitted for approval in such a way that a balance sheet of land use may be drawn up. The Association submits that the collection of this factual information is a vital need in the present stage which town and country planning has reached in this country and in the formulation of national policies of land use". JOHN DAVY

# SOCIETY FOR THE STUDY OF FERTILITY

## ANNUAL CONFERENCE

THE Society for the Study of Fertility held its annual conference during June 23–24 in the Anatomy Department of the University of Birmingham. Prof. A. M. Dalcq discussed some of the processes of synthesis occurring during the early stages of embryological development in rodents, as revealed by cytochemical studies. In the first of two stages which can be differentiated, there is a step-wise production of deoxyribonucleic acid. In the second stage, heralded by the differentiation of the embryonic knot, synthesis leads to the formation of granules rich in ribonucleic acid, which afterwards gives rise to specific proteins and the formation of enzymes. The enzymes at first are polyvalent; but later different specific enzymes appear. Embryonic development will be described more and more in terms of biochemical differentiation; at present, of course, it is possible to demonstrate this only in terms of cytochemistry. R. A. Beatty described experiments with rabbits designed to test the Russian hypotheses that heterospermic insemination (where semen from two or more donors is mixed prior to insemination) leads to specially beneficial effects among the offspring in respect of litter size and foetal weight. The results he has obtained give no support whatever to these views, and it is concluded that the litters derived from heterospermic insemination are in no way superior to those resulting from homospermic insemination.

W. R. M. Morton has studied the effects on the mating behaviour of rats caused by section of the olfactory tracts and removal of the olfactory bulbs. He concludes that complete removal of the olfactory pathways interferes with the total mating reaction but does not entirely prevent effective copulation. P. P. Scott and M. A. Lloyd-Jacob have made a study of reproduction in the domestic cat as maintained in an animal colony. It proved possible to follow the oestrous cycle by means of vaginal smears, and oestrus was found to occur at 12–14 days intervals, lasting 4–6 days. Typical oestrous behaviour was usually shown only in the presence of a tom cat, and the authors described a characteristic lateral flexion of the tail which was never observed except when oestrogens were present in significant amounts. Several consecutive matings during the period of oestrus seemed to be necessary in order to lead to conception, and the average duration of pregnancy was 65 days. A remarkable excess of males over females in the litters born was found, the ratio being 133 males per 100 females at birth.

Further studies were reported from the Anatomy Department of the University of Liverpool, under the direction of Prof. R. G. Harrison, on male reproductive physiology. E. W. MacMillan and R. G. Harrison demonstrated that the ductus epididymidis possesses an inherent peristaltic activity essential to sperm propulsion by following radiographically the passage of 50 per cent barium sulphate solution injected into the rete testis. Within four days of injection, the mass occupies a position at the junction of body and tail, and by seven days it has reached the tail loop. The vas deferens is entered on the thirteenth day, and the genital tract is completely emptied by the fourteenth day. The rate of progress is unaffected by ligation of the vasa efferentia or by ipsilateral orchidectomy. R. Harris and R. G. Harrison have investigated the effect of low temperature on the guinea pig testis. They found that little permanent damage resulted, provided the temperature within the testis did not fall below 0° C., and that freezing was more damaging than supercooling. Below that temperature occlusive spasm of the testicular artery occurred. Severe spermatogenic damage resulted from exposure of the testis to − 3° C. for one hour, but a temperature of − 10° C. was necessary to ensure an intratesticular temperature of − 4° C. when the scrotum was frozen. Severe spermatogenic destruction led to a 90 per cent fall in testicular volume.

T. D. Glover described the effects of scrotal insulation, as a means of raising the testicular temperature, on the semen of the ram. Five days elapsed before any changes in the semen appeared, and then an increased proportion of coiled tails was seen. Following this, separation of heads and tails was observed, and a marked fall in the sperm density took place about two weeks after the commencement of the scrotal insulation. Insulation for a period of only twenty-four hours led to a brief change in the semen about twenty days later, but, after a further four days, the normal semen picture was resumed.

M. W. H. Bishop discussed the inter-relationships of semen characteristics in the bull. Conception-rate was found to be most closely correlated with impedance change frequency and inversely with the percentage of dead sperms. The most significant conclusion, however, arising from his study was that a large amount of variation in fertility could not be related to any of the numerous semen characteristics examined. E. G. Bassett gave a review of investigations recently carried out at the Ruakura Animal Research Station in New Zealand on problems related to fertility in farm animals.

A number of papers on human fertility were given by workers at the Royal Free Hospital, London

Mary Barton has found a high frequency of female infertility in couples where the husband was sterile and donor artificial insemination was contemplated. The high rate of failure of such insemination in women who, by the usual standards of investigation were regarded as fertile (and for whom, of course, apparently highly fertile semen was used), was also noticeable. Sara Field-Richards and M. Moore White described the use of local œstrogen therapy for uterine hypoplasia, and Phyllis Wade reported a pregnancy in a woman who had suffered from amenorrhœa following radiotherapy for ankylosing spondylitis.

G. I. M. Swyer reported a statistical assessment of post-coital test results which confirms the diagnostic, and to a lesser extent prognostic, value of the test. The not infrequent discrepancy between post-coital test results and semen examination means that the former cannot be regarded as a redundant step in infertility investigation. Clare Harvey discussed cytological events in the human testis, as revealed by biopsies in subfertile men, in relation to abnormalities in sperm morphology. She found that a high proportion of pear-shaped heads was correlated with subfertility and that these pear-headed spermatozoa developed as a result of abnormal maturation of spermatogonia. Claude Taylor reported a conception following the insemination of centrifuged urine passed after intercourse by a man who was suffering from retrograde vesicular ejaculation. Oral treatment with potassium citrate maintained an alkaline urine in which spermatozoal activity persisted. Vigorous spermatozoal activity was found, so long as the urine *p*H was close to 7, but when either too acid or too alkaline, the spermatozoa failed to survive.

Three films were shown: one was on social behaviour in rhesus monkeys, by M. R. A. Chance; another, by H. G. Hanley, demonstrated a simplified and apparently effective technique for the operation of epididymo-vasostomy; and the third, by Prof. Richard J. Blandau, was on reproduction in the rat.

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# INTERMETALLIC SEMICONDUCTORS

ALTHOUGH some of the earliest semiconductors of practical importance were chemical compounds, research interest in later years has been mainly in the elements germanium and silicon, partly due to the importance of transistor technology and partly because the problems of obtaining high purity and crystalline perfection appeared to be easier in a monatomic solid, and the theoretical interpretation more promising. However, with the extension of applications, new combinations of properties are desired, and it has been necessary to consider new materials—in particular, compounds, as there is little scope among the remaining elements. This trend was stimulated by the work of Welker in 1952 on compounds of the zinc-blende structure (isomorphous with germanium, but with alternate sites occupied by the respective elements). These were shown to have the high electron mobility characteristic of germanium and silicon which is essential for many applications. Still other types of compound may also have this property, so that the search has not been confined to zinc-blende types: generally, the group of compounds known as 'intermetallic' (that is, between elements having metallic properties, although the limits are not clearly defined) have shown the most interesting properties, and these are now being studied in a number of laboratories.

A study of compound semiconductors brings new problems of purification and crystal growing. The properties have then to be determined and interpreted in terms of theory, which may have to be extended or adapted in the process. Generalizations have to be attempted in order to guide further work. Finally, new applications of particular materials have to be considered. These points formed the theme of a symposium on intermetallic semiconductors which was held during April 26–27 at the Services Electronics Research Laboratory, Baldock, Herts, attended by more than a hundred and thirty visitors. The chairman for the first day was Prof. N. F. Mott (Cambridge), and for the second Prof. H. Welker (Siemens-Schuckertwerke, Erlangen, Germany). A total of nineteen papers was presented, mostly of a fundamental nature, with the emphasis on compounds of the zinc-blende type. In particular, the compound InSb, for which both the technology and theory are furthest advanced, received much attention. Arrangements have been made to publish the full papers in a special issue of the *Journal of Electronics*.

Three of the papers dealt with generalizations of a theoretical nature. Dr. F. Herman (R.C.A., Princeton), in a paper read by Dr. H. W. Leverenz, put forward a method for correlating the electronic band structure of zinc-blende type compounds with position in the periodic table of the elements concerned. In, for example, the isoelectronic sequence Ge (which may be regarded as the zinc-blende compound GeGe), GaAs, ZnSe, CuBr, the crystal potential is regarded as primarily that of germanium with a small perturbing potential due to the ionic contribution in the binding, the strength ($s$) of which increases in equal steps as we proceed along the sequence. For the regions of interest in momentum-space, the energy shifts are found to be quadratic in $s$. Measured values of the forbidden energy gap should show this same dependence, provided that no switch over occurs in the positions of the band edges in momentum-space. This latter possibility prevents outright prediction in the absence of supporting evidence, but the theory should be very useful in forming an early picture of the band structure in particular compounds of this type.

Similarly, C. H. L. Goodman (General Electric Co., Ltd., Wembley) offered a basis for the prediction of the electron mobility for a zinc-blende compound from a knowledge of the forbidden energy gap and the lattice spacing. He assumes that the covalent contribution to the binding energy and hence to the energy gap depends only on the interatomic distance ($d$) and is the same function of this as in the case of the Group IV elements. The excess of measured energy gap over that for a hypothetical Group IV element of the same spacing is regarded as an ionic contribution ($E_{\text{ion}}$). The quantity $(E_{\text{ion}}d^2)^{1/2}$ should be closely related to the bond dipole, which in turn should control the mobility, both through its influence on the effective mass, as discussed by Seraphin, and through its effect on the scattering of electrons by optical modes of lattice vibration. A plot of existing data on mobility against this parameter does give, in fact, a smooth curve, with a peak in the region of InSb, from which values for other compounds can be estimated with a fair amount of plausibility.

Still another general paper dealt with the problem of donor impurity-levels. Dr. G. Rickayzen (Services Electronics Research Laboratory, Baldock) outlined an attack on this problem in which he has examined quantum mechanically the validity of the usual hydrogen-atom model for a donor centre. He finds on certain assumptions—in particular, that the bound electron can be regarded as moving adiabatically through the lattice—that the model is justified to within an accuracy of 10 per cent, which is in rough agreement with the spread of activation energies found in practice. The accuracy should improve for structures in which the effective mass of conduction electrons is low.

Of the papers dealing specifically with InSb, the first two were concerned with photo effects. Dr. T. S. Moss (Royal Aircraft Establishment, Farnborough) gave the theory of photoconductive and photovoltaic behaviour for the case of a material like InSb which is in the intrinsic range of conduction, which has a high ratio of electron to hole mobility, and in which the rate of recombination of holes and electrons at the surfaces can be high. From photovoltaic measurements, a value of the carrier life-time can be deduced, typical values obtained for InSb being of the order of 1 μsec. Photoconductive data lead similarly to values of the surface recombination-rate; this is very dependent on surface processing, but values in the region $5 \times 10^4$–$6 \times 10^5$ cm./sec. were quoted (compare with $\sim 100$ cm./sec. in germanium). The second paper, by C. Hilsum, Dr. D. J. Oliver and Dr. G. Rickayzen (Services Electronics Research Laboratory, Baldock), dealt similarly with the photoelectromagnetic (Kikoin) effect. From this also the surface recombination velocity can be derived, the values reported agreeing with those of Dr. Moss. The method also measures life-time, for which values in the range 0·07–0·3 μsec. have been obtained.

Carrier life-time in InSb was the subject of two further papers. The first by I. M. Mackintosh (University of Nottingham) and J. W. Allen (Ericsson Telephones, Ltd., Nottingham) discussed the photon-radiative recombination process, which appears to be the dominant mechanism in this material, since it leads to the correct order of magnitude for the life-time. They showed that a theory of radiative recombination in which the probability of a transition between two levels is independent of the energies, at least over a small range, gives the correct frequency-dependence. They suggested also that InSb should be an efficient infra-red emitter. In the second paper, Drs. D. G. Avery and D. P. Jenkins (Radar Research Establishment, Malvern) described an experimental determination of the life-time by the light-spot method. Values of 0·3 μsec. were obtained at room temperature for InSb of high purity. The life-time rises with decreasing temperature, as expected from a photon-radiative process, but falls anomalously below 200° K.

V. Roberts and J. E. Quarrington (Radar Research Establishment, Malvern) described work on an accurate determination of the optical absorption in InSb over a range of temperature down to 4° K., the aim of which was to interpret in detail the electronic transition processes taking place at wave-lengths close to the absorption edge. Comparison of the results with published theoretical predictions suggests that 'indirect' transitions—that is, those in which momentum is conserved only by simultaneous emission or absorption of a phonon—are important at low levels of absorption. It is usually assumed in semiconductor work that the energy ($E$) of conduction electrons varies quadratically with their momentum ($k$); Dr. R. Barrie and J. T. Edmond (Services Electronics Research Laboratory, Baldock) showed by an analysis of thermoelectric, Hall effect and optical data that, for InSb with concentrations of electrons of $10^{18}$/c.c. or above, this approximation is not a good one. A better overall fit up to $10^{19}$/c.c. is obtained with a law of the form $E = \alpha k^2 (1 - \beta k^2)$.

Dr. B. V. Rollin and A. D. Petford (Clarendon Laboratory, Oxford) reported results of conductivity and Hall effect measurements down to a temperature of 1·5° K. on single crystals of InSb with total impurity contents in the range $10^{14}$–$10^{17}$/c.c. In $n$-type material the activation energy for conduction appears to be zero. This, they suggested, is due to overlap of bound orbitals, which will occur at lower impurity concentration in InSb, than, for example, in germanium, because of the lower effective mass. For $p$-type material an activation energy of 0·005 eV. was obtained. The carrier mobility fell off at very low temperatures, suggesting that conduction was now taking place in an impurity band. In $p$-type material at low temperatures the anomaly was found of a negative magneto-resistance coefficient. Magneto-resistance also was the subject of a paper by Dr. R. Mansfield (Bedford College, London), who had studied the behaviour of highly degenerate polycrystalline specimens of InSb. The magneto-resistance coefficient did not fall off with decreasing temperature in the manner expected from simple theory, but he felt that this would need confirmation on single crystals, since it may have its explanation in inhomogeneities associated with grain boundaries.

In a semiconductor, such as InSb, in which the ratio of effective masses of holes and electrons is appreciably different from unity, Fermi–Dirac degeneracy can occur in the intrinsic range. It is not then possible to calculate the electron and hole concentrations analytically for a known temperature and energy gap. Prof. G. Busch (Physikalisches Institut der Eidgenössen Technischen Hochschule, Zurich) discussed a simple method of doing this graphically and illustrated a slide rule based on the same principle.

A further group of papers was concerned with other compounds. Prof. H. Welker described recent work on Group III–V compounds. The energy gap in GaAs is now believed to be 1·4 eV and the ratio of electron to hole mobility to be 10 the former being estimated as 6,800 cm.$^2$/V. sec. a room temperature in the pure substance. Resistivitie as high as 100 ohm cm. have been obtained. Fo InP, the corresponding figures are 1·3 eV. and 3,300 cm.$^2$/V. sec. with resistivities up to 10 ohm cm The compound GaP is interesting in that it is transparent and of a light-golden colour. The energy ga is 2·2 eV. By mixing GaAs and GaP it is possibl to vary the energy gap continuously between the tw extremes.

Another III–V compound, InAs, was the subjec of a paper by Drs. R. M. Talley and F. Stern (U.S Naval Ordnance Laboratory, Washington, D.C. This material shows properties similar to InSb, in cluding a shift of absorption edge with increasin concentration of donor impurity. Assuming that th impurities are distributed in an ordered manne an overlap of bound orbitals will lead to an impurit band the width of which increases with concentration of impurity. The mid-point of this band will overlap the conduction band, they estimate, at a concentration of $10^{19}$ atoms/c.c. Above this concentration the material will continue to be conducting down to zero temperature, analogously to the results reported by Rollin and Petford for InSb. The lowest unfilled level available for optical transitions will increase with rising donor impurity content; on the other hand, the addition of electron acceptor impurities should empty the upper levels and therefore extend the limit of optical transitions to longer wave-lengths. This they have observed experimentally.

The compound CdTe was dealt with in a paper by Dr. F. A. Kröger and D. de Nobel (Philips Research Laboratories, Eindhoven) in which they described the preparation and properties of single crystals. Both *n*- and *p*-type crystals can be obtained by adjusting the stoichiometric balance, which can be done by heating the crystal in a suitable pressure of cadmium vapour. Thermoelectric measurements gave values for the effective masses of electrons and holes of 0·37 and 0·14 times the free mass, respectively. The corresponding mobilities were 600 and 50 cm.$^2$/V. sec. Estimates of the energy gap gave two different possible results: the value could be either 0·37 or 0·2 eV. W. S. Lawson (Radar Research Establishment, Malvern) similarly dealt with the compound $Mg_2Sn$, of which he has grown crystals of high purity. The value of the energy gap is 0·34 eV. from measurements of Hall constant, and the same result can be derived from variation of the conductivity with temperature if plausible assumptions are made about the dependence of mobility on temperature. The mobilities at room temperature are 220 for electrons and 260 cm.$^2$/V. sec. for holes.

Drs. J. van den Boomgaard, F. A. Kröger and H. J. Vink (Philips Research Laboratories, Eindhoven) gave a short paper on a technique of zone-refining a compound, such as PbS, in which one of the components, here sulphur, is volatile. The compound is sealed in a silica tube, one end of which is extended and connected to a sealed reservoir of the volatile compound. During the refining the auxiliary reservoir is kept at a temperature sufficient to give the desired vapour pressure of the volatile constituent, the remainder of the tube being kept at a rather higher temperature.

Finally, there were two papers dealing with applications. H. J. Goldsmid (General Electric Co., Ltd., Wembley) discussed the factors controlling the efficiency of a thermoelectric generator. The Fermi level (chemical potential) should lie near the edge of the appropriate band, and the mobility ($\mu$) should be large, but not due to the occurrence of a small effective mass ($m^*$); the controlling factor is $\mu(m^*)^{3/2}$, which should be large. The lattice component of thermal conductivity should be small. These requirements are most likely to be met when the mean atomic weight is large. For example, bismuth telluride (mean atomic weight 160) is particularly efficient. Using a junction of *n*- and *p*-type material, an appreciable Peltier cooling has been obtained (40 deg. C. refrigeration). The abnormally high electron mobility of InSb has led to a number of new applications, discussed in a paper by I. M. Ross and Dr. E. W. Saker (Services Electronics Research Laboratory, Baldock). The power available from the Hall effect is proportional to the square of the mobility, which gives InSb, with its electron mobility of 60,000 cm.$^2$/V. sec., a factor of ~ 300 improvement over germanium. Applications based on this feature include sensitive magnetometers, an electric compass, and a new type of power amplifier in which the input signal modulates the magnetic field in a thin crystal of the material. A new transducer principle is also possible in which the displacement to be observed causes the crystal to move in a steeply varying magnetic field. Using InSb as a resistance 'gyrator', a backward attenuation of ~ 80 db. can be obtained for a forward loss of only 7·5 db.

I. M. Ross

# LIBERAL VALUES IN FURTHER EDUCATION AND TRAINING

UNDER the title "Liberal Education in a Technical Age", the National Institute of Adult Education has published the report of a survey of the relationship of vocational and non-vocational further education and training conducted by a Committee set up early in 1953 by the Institute jointly with the Associations of Technical Institutions and of Principals of Technical Institutions, with Sir Robert Wood as chairman and Dr. P. F. R. Venables as vice-chairman. Regarding a liberal education as one which includes a training in the use of language, in the handling of ideas, in recognizing relationships, and in establishing values as touchstones for questions of taste and morals, the Committee concerned itself with the fundamental questions of the extent to which these values are affected if a study is undertaken from motives connected with personal advancement, and the extent to which they are excluded from certain studies because of their subject-matter. Attention was concentrated on the work of the technical institutions and colleges of art, correspondence courses, adult education and residential colleges, and on the role of the professional and examining bodies. Following three chapters dealing with the background of the inquiry, which include statistics relating to institutions and students, there are chapters on each of these aspects, as well as one on teachers and students in technical institutions.

Broadly, the Committee addressed itself to three questions: the extent to which technical institutions recognize any responsibility for giving their students something more than vocational instruction; if such responsibility is recognized, whether the conditions under which further education is carried on permit of anything beyond the essential technical instruction; and whether, to maintain a due balance between vocational and general education, we should look to changes in the curricula of technical institutions, or to the phasing of the whole educational process. The Committee believes that at no period in the educational process should the values commonly associated with a general education be dropped because of the intense pressure of vocational preparation, and it declined to support any suggestion that students entering technical institutions can properly embark upon a period of narrow and specialist education to the neglect of other studies. This more generous view of vocational education, it found, is held by many principals and teachers in technical institutions in spite of the gap existing between what is regarded as desirable and what is, in practice, achieved. It emphasizes that the problem can only be resolved by the pressure of public opinion and, in particular, when industry, commerce and public administration at all levels of responsibility, from higher management to supervision, share the serious concern voiced by a minority, to the extent of a readiness to extend day-time release and insist on including non-vocational as well as vocational studies.

The sharpest criticism made by the Committee is of some of the professional and examining bodies, the papers and syllabuses of which are framed to encourage the memorizing of facts rather than the discussion of underlying principles. This practice is largely responsible for the narrowness of certain technical studies, and the Committee believes that these bodies should be invited to re-assess the purpose and nature of their examinations. The Committee also comments on the unsatisfactory physical environment in which the work of technical institutions is often performed. It welcomes the recent relaxation of the utilitarian attitude of the Ministry of Education towards vocational education and hopes that local education authorities and governing bodies will now press forward with the improvement of physical conditions, including the equipment and maintenance of libraries, an increased supply of technical and non-technical books and periodicals, and the provision of adequate refectories, recreation and common rooms. The Committee believes that all education must aim at increasing human sympathy and understanding, sharpening æsthetic appreciation and giving a better command of language, and to this end it recommends that human relations in industry and commerce should be more widely studied and the æsthetic appreciation of design appropriately emphasized. It further recommends that, in technical and professional examinations at all levels, some regard should be had to the qualities derived from liberal studies, and directs attention to the value of short periods of residential education and of foreign travel. It suggests that the links between technical institutions and the responsible bodies in adult education could be strengthened with advantage to both and that the experiments being made in the university world on the reconciliation of vocational and liberal education could be profitably studied in relevance to other forms of higher education.

## INTAKE OF NUTRIENTS BY SUGAR-BEET

A STUDY of the interactions of nitrogen, phosphorus and potassium, supplied in leaf sprays or as fertilizer added to the soil, has been reported on by G. N. Thorne (*J. Exp. Bot.*, 6, 16, 20; 1955). Among findings of special interest are the following.

When sugar-beet plants grown in pots were sprayed daily with nutrient solutions supplying nitrogen, phosphorus and potassium separately or in all combinations, with precautions to prevent spray falling on the soil in which the plants were grown, all three nutrients were absorbed through the leaves. In one experiment nitrogen and potassium, and in another only nitrogen, caused increases in plant dry weight and leaf-area. Swedes absorbed phosphorus from leaf sprays and from fertilizer applied to the soil, but only the fertilizer caused an increase in dry weight.

Absorption of any of the nutrients tested from a spray containing more than one nutrient was unaffected by the presence of others in the spray; but spraying with nitrogen-containing solutions increased the absorption of phosphorus and potassium from the soil, and potassium in sprays increased the uptake of phosphorus from the soil. Nitrogenous fertilizer applied to the soil increased the leaf-area of sugar-beet plants, and hence it also increased the amounts of nitrogen, phosphorus and potassium deposited on the leaves when they were sprayed with solutions of these nutrients, and the amounts absorbed from the spray into the plants. Phosphatic fertilizer had no effect on uptake from leaf sprays. Potassic fertilizer did not affect leaf-area or the estimated volume of spray solution retained on the leaves; but it appeared to reduce uptake of potassium from the spray. Dry weight per plant was increased by all three nutrients in fertilizer, and sugar yield of the roots was increased by nitrogen and potassium in fertilizer, and by nitrogen in spray. Application of a nutrient in leaf spray reduced the responses in dry weight and sugar yield to the same nutrient applied in fertilizer to the soil.

## JUTE PRODUCTION AND RESEARCH

READERS interested in the problems of jute production in India will find a comprehensive account of relevant matters in the annual report of the Indian Central Jute Committee (for 1953–54, pp. 1–300; Calcutta) and in the annual report of the Jute Agricultural Research Institute (1953–54, pp. 1–145; 1955, Calcutta).

The primary object of this central authority is to deal with research on all aspects of jute from field to factory. The reports accordingly have sections devoted to the relevant agricultural, technological and economic aspects. At the Jute Agricultural Research Institute the programme includes jute breeding and cytogenetics, special problems of anatomy, the agronomy of jute and of crops yielding substitute fibres, and related physiological, microbiological and entomological problems. On the technological side, in addition to the normal testing, development and processing work, more fundamental researches on chemical and physical aspects have also been undertaken.

In investigations of the chemistry of the hemicelluloses of jute and other fibres it has been found that these are generally similar. Further evidence has been obtained supporting a hypothesis put forward earlier of a chemical combination between the carboxyl group of the hemicellulose and the hydroxyl group of the lignin in jute. On the physical side, the torsional rigidity of jute, ramie and sisal has been measured. It has been ascertained that heavier filaments have generally lower values for rigidity modulus and that porosity appears to be related inversely to rigidity. The elastic properties of jute filaments from plants at different stages of growth, and the effects of chemical and physical treatments on the hardness modulus of jute fibre have been investigated. Some progress in X-ray investigations of jute fibre is also reported: here the principal aim was to ascertain the size of the micelles in fibres of different quality ratios.

# THE LAMELLIBRANCH MUSCLE

## Contractile Mechanism

THE tetanic nature of muscle activity is no longer disputed except in the case of lamellibranch smooth muscle, which is supposed to maintain tension by a unique 'catch' mechanism. This postulates that viscous components within the muscle fibre should 'catch' the contractile elements and hold them at constant length in the manner of a ratchet[1,2]. I have found previously[3,4] that maintenance of tension in *intact* smooth lamellibranch adductors is accompanied by continuous electrical activity due to discharges from muscle fibres. From this it could be argued that tonus in these *intact* muscles is due to a shifting pattern of tetanic stimuli controlled by the nervous system, thus bringing it into line with tonus in other muscles and making unnecessary the hypothesis of a 'catch' mechanism.

There remained one major difficulty: if the nerves leading to the posterior adductor of ***Mytilus*** are cut, the muscle continues to maintain tension although it seems to be electrically 'silent'[3]. By using an improved recording technique I have now shown that, in fact, spontaneous electrical activity always accompanies maintenance of tension in such (externally) denervated lamellibranch muscles—a finding which strongly suggests that, even in this case, the mechanism is tetanic.

The improvement in technique mentioned above was a modification of the recording conditions. Instead of using fine electrodes recording from a very localized region[3], larger electrodes were employed in order to detect activity in a greater number of muscle units. Such electrodes consisted of 3 cm. length of 40 s.w.g. platinum wire (coated with platinum black), and they were placed around isolated muscles of eviscerated animals in air. After amplification the muscle potentials were recorded with an ink-writing oscillograph.

As recorded, the largest action potentials in muscles denervated as described above measure about 50 μV.; but in many preparations the spikes were barely visible above the noise-level of the amplifier. However, by using completely fresh animals, spontaneous action potentials have been recorded from the following (externally) denervated muscles: the wholly smooth adductors of ***Mytilus***, the smooth and spirally striated parts of the adductors of ***Anodonta*** and ***Modiolus***, the smooth part of the ***Pecten*** adductor, and from the smooth retractors of these animals.

In an earlier paper[3] I have shown that the pattern of electrical activity during tonus in the intact ***Mytilus*** adductor consists of persistent asynchronous discharges of greatly varying size, indicating continuous local activation; and of intermittent volleys of muscle potentials, evidently due to discharges from a much greater number of muscle units (Fig. 1*a*). Now in the case of all the lamellibranch muscles examined so far, there is generally less electrical activity in (externally) denervated than in intact muscles. Apart from this—in smooth adductors—the only difference is the absence of the volley response in all but the ***Mytilus*** muscle. Here volleys of a relatively shorter duration have been observed in many (but not in all) denervated preparations (cf. Fig. 1*b*). Spontaneous asynchronous discharges are also present in denervated spirally striated adductors, though their amplitude is considerably smaller than that of the discharges in the smooth muscle (Fig. 1*c*). Volleys have only been observed in very few preparations of denervated spirally striated adductors (cf. Fig. 1*c*). So far, no electrical activity has been detected in the denervated transversely striated *Pecten* adductor.

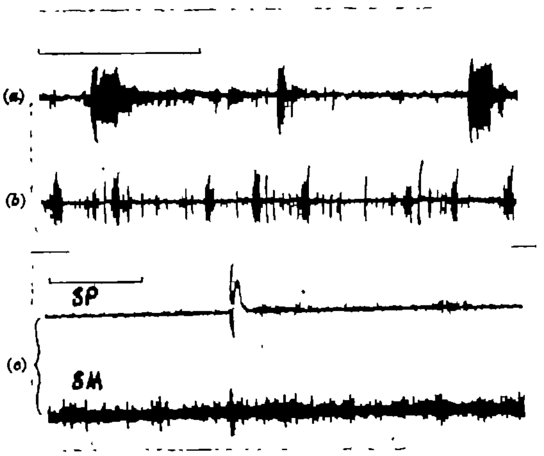

Fig. 1. The records read from left to right; time marker indicates 1 min.: *a*, ***Mytilus***, intact posterior adductor. Spontaneous electrical activity during tonic contraction; *b*, same, after (external) denervation in a preparation which showed volley responses; *c*, ***Modiolus*** (externally) denervated posterior adductor. Spontaneous electrical activity in the spirally striated (*SP*) and smooth (*SM*) parts during tonic contraction. (Note: in this preparation the spirally striated muscle showed sporadic volley responses)

The experimental evidence presented here leaves little doubt about the tetanic nature of tonus in (externally) denervated lamellibranch muscles. But how is the tetanus maintained? There are certain difficulties in the way of a myogenic explanation: only in syncytial muscle systems, like the vertebrate heart, has the self-excitatory capacity of the muscle fibres been conclusively demonstrated—and here the action potential is of the 'unitary' type. In contrast, the electrogram of lamellibranch muscle shows responses of such irregular nature and variable size that a total syncytium seems out of the question. The electrical picture is much more in keeping with the activity of numerous independent units. Of course, the units themselves could be syncytial, thus allowing for localized activity. For this, however, there is as yet no histological evidence, and in view of the very small size of the muscle fibres (2–10μ diameter) the problem is not readily tackled from the structural point of view. Considerations of size also make it difficult to look for syncytial continuities between muscle fibres with intracellular electrodes.

The recent finding of nerve-cell bodies in a variety of lamellibranch adductors and retractors[5] appears to favour a nervous origin of the spontaneous muscle-action potentials in preparations where the nerves leading to the muscle have been cut. If this be the case, then (to give both phasic and tonic responses) either the muscle fibres themselves would have to be doubly innervated or the peripheral neurones would have to be in synaptic relation with two types of motor nerve. Experiments designed to block selectively the excitatory action of possible peripheral nerve elements have so far not given conclusive results. Therefore, the question whether tonic activity in lamellibranch muscles is neurogenic or myogenic remains open.

Considering the evidence at present available, it appears that smooth and spirally striated lamellibranch muscles maintain a certain level of tension all the time due to the activity of a peripheral automatic (neurogenic or myogenic) system which works by successive activation of limited areas. Upon this spontaneously maintained tonic level, graded phasic contractions can be superimposed via a system which involves activation of large parts of the muscle and is under central nervous control[3]. Co-ordination of the numerous small muscle units is presumably made possible by the very rich nerve supply found in lamellibranch adductors and retractors[5]. An additional measure of nervous control might be provided by the action of inhibitory nerves[2]. But it has yet to be decided whether lamellibranch muscles are directly innervated by excitatory and inhibitory nerves or whether such nerves act via a peripheral ganglionic plexus.

I wish to thank Prof. B. Katz for criticism of the draft, Prof. J. J. Pritchard for much valuable discussion, and Prof. R. A. R. Gresson for his continued helpful interest. The electrical apparatus was purchased in part by a grant from the Royal Society.

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## Innervation

Only two authors claim to have shown the minute innervation of lamellibranch muscle[1,2]. In 1888 Galeazzi[1] demonstrated the presence of an extremely rich intramuscular nerve plexus in the *Mytilus* adductor; but his work has hitherto been overlooked. He used the well-known formic acid–gold chloride technique to show how large nerve bundles divided and subdivided to form branches which for the most part ran parallel to the muscle fibres. From these nerves arose numerous finer branches, some of which ran towards muscle fibres, while others anastomosed freely to form a complex network. In addition to nerves, Galeazzi also reported the existence of a large number of nerve-cell bodies.

Bruch[2], using a Golgi technique, has reported the presence of motor end-plates in the spirally striated fibres of *Anodonta*. He maintained that these structures were essentially similar to those found in vertebrate skeletal muscle and differed from them mainly in being orientated at right angles to the long axes of the fibres. He was unable to obtain any nerve staining in the smooth part of the same muscle. Neither he nor a number of other workers[3-5] has made any mention of the presence of nerve-cell bodies.

In an attempt to confirm the above observations, a very large number of metallic impregnation and methylene blue techniques was tested. With the Ranvier gold chloride method it proved possible to demonstrate fine nerves, ending in bulbs, in the radial pallial muscles of *Pecten* and *Chlamys* and in the siphonal retractor muscles of *Mya arenaria*; but the results were never really satisfactory. Methylene blue was found to be excellent for tracing the course of the large nerves, but useless for showing details of innervation. With the other methods, no nerve elements could be stained. In view of the probable cholinergic nature of the lamellibranch neuromuscular system[6], histochemical methods for localizing cholinesterase were therefore tried.

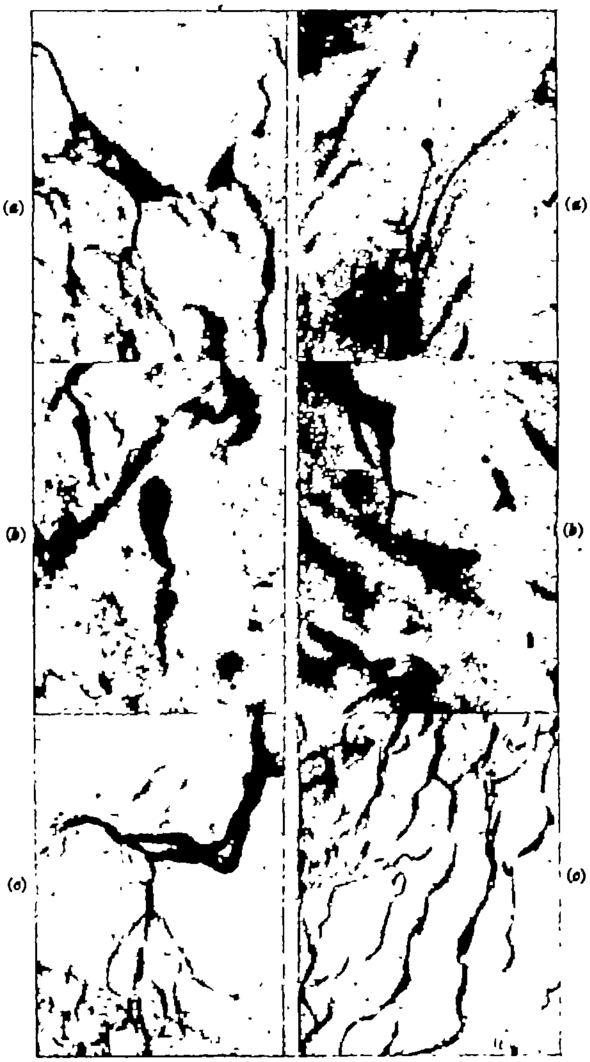

Fig. 2 Fig 3

Fig. 2. Stained by the Koelle method (× 225). *a*, Multipolar nerve-cell bodies from the anterior byssal retractor muscle of *Mytilus*; *b*, unipolar nerve-cell body from the posterior adductor of *Mytilus*; *c*, nerve trunk branching to join nerve plexus in the posterior adductor of *Mytilus*

Fig. 3. Stained by the Koelle method. *a*, Nerve endings arising from finest branches of nerve plexus in the anterior byssal retractor of *Mytilus* (× 325); *b*, nerve ending arising from nerve trunk in the posterior adductor of *Mytilus* (× 300); *c*, nerve plexus from the smooth part of the posterior *Anodonta* adductor (× 375)

With the myristoylcholine techniques[7], nerve-cell bodies can be seen in all the lamellibranch muscles so far examined; but the precipitate is too coarse to show the finer nerves. On the other hand, the Koelle method[8] gives excellent staining and reveals a nerve plexus corresponding closely to that described by Galeazzi (Fig. 2 *a*, *b* and *c*; and Fig. 3 *c*). This intrinsic nervous system is present not only in smooth adductors and retractors, but also in the spirally striated adductors. In addition, it is possible to demonstrate nerve endings with the Koelle method; but no structures like the 'motor end-plates' figured by Bruch[2] have yet been seen. Our work is still in progress and at present it is only possible to state that endings which arise from the larger nerves, as well as from the finest branches of the plexus itself, appear to terminate in bulbs (Fig. 3 *a* and *b*).

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# AZETIDINE-2-CARBOXYLIC ACID : A NEW CONSTITUENT OF PLANTS

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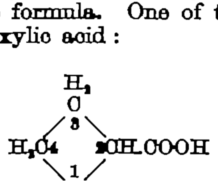
In recent years several new amino- and imino-acids have been encountered in plants and, in many cases, the new nitrogenous substances have constituted a large percentage of the total soluble plant nitrogen[1]. A further example has been found in *Convallaria majalis* L. (lily-of-the-valley). Two-directional paper chromatograms (phenol: butanol–acetic acid) of leaf extracts, prepared using 70 per cent ethanol, showed that the main spot was one reacting brown with ninhydrin and represented a substance not previously reported as present in plants. This new substance (hereafter termed *Z*) had an $R_F$ value of 0·80–0·84 in phenol-ammonia, and moved at a rate similar to threonine and glutamic acid in *n*-butanol-acetic acid.

By ion-exchange column chromatography ('Zeocarb' 215—0·15 *N* ammonia displacement) and subsequent paper chromatography on washed Whatman No. 3 filter paper, 250 mgm. of *Z* were isolated from 1·8 kgm. of fresh, mature *Convallaria* leaves. Three recrystallizations from 95 per cent methanol yielded *Z* as a white solid, with an elementary analysis of C, 47·6; H, 6·82; N, 13·4; O (by difference), 32·2. This approximated to the analysis calculated for $(C_4H_7NO_2)_n$, namely, C, 47·53; H, 6·93; N, 13·86; O, 31·68. Barger's method showed that the molecular weight of *Z* was approximately 100, indicating that *n* is 1 in the provisional formula.

Assuming the formula $C_4H_7NO_2$ and that the molecule contains a —COOH group and either an amino- or imino-group, the only type of open-chain compounds compatible with the formula would contain either a C=O or a C=N. *Z*, however, did not show any of the typical reactions associated with such structures, being unaffected by catalytic hydrogenation or ozonolysis. Alternatively, cyclic structures could satisfy the formula. One of the possibilities, azetidine-2-carboxylic acid :

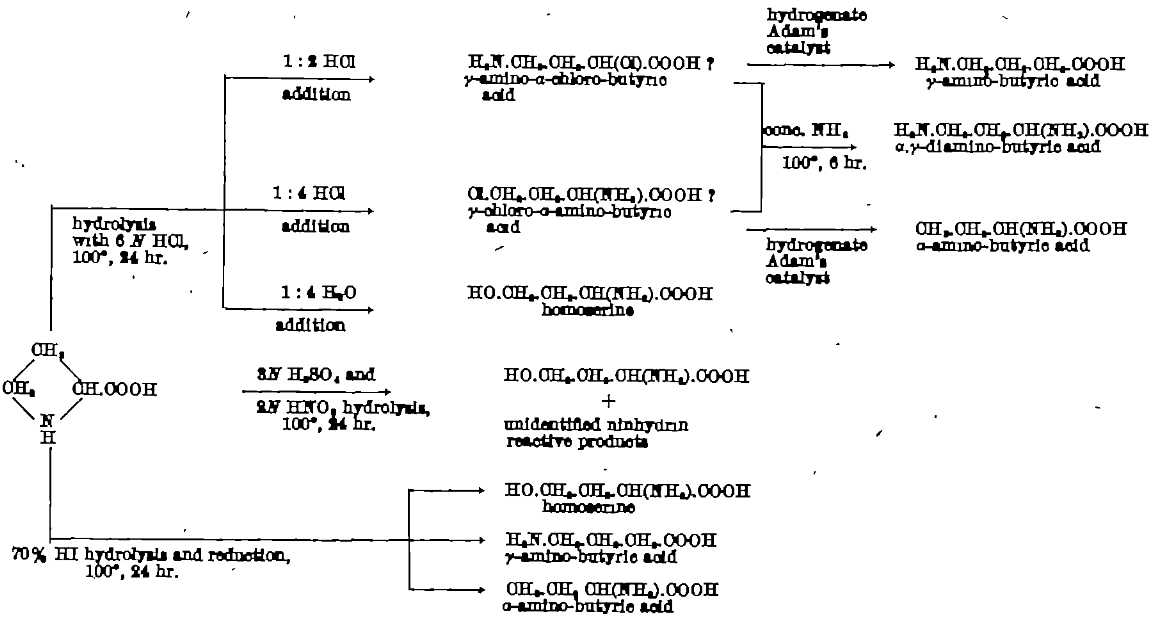


might be expected to possess all the properties determined for *Z*. Although no account of this cyclic imino-acid appears in the literature, the parent compound, azetidine, is known, and is stable under conditions of alkaline hydrolysis, but is unstable to acid hydrolysis. Hydrolysis of azetidine with aqueous hydrochloric acid yields two products, α-amino-γ-hydroxy-propane, and α-amino-γ-chloro-propane, by ring fissure and simultaneous addition of either water or hydrochloric acid[2].

*Z* was stable to alkaline hydrolysis (5 *N* barium hydroxide solution for 24 hr. at 100°), but was completely decomposed by 6 *N* hydrochloric acid at 100° for 24 hr., yielding three ninhydrin-reactive products. The major product was always inseparable from homoserine on paper chromatograms, irrespective of the five solvents used ; the other two products first appeared as yellow spots after ninhydrin development, later changing colour through brown to a bluish-purple. These two compounds were first thought to be unsaturated since they could be converted by catalytic hydrogenation to substances inseparable from γ-amino- and α-amino-butyric acids on chromatograms ; but evidence now exists suggesting that they were α-chloro-γ-amino- and γ-chloro-α-amino-butyric acids respectively. Treatment of both compounds with concentrated ammonia solutions yielded α.γ-diamino-butyric acid. By comparison with the known mode of hydrochloric acid fissure of azetidine, the primary products of hydrochloric acid hydrolysis of *Z* are those that would be expected to arise from azetidine-2-carboxylic acid by addition of water or hydrochloric acid after splitting of the ring in either the 1 : 2 or 1 : 4 positions. The fourth possible product, α-hydroxy-γ-amino-butyric acid, has not been recognized. Extra support is available in that the nature of the products of acid hydrolysis vary with the acid used. Homoserine, as would be expected, was formed when either 3 *N* sulphuric acid, 2 *N* nitric acid or 70 per cent hydriodic acid replaced hydrochloric acid, but the additional products were characteristic of the acid used. Since hydrogen iodide is a strong reducing agent, α- and γ-amino-butyric acids appeared, together with homoserine, as direct products of ring fissure. The suggested transformations following acid hydrolysis of *Z* are outlined in the accompanying scheme (p. 348).

*Z*, like proline, gave an intense blue colour with sodium nitroprusside in 10 per cent acetaldehyde solution in the presence of sodium carbonate[3]. This test is recorded as specific for secondary amines, and, under the test conditions used, was not given by a number of α-amino-acids tested simultaneously.

The identity of *Z* as azetidine-2-carboxylic acid has been confirmed by comparison with synthetic material. This was prepared by two methods. In the first method γ-amino-butyric acid was brominated to α-bromo-γ-amino-butyric acid, which was then refluxed for 10 min. with 0·5 *N* barium hydroxide solution to remove hydrogen bromide and effect ring closure. The alternative synthesis was based on that published for proline[4]. *l*-Diamino-butyric acid monohydrochloride, kindly supplied by Wellcome Research Laboratories, Beckenham, was first converted to α-chloro-γ-amino-butyric acid, and ring closure again effected using barium hydroxide to remove hydrogen chloride. The product of the first synthesis would be the *dl*-form of azetidine-2-carboxylic acid, whereas, by comparison with the proline synthesis, optical activity could be retained with inversion of configura-


1 : 2 HCl addition
$H_2N.CH_2.CH_2.CH(Cl).COOH$ ? γ-amino-α-chloro-butyric acid
hydrogenate Adam's catalyst
$H_2N.CH_2.CH_2.CH_2.COOH$ γ-amino-butyric acid
conc. $NH_3$ 100°, 6 hr.
$H_2N.CH_2.CH_2.CH(NH_2).COOH$ α,γ-diamino-butyric acid
1 : 4 HCl addition
$Cl.CH_2.CH_2.CH(NH_2).COOH$ ? γ-chloro-α-amino-butyric acid
hydrolysis with 6 N HCl, 100°, 24 hr.
hydrogenate Adam's catalyst
$CH_3.CH_2.CH(NH_2).COOH$ α-amino-butyric acid
1 : 4 $H_2O$ addition
$HO.CH_2.CH_2.CH(NH_2).COOH$ homoserine
$CH_2$ $CH_2$ CH.COOH N H
2N $H_2SO_4$ and 2N $HNO_2$ hydrolysis, 100°, 24 hr.
$HO.CH_2.CH_2.CH(NH_2).COOH$ + unidentified ninhydrin reactive products
$HO.CH_2.CH_2.CH(NH_2).COOH$ homoserine
70% HI hydrolysis and reduction, 100°, 24 hr.
$H_2N.CH_2.CH_2.CH_2.COOH$ γ-amino-butyric acid
$CH_3.CH_2.CH(NH_2).COOH$ α-amino-butyric acid

tion in the second method of preparation. The samples of synthetic azetidine-2-carboxylic acid showed the same ninhydrin colour responses as *Z*, and were inseparable from it on phenol, butanol–acetic acid and collidine–lutidine chromatograms. The synthetic compounds were also cleaved on acid hydrolysis in identical ways to *Z*. Finally, the infra-red absorption spectrum of *Z* was identical with that of the synthetic material prepared from *l*-diamino-butyric acid (Fig. 1).

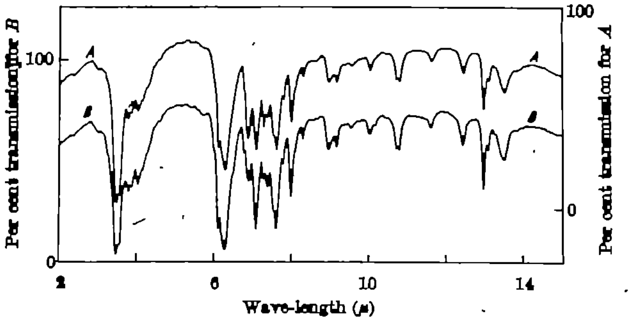
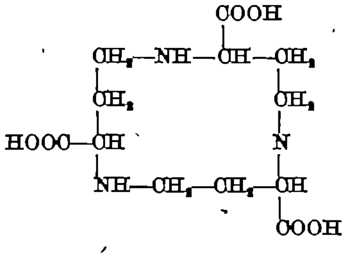


Fig. 1. Infra-red absorption spectra of nujol mulls of azetidine-2-carboxylic acid. (*A*) Isolated sample, (*B*) sample synthesized from *l*-diamino-butyric acid. Absorption peaks at wave-lengths of 3·48, 3·53, 6·86 and 7·27 μ are largely attributable to the nujol

This finding of azetidine-2-carboxylic acid has extended the types of cyclic nitrogen compounds known to occur in plants, for simple four-membered ring systems based on azetidine have not previously been recorded. The existence in plants of this lower analogue of proline follows closely upon the recent discovery in plants of the higher analogue of proline, pipecolic acid.

The latter part of this work has been carried out in the laboratories of Prof. F. C. Steward, whose ready co-operation is gratefully acknowledged, during the tenure of a Rockefeller Foundation Fellowship. A fuller account of the investigation will be published elsewhere at a later date. [May 23

*Note* (June 17). Since this manuscript was prepared, an article by Prof. A. I. Virtanen and P. Linko has been published (*Acta Chem. Scand.*, 9, 551; 1955), in which the isolation of a new nitrogenous compound from *Polygonatum officinale* was described. This compound (called I), which was also stated to occur in *Convallaria majalis*, is almost certainly the same as the substance *Z* described above. All the experimental data cited for I by Virtanen, with the exception of a molecular weight determination of 303, support the idea that I is in fact azetidine-2-carboxylic acid. Virtanen, however concluded that I had the structure :



although no comparison with synthetic material was made. It would appear that this structure was dictated largely by the results of elementary analysis and molecular weight determinations.

Virtanen also described a compound (called II) which arose after hydrochloric acid hydrolysis of I and he has ascribed a complex, unorthodox formula to this compound without supporting evidence. Compound II (stated to have an elementary analysis of $C_4H_7O_2N.HCl$) would seem to be more simply explained as a chloraminobutyric acid ; II appears in fact, to have the same chromatographic properties as the α-chloro-γ-amino-butyric acid described above which gave γ-amino-butyric acid on reduction.

[1] Steward, F. C., Zacharius, R. M., and Pollard, J. K., *Ann. Acad. Sci. Fennicae*, A, II, 60, 321 (1955).
[2] Howard, C. H., and Marckwald, W., *Ber.*, 32, 2031 (1899).
[3] Feigl, F., "Spot Tests" (II), "Organic Applications", p. 189 (Elsevier, 1954).
[4] Hamilton, P. B., *J. Biol. Chem.*, 198, 587 (1952).

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Instability of the Earth's Axis

IN connexion with the theory of the instability of he earth's axis of rotation[1], it may be worth pointing ut that, besides the evidence from fossil magnetism, t is possible that independent biological confirmation ould be found of the occurrence of major latitude hanges in the past history of the earth.

However the climate may have changed in the ast, it is certain that the seasonal variation in ength of day at any particular latitude must always ave been the same; however warm the arctic winter nay have been, it was always dark. Since photoynthesis is possible only in daylight, there must lways have been a check to plant growth at high atitudes during the winter, whatever the temperaure, and this will have left its mark in the form of nnual growth rings in trees and other perennial lants. If plant fossils showing continuous growth vithout well-defined annual rings or other signs of a vinter check could be found at the present time at igher latitudes, that would be good evidence of past atitude changes, for continuous growth without an nnual winter check can never have been possible ar outside tropical latitudes.

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Gold, T., *Nature*, 175, 526 (1955).

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THE possibility that changes have occurred during he past in the position of the earth's axis of rotation, elative to present surface features, is of great interest o all students of fossil plants. It has long been clear hat the geological evidence of former vegetation hows that the lands around the Arctic Sea bore an mple covering of plants during a long period, probbly from Devonian to Tertiary times. This vegetaion included many large trees and was very different rom the scanty flora of those regions living to-day. rom other areas, such as South Africa, India and ustralia, there is evidence of glacial conditions ssociated with relatively small flora.

Hitherto, almost all palæobotanists of the past wenty years have accepted the hypothesis of coninental drift as being the only possible explanation f all the observed facts, in spite of the objections requently raised to this theory. The new views ummarized by Mr. T. Gold[1] will stimulate a rexamination of the palæobotanical evidence.

The use of fossil plants as tests of past climates as been under consideration for many years by many nvestigators, especially by Seward. The interpretaion of the evidence is by no means easy, since the actors of temperature, rainfall, length of day and ntensity of light are involved. The significance of rowth rings in the stems of woody plants found in petrified condition has been discussed by Gothan, nteys and others; but there is a great lack of nformation about the stems of coniferous and other lants from the older rocks of high latitudes. Wellarked growth rings were present in trees of Mesozoic ge from the arctic regions; but we should like to know whether they also occurred in trees of the same area during the Upper Devonian and Carboniferous periods. At this time the gymnospermous trees from Europe and North America showed little or no signs of a seasonal cessation of growth, whereas those from South Africa, India and Australia have very conspicuous growth rings. A specimen of petrified wood from the Antarctic Continent was described by Seward, in the report of the Scott expedition[2], as showing annual rings; but these were much less conspicuous than those in somewhat similar wood from South Africa.

There can be little doubt that the climatic changes, of which both rocks and fossils provide evidence, were of great importance in relation to the evolution of plants, and consequently to the past history of terrestrial animals. If geophysical research can establish how these changes came about, an important contribution to biology will be made.

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[1] Gold, T., *Nature*, 175, 526 (1955).

[2] *British Antarctic (Terra Nova) Expedition*, 1910, 1, 17 (1914).

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## Reactions of Herring Larvæ to Light: a Mechanism of Vertical Migration

DURING the course of studies on the reactions of fish to light the opportunity arose for observing the behaviour of herring larvæ, *Clupea harengus* (Linn.). Initial observations were made on larvæ in shallow dishes illuminated from below by diffuse light. Each larva was dark-adapted and then observed for fifteen minutes at different light intensities, the total time spent moving in this period being recorded as a measure of its activity. The larvæ exhibited a positive photo-orthokinesis[1], their activity being proportional to the light intensity between two limits. The lower threshold for the kinesis was about 20 metre-candles, the larvæ being active for 20 per cent of the time below this intensity (down to at least 0·3 m.c.). At higher intensities, activity increased to a maximum at 4,000 m.c. when larvæ were active for 35 per cent of the total time; still higher intensities (up to 65,000 m.c.) did not increase activity further. When a light was shone at the side of the dish, larvæ swam directly towards it, showing a positive phototaxis.

Later experiments were carried out in a tall glass cylinder illuminated by diffuse light from above. Inactive larvæ sank head first weighted by their yolk-sacs; active larvæ swam directly upwards 'standing on their tails' or maintained their midwater level, swimming horizontally. Very little swimming was observed at inclinations between these planes in larvæ up to five days old at 7·5° C., although the behaviour of older larvæ became more variable. Time spent swimming horizontally, vertically, and the distance swum vertically were recorded during each observation period. The positive photo-orthokinesis persisted in this apparatus. At lower light intensities (down to 3 m.c.) and also in red light (above 6500 A.) the larvæ swam only vertically upwards when active or sank passively. After a period in the dark, larvæ were always found in midwater, so that they would appear to be active in total darkness, activity probably being at the basal

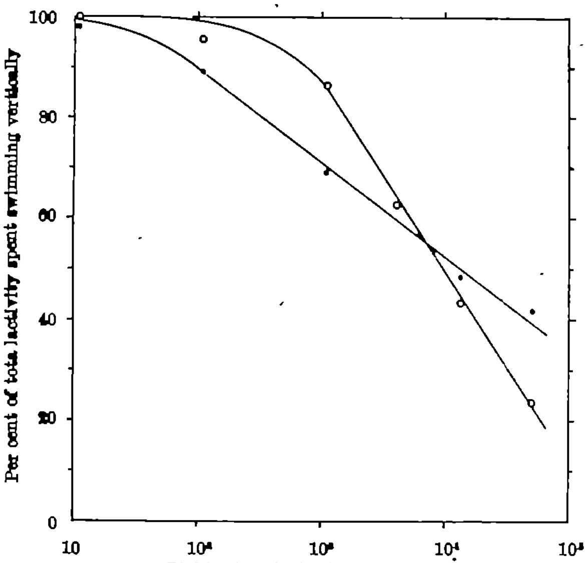

Fig. 1. Relation of change in orientation to light intensity for two typical larvæ

level observed at lower light intensities. At higher intensities (above 100 m.c.) larvæ also swam horizontally for part of the time active, this horizontal component increasing, together with the kinesis, finally increasing at the expense of the vertical component. The degree of change in orientation could be shown by expressing time spent swimming vertically as a percentage of the total time active and is directly related to the light intensity as shown (Fig. 1).

Since the change in orientation is definite, being at 90° to the light, it is assumed that the phototactic orientation is replaced by a dorsal light reaction at higher intensities. A dorsal light reaction has been demonstrated in several fish, and von Holst[2] has related the strength of this reaction to light intensity.

The reactions to light described fit the herring larva well for its environment. The larva is active in total darkness; this activity may be random, or vertically orientated as observed at lower light intensities; in the latter case it would be necessary to postulate a negative geotaxis[1] in addition to a positive phototaxis. The larva hatches from its demersal egg at low light intensities; activity directed vertically upwards either by a photo- or geo-taxis would take the larva towards the surface and higher light intensities. Once past a certain light threshold a larva will swim for a longer time and increasingly in a horizontal direction. This increase in the horizontal component will continue until the vertical component just compensates for passive sinking. Cushing[3] has suggested that the pattern of vertical migration consists of four parts; all four would be completed by the mechanism described, except that 'midnight sinking' would not occur if a negative geotaxis does indeed exist.

It is of considerable interest that such a mechanism of migration has recently been described by Harris[4] for a pond-living crustacean, *Daphnia magna*, although it would appear that the dorsal light reaction is of an all-or-none character in *D. magna*, as opposed to the finer mechanism of constant correction for sinking in the herring larva. The occurrence of similar mechanisms of depth control in planktonic animals so widely separated phylogenetically suggests that this type of behaviour may be of fairly widespread occurrence in the plankton community.

We wish to acknowledge our indebtedness to Mr. G. C. Bolster for very kindly supplying the herring larvæ.

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April 6.

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## Rate of Milk Secretion with Increasing Interval between Milking

THE belief that the rate of milk secretion declines with time during the interval between successive milkings is based on an observed increase from thrice daily and a decrease from once daily milking over normal twice daily milkings, and on Edwards's[1] calculations of secretion-rates in milking intervals of different length. Turner[2] recently questioned Edwards's conclusions on the grounds of the regression of residual on total milk yield and suggested that the secretion-rate does not decrease until after twenty hours. On the other hand, Bailey, Clough and Dodd[3] claim to have re-established that milk secretion rate does decrease with time.

Work on the problem has been undertaken at Ruakura in view of the fact that past results have been confused by a failure to hold constant the amount of residual milk, and further by the *a priori* belief that the length of the interval preceding each experimental interval may influence the measured secretion-rate.

In these Ruakura experiments, the measurement of secretion-rate *per se* has been aimed at by removal of residual milk with 10 I.U. of 'Pitocin' and by an experimental design which also eliminated any possible effect of the preceding interval. In addition, the design has permitted the measurement of preceding interval effect.

A balanced latin square has been used, an example of which follows, the intervals used being 4, 8, 12, 16, 20 and 24 hr.:

| | Order of intervals | | | | | |
|---|---|---|---|---|---|---|
| Cows | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 8 | 20 | 16 | 4 | 12 | 24 |
| 2 | 20 | 4 | 24 | 8 | 16 | 12 |
| 3 | 16 | 24 | 20 | 12 | 8 | 4 |
| 4 | 4 | 8 | 12 | 20 | 24 | 16 |
| 5 | 12 | 16 | 8 | 24 | 4 | 20 |
| 6 | 24 | 12 | 4 | 16 | 20 | 8 |

To eliminate preceding interval effects, 12-hr. intervals were interposed between all the experimental intervals. It should be noted that the final result of any one square represents an aggregate of six cows. The design has the disadvantage that should the feed supply or the 'Pitocin' have an undue effect on milk secretion, or should there be a carry-over effect of preceding interval through the intervening twelve-hour interval, the result of any one animal may not be considered individually.

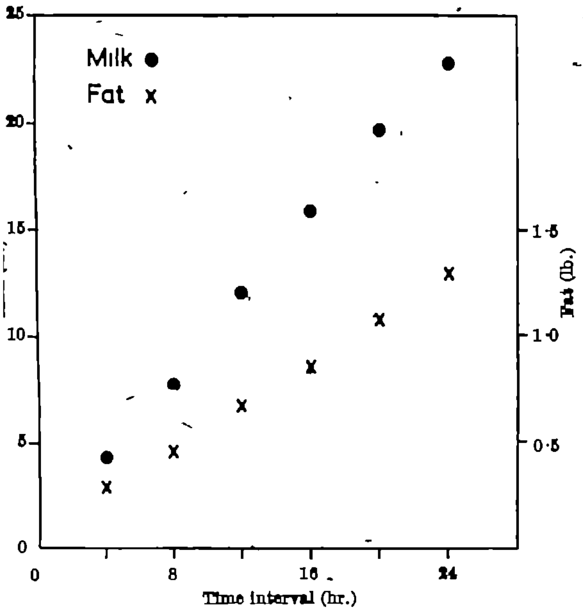

Fig. 1

Four trials have been carried out involving in each case six cows and using the design outlined above. In the first two trials the same six animals (second calvers) were used, the first being carried out when the animals averaged sixty-two days in milk, the second when 112 days in milk. The third and fourth trials involved a further twelve animals of varying ages averaging 135 days *post partum*.

Fig. 1 illustrates the type of result obtained (Trial 4). The other three experiments gave similar results. Both milk and fat secretion-rates showed no significant decline before 20–24 hr.

It is clear that up to an interval of approximately twenty hours neither milk nor fat secretion-rate decreased with increasing interval between milkings. The effect of an increase in length of the interval preceding the experimental interval was not clear-cut, but there were indications that increasing this period had a deleterious effect on rate of milk secretion and a beneficial effect on rate of fat secretion. Thus, the significant decrease obtained by Bailey *et al.* may be attributed, not to a direct pressure effect of increasing amount of milk in the udder, but to either or both of the two factors present in the Shinfield experiment and eliminated in the Ruakura experiment, namely, the effect of an increasing amount of residual milk and/or an increasing length of the preceding interval.

The significance of this conclusion in regard to the practices of milking at equal intervals and of milking three times a day is bound up with the action of these other two factors. So far as twice-daily milking is concerned, it may be suggested that unequal intervals, of a length indicated by the results of an experiment such as this, could be employed with no fear of a decrease in milk secretion due to direct pressure effects. A preliminary field trial at Ruakura using eight sets of identical twin cattle split between a 12–12 and 16–8 hourly milking regime and now in the final stages of lactation supports this contention. Similarly, observed increases with three times a day milking may not be the result of assumed reduction in udder pressure. Rather, the indications are that some other physiological function is involved. Both the Shinfield experiment and work at Ruakura indicate that such may be the case.

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[1] Edwards, J., *J. Agric. Sci.*, 40 (1950).

[2] Turner, H. G., *Aust. J. Agric. Res.*, 4, 118 (1953).

[3] Bailey, G. L., Clough, P. A., and Dodd, F. H., *Nature*, 172, 404 (1953).

## Site of Phosphorus Absorption in the Sheep

THOUGH several reports[1–4] deal with phosphorus uptake by the various divisions of the gastro-intestinal tract of the sheep, they do not compare the absorption of added physiological amounts of phosphorus from normal ingesta in these organs. To satisfy this requirement sheep were allowed to graze normally until approximately four hours before being anæsthetized. The organ under investigation was then tied off and radiophosphorus, in the form of orthophosphate with 1 mgm. per mc. carrier, injected into it. Blood samples were taken, at intervals, from the left jugular vein, and the plasma assayed for radioactivity in a dipping counter.

The graph (Fig. 1) shows the level of plasma activity, measured in μc./ml. per unit dose, plotted against time. The term unit dose refers to a dose of 66·7 μc. per litre of organ volume. This gives a rumen dose of 1 mc. Doses were calculated from organ volumes taken from Sisson[5].

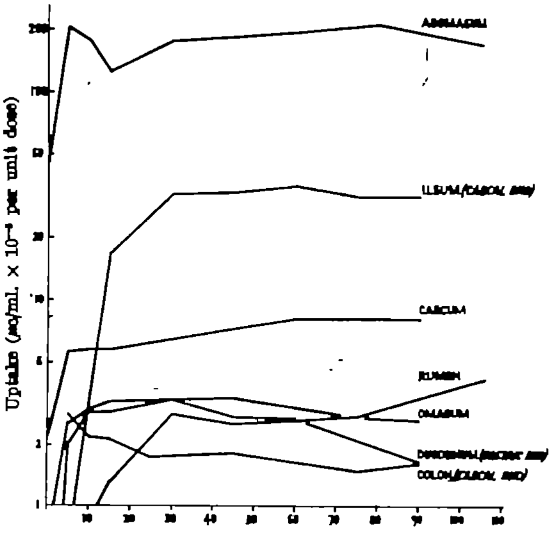

Fig. 1

The curves show that the absorption by the rumen, omasum, duodenum, colon and the cæcum are of the same order of magnitude. The apparently higher value for the cæcum is not considered significant. By contrast, absorption by the ileum is of an order ten times, and that by the abomasum one hundred times, greater.

The similarity of the figures for organs other than the ileum and abomasum suggests that the mechanism involved is one of simple exchange as distinct from true absorption by the latter.

The suggestion by Pathasarathy[6] that absorption occurs from the omasum is not supported by these figures.

This work is continuing and will be reported in full elsewhere.

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March 1.

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[3] Sperber, I., and Hydén, S., *Nature*, 169, 587 (1952).

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[5] Sisson, S., and Grossman, J. D., "The Anatomy of Domestic Animals" (W. B. Saunders, London, 1938).

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## Plant Growth on 'Fly Ash'

THE difficulties of the satisfactory disposal of the pulverized fuel waste from power station boilers, often referred to as fly ash, is world wide. In Britain the problem is particularly acute, especially where agricultural land is used for its disposal[1]. The present findings are the result of an intensive study of crop problems which are likely to be encountered when attempts are made to revegetate areas of agricultural importance which have become contaminated with this waste product.

Preliminary field-observation had suggested that the ash might contain certain substances which seriously retard the growth of plants. Indeed, the common weeds which rapidly establish themselves on other industrial wastes seem unable to colonize this material with probably three exceptions, the most successful being the chenopodiaceous plant *Atriplex hastata* var. *deltoidea* (hastate orache). This plant quickly forms practically pure stands on the bare ash when other weeds and rough grasses are completely excluded. It seems, therefore, that the properties of the ash which seriously affect the normal physiology of most plants are resisted by *Atriplex*. These circumstances would appear to afford an opportunity for further contributions to our knowledge of the physiology and autecology of ruderal plants, and at the same time to produce valuable information on the plant/ash nutrient relationships.

Chemical analyses of the main constituents of the fly ash are periodically published by the Central Electricity Authority; but as yet no attempt seems to have been made to examine its plant nutrient properties as compared with those of a normal soil. Detailed spectrographic analysis of the ash and a typical soil, kindly made for us by the Macaulay Institute, together with our own exhaustive analytical studies, indicate that aluminium, manganese, iron and nickel only are present in quantities toxic to plants. Other potential toxins present, for example, zinc, cobalt, chromium and titanium, at first suspected, in all probability exist in harmless quantities. Of the major plant nutrients, nitrogen alone appears deficient, forming some 0·04 per cent of the oven-dried ash.

Sand culture experiments with barley using the following levels of toxic metals: aluminium, 3 meq., manganese, 3 meq., nickel, 1 meq., and iron, 1 meq., in one litre of ordinary culture solution, singly and in all combinations, produced the following symptoms:

Aluminium: stunting, lack of tillering; purplish tint on stems; erect pointed leaves with brown brittle tips and die back

Manganese: slight stunting; leaves with brown tips and die back and dark brown spotting on the lamina later coalescing as brown streaks.

Nickel: plants severely stunted and chlorotic; leaves with white necrotic areas beginning in the middle of the leaf and causing its collapse.

Iron: Slight purplish tint, otherwise growth as per control.

Metals in combinations produced additive symptoms.

Barley grown on ash to which a full culture solution had been added developed symptoms identical with those produced in the sand culture which contained manganese and aluminium. No nickel symptoms were produced. On the other hand, *Atriplex* grew normally in sand culture containing aluminium, manganese and iron at toxic levels, but was severely stunted and chlorotic when nickel was added.

In another series of culture experiments, a number of crop plants were grown in an ash/culture medium. The plants selected have been shown by Hewitt[2] to be sensitive indicators of toxic levels of aluminium and manganese alone or in combination. In all cases the ash induced symptoms comparable to those described by Hewitt. These findings were confirmed by tissue analyses. Plants grown on ash always showed an excess uptake of manganese and aluminium as compared with the controls.

Water-culture experiments using different levels of nitrogen have shown that *Atriplex*, in contrast to crop plants, can tolerate low levels of nitrogen without effect on its normal growth.

We thank Dr. E. J. Hewitt, of Long Ashton, for his help, and the Central Electricity Authority for providing facilities for field-studies. A fuller account will be published elsewhere.

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June 4.

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## Œstrus in Zebu Cattle in Uganda

DURING investigations into the possibility of artificial insemination of indigenous Zebu and Nganda cattle with homologous semen obtained by electrical stimulation, the œstrous cycles of an experimental group of heifers have been determined, using marked vasectomized bulls. The animals have been examined for evidence of service at 0700 and 1900 hr. local time. In two months, œstrus has been detected in five animals on fifteen occasions; but marking by the bull has never occurred on less than two occasions. These were recorded as of 12 hours duration (0700–1900 hr., and vice versa). Based on this marking of the females, three heat periods lasted 12 hr., nine lasted 24 hr., two lasted 36 hr. and one lasted 48 hr. Of this total, six (40 per cent) were first recorded at 0700 hr. (commenced during darkness), and nine were first recorded at 1900 hr. (commenced during daylight).

More recently, during observations of the habits of Zebu cattle[1], two cows have been observed in detail throughout œstrus, and these observations have helped to explain the above results. Our observations show that the cows are attractive to the bull for some hours before and after they are ready to accept service. Thus in one instance the bull detected the ow 4 hr. 33 min. before she would accept service, nd during the last 1 hr. 44 min. of this period, xteen attempts to serve were made. One service nly was allowed; but the bull's interest continued r a further 9 hr. 37 min. In the second instance, he bull detected the cow 10 hr. 24 min. before ervice was allowed. The cow then permitted service wice in 16 min., and the bull continued to attempt ervice for a further six hours; in fact, serving the ow once again 2 hr. 12 min. after the preceding ervices, when the cow was no longer truly receptive.

These results are of interest, for they agree with eld-observations that African cattle owners may uccessfully walk cows several miles 'to the bull', ut differ from previous scientific work in some espects. The observations suggest that while the uration of œstrus is short in the Zebu at Entebbe, he period of pro-œstrus is much longer than the 4–63 min. reported in Kenya[2], the behaviour of the emale remaining at stage 1 and 2 of œstrus[3] for a onsiderable period before and after œstrus. These esults are more in agreement with South African orkers[4], who found the mean duration of onset of estrus in indigenous Afrikander cows to be 7·46 hr. range 0–24 hr.), and the average time of the disppearance of œstrus 5·73 hr. (range 0–18 hr.).

The proportion of animals coming into œstrus uring darkness (40 per cent) is very similar to that eported in Kenya[2] (31·3 per cent, allowing one-third or 1 hr. difference between 0600 and 0700 hr. within he period of observation, 0600–0900 hr.). It has een reported that at the Messina Experiment tation in South Africa[5], 90 per cent of œstrus commenced between midnight and 0900 hr. This compares with 45·3 per cent in Kenya[2] for the identical ime. On the other hand, in Sweden[6] it has been eported that 43 per cent of œstrus commenced during aylight and 57 per cent during darkness.

The duration of œstrus in the above two observaions is very similar to that reported from Kenya[2,7] nd shorter than that reported for South Africa[4] 7·88 hr., range 1–14 hr., indigenous Afrikander), or the Philippines[8], where a mean of 13·3 hr. (range ·5–22·4 hr.) was recorded for native cattle.

There are marked climatic differences between ntebbe and the sites of the stations where the bservations referred to above were made. The limate at Entebbe (altitude 3,780 ft.) is very equable, ith a well-distributed rainfall (average 59 in.), and umidity frequently high due to the proximity of ake Victoria[9]. The latitude of 0° 02′ N. gives little ariation in length of daylight.

It is hoped to extend and report these findings in rther detail at a later date.

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## Reaction to Light of Iris-Chromatophores

FIELD workroom observations in this Sanctuary show that intensity of daylight controls reaction of chromatophore cells in irises of the male duck *Netta erythropthalma* (Wied.). A minor field characteristic of the male African pochard is the brilliant vermilion iris—a feature easily discernible with binoculars at up to about a hundred yards. The female's irises are umber.

Timed observation revealed, on taking the male from a lightproof box in a daylit workroom to the window:

| | |
|---|---|
| 0 min. | Irises dull yellow ochre |
| 1 ,, | First suggestion of red suffused: no noticeable pattern |
| 2·5 ,, | Irises much warmer and darker |
| 3 ,, | Red area extends; grows stronger |
| 4 ,, | Irises nearly all red |
| 5 ,, | Irises 'normal'. Brilliant vermilion suffused over dull ochre background |

The radical reaction of chromatophores occurs simultaneously in various parts of the iris. When colour-change is apparently complete there remain pinpoints of ochre. The action commences before pupils have completely contracted.

Further field-work is in progress, and laboratory examination of the eyes will be carried out. Other members of Anatidae are being subjected to examination.

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## Two New Mutations in the Syrian Hamster

THE Syrian hamster, *Mesocricetus auratus*, introduced to the laboratory by Adler and Theodor[1] in 1931, is a golden-brown rodent with pale cream belly fur and two characteristic throat flashes. Melanic pigment darkens the skin of the ears and is present about the genitals in both sexes (in the region of the vulva and anus in females, and in the scrotum and spots on the prepuce in males). It is to be expected, as increasing numbers of hamsters are bred, that mutant types will appear. This note records the occurrence of two new mutations.

*Cream* (proposed symbol *e*). The cream is devoid of melanic pigmentation in the fur but retains the skin colouring present in the ears, genitals and hip-gland. The eyes are dark. The coat colour is a rich creamy yellow, lighter on the belly than on the dorsum. Growth, viability and fertility are comparable to the normal. Reciprocal matings of cream × normal produced a normal $F_1$ and an $F_2$ segregation of 154 normal and 58 cream ($\chi^2_1 = 0\cdot629$; $P = 0\cdot5 - 0\cdot3$). An autosomal recessive is apparently involved with normal penetrance and viability.

*Ruby-eye* (proposed symbol *ru*). The coat colour of ruby-eye animals is distinctly weakened. Both black and yellow are affected; the black to bluish and the yellow to fawn. The skin colour is appreciably paler and develops much later in the young animal. New-born animals display an annulus of pigment in the iris, clearly visible beneath the closed eyelids. When the eyes open, the pupil possesses a ruby mien in most but dull lights. As adults, the ears are faintly pigmented while the genitals are usually flesh pink. Growth-rate, viability and fecundity are all subnormal. Adult size is reduced in both sexes and the males are frequently sterile. The $F_1$ of normal ♂♂ × ruby-eye ♀♀ are normal and an $F_2$ segregated into 220 normal and 35 ruby-eyed ($\chi_1^2 = 17\cdot29$; $P < 0\cdot001$). There is a significant deficiency of ruby-eyed individuals for the assumptive inheritance of an autosomal recessive gene. Impenetrance is considered improbable since the distinction between normal and ruby-eye is sharply defined; there is no intergrading.

The estimated viability of ruby-eye homozygotes is $0\cdot477 \pm 0\cdot087$ at the recording age of twenty-one days. The lowered viability could be the result of the interplay of several factors: (1) the perishing of some *ru*-bearing gametes; (2) the selective degeneration of some *ruru* foetuses (since these probably have impaired growth); (3) a greater proneness for *ruru* young to succumb during parturition; (4) selective cannibalism of *ruru* young by the mother (again possible as a consequence of the impaired growth-rate). It may be remarked that no obviously inferior *ruru* young could be detected at birth; unfortunately the mothers resent viciously the handling of new-born young, making detailed scrutiny hazardous for the litter.

All new-born litters are examined as soon as possible after birth, thus (4) could be partitioned into (*a*) cannibalism prior to examination and (*b*) cannibalism later. The latter usually occurs within 1–3 days. Only this last factor can be analysed with the present material. If selective cannibalism occurs, it is to be expected that in litters with no or little observed cannibalism, the proportion of ruby-eye should approach more closely to a 3 : 1 ratio. The pertinent data are shown in Table 1.

Table 1. NUMBER OF YOUNG EATEN PER LITTER

| Phenotype | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| *Ru*– | 54 | 80 | 54 | 12 | 4 | 0 | 5 | 11 |
| *ruru* | 9 | 8 | 12 | 3 | 0 | 0 | 1 | 2 |

Total number of young in litter with degrees of cannibalism or losses.

To apply a test for heterogeneity, the five classes on the right were merged, resulting in a $\chi_3^2$ of $6\cdot12$; $P = 0\cdot20 - 0\cdot10$. The data clearly fail to substantiate a claim of selective cannibalism of type 4*b*. The most favoured explanation is that of (2)—a relatively greater propensity for *ruru* foetuses to atrophy in face of *in utero* competition.

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## Chromosome Number of Human Cervix Uteri

IN a recent review, Beatty[1] has shown much evidence in favour of the inconstancy of chromosome number in various somatic tissues of mammals, including man. Sachs[2], however, did not observe any variation in the chromosome number of human and some other mammalian endometrial tissues from a count of fifty nuclei in each case by using the squash technique. Walker and Boothroyd[3], using a similar method, obtained wide variations in the chromosome number in somatic tissues of mouse and to a le extent in human endometrium; but when the employed the membrane and spinning technique[6] fc the same tissues, the variations were within a narro limit. Human endometrial tissues have also bee examined by me[4] and by Timonen[5]. Except Sachs we have found variation of the chromosome numb in human endometrium, although my results[4] agr more with those of Walker and Boothroyd[3] showing a narrower range of variation than those Timonen[5]. Since the chromosome number of huma endometrium is a matter of controversy, I have bee studying the chromosome in the epithelium of no neoplastic cervix uteri with an improved technique Preliminary results for chromosome counts from o hundred nuclei have been obtained.

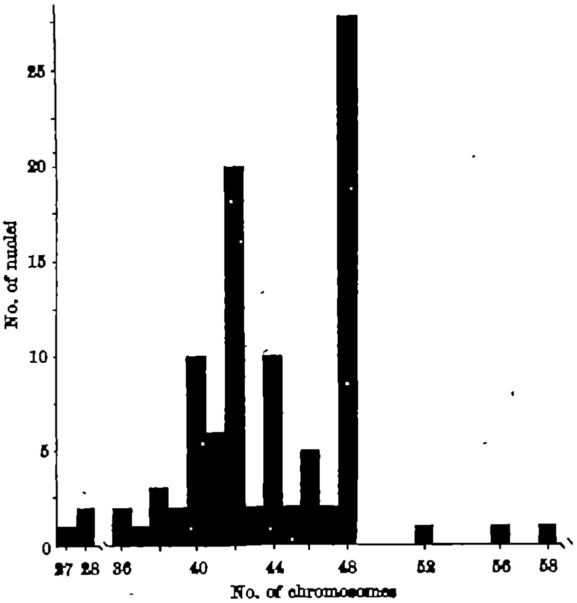

Fig. 1. Frequency distribution of chromosome number in cell from human cervix uteri

The distribution of the chromosome numbers the present work ranges from 27 to 68 (Fig. 1 Of 100 nuclei, four had the following hyperdiplo numbers: 52, 56, 58 and 68 chromosomes, twent eight nuclei had the normal diploid set, and t remaining sixty-eight nuclei had subdiploid numbe (fifty-seven of them had numbers ranging betwe 40 and 47). The frequency distribution peak w found at the diploid number, but there was al another lower peak at 42.

Some error in counting may have occurred owi to technical difficulties; but this has been min mized by various recent techniques. Hence must be concluded that variations occur in t chromosome number of normal somatic tissues of m and mammals. The results obtained with somat tissues by various workers[1] and in the present wo show that the same somatic tissue may have different chromosome number distribution in differe cells at different times, and this will be more appare when periodic regeneration and degeneration tak place[4] and mitotic abnormalities are not infreque In our study of human cervix tissue there is so indication of the existence of difference in the fr quency distribution of chromosome numbers different patients; further results will be necessa to substantiate it.

I am indebted to Dr. S. P. Ray-Chaudhuri, of the University of Calcutta, for his initiation of the present study, and to Dr. Subodh Mitra, director of the Chittaranjan Cancer Hospital, Calcutta, for his interest.

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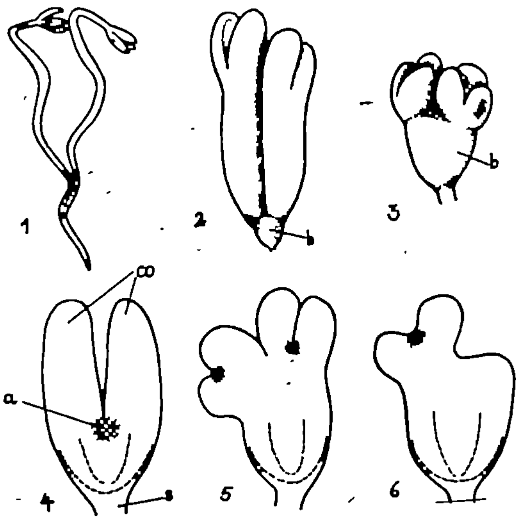
# Experimentally Induced Twinning in Plants

It is well known that characteristic changes in leaf-form and growth habit can be induced by treating shoot apices with synthetic growth substances. The question arises as to whether entire plant embryos also can be induced to develop abnormally by the action of growth regulators. For this purpose the solutions must be applied in a suitable manner to the earliest embryo stages through the growing carpel walls, or it would be necessary to remove the still quite small embryos and to expose them *in vitro* to the proper influences. Both methods are difficult to apply and have as yet proved unsatisfactory.

These difficulties can be overcome by using especially suitable material, such as mature seeds of *Eranthis hiemalis* L. *Eranthis*, in common with several other spring-flowering plants, discharges its seeds, which outwardly appear to be mature but which really contain only undifferentiated pear-shaped embryos. The development of the embryos occurs between May and December in the seeds lying in the soil[1]. Consequently, the still very small embryos in the freshly collected seeds can be exposed to the desired treatments. By successive removal of the embryos during the summer and autumn, all stages of normal and experimentally altered development can be observed.

The experiments, which were begun in 1953 and which have been continued to date, were carried out in the following manner. The freshly collected seeds were either submerged for 12–14 hr. in solutions of the active substances or were planted out in flower-pots in groups of a hundred each, and 50 c.c. of the solution was poured on. A 0·1 per cent solution of 2,4-dichlorophenoxyacetic acid caused almost 100 per cent cotyledon anomalies (syncotyly and pleiocotyly of all degrees); this contrasts with only 0·37 per cent in untreated material[2]. In addition, there was always a certain percentage (3–8) of twinning. The normal rate of twinning in *Eranthis hiemalis* is approximately 0·03 per cent. The twins were almost always fused at the base in varying degree and frequently showed cotyledon anomalies (Fig. 1). 2,4,5-Trichlorophenoxyacetic acid and α-naphthalene acetic acid produced a similar effect within the same range of concentration. With lower solution concentrations (less than 0·1 per cent) the number of anomalies decreased, while in the case of concentrations of more than 0·2 per cent lethal deformities increased.



Figs. 1–6. *Eranthis hiemalis.* (1), Twin seedling; (2 and 3) twin embryos removed in September and towards the end of June (× 110 and × 200, respectively); (4–6) longitudinal sections; (4) normally developed embryo, (5 and 6) embryos with two- and one-sided regeneration (× 280). *a*, apex; *b*, pear-shaped body; *co*, cotyledons; *s*, suspensor

In order to obtain information on the mechanism of twin origin, which is apparently the result of cleavage, various developmental stages were subjected to anatomical investigation. Fig. 2 shows a pair of twins removed from the seed in September. Here again both embryos are fused together at the root end. They originate from a pear-shaped body (*b*), the shape of which suggests that it is the original embryo itself which has regenerated two new embryos. This assumption is strengthened by viewing a still younger twin stage, as can be obtained towards the end of June (Fig. 3). Where normally both primordial cotyledons would be expected (Fig. 4), two new embryo buds with three cotyledons each have developed. A longitudinal section of the same embryo shows the relationships in a still more clear-cut manner (Fig. 5). The original embryo has developed normally in its basal part; the suspensor (*s*), the initial root cap and the new cell divisions of the procambial cylinder can be seen. However, the centrally located shoot apex is completely lacking and, in place of both cotyledons, two new embryonic upper parts with apices and cotyledon primordia have formed.

The following hypothesis may be advanced. The still undifferentiated embryo, such as is present when treatments are being carried on, already possesses an 'apical dominance'. The group of cells out of which the shoot apex later arises inhibits (either competitively or regulatively) the formation of further apices. These cells of the embryo apex are especially likely to be damaged due to the action of synthetic growth substances on the pear-shaped embryo. In this manner their influence disappears, and the cells which normally would give rise to the cotyledons grow into new stem tips.

Now we would expect, on the basis of our knowledge of correlation phenomena, that the regenerative formation of two new shoot apices would occur relatively infrequently and that a slight precocity in the one would necessarily inhibit the formation of the other. Such is the case of the embryo in Fig. 6. In place of the one cotyledon an embryonic bud has arisen while, on the opposite side, where the other cotyledon would be expected, only a few rather closely clustered nuclei suggest a short activity period. Embryos with one-sided regeneration were encountered in our material exceptionally frequently. This would tend to support our hypothesis.

In this connexion we must refer to the results of Wardlaw and Cutter[4-6]. When in the apical cone of *Dryopteris austriaca* the positions of the youngest visible primordia or of the site of the next primordium were partially isolated from the shoot apical cell by two wide tangential incisions, buds instead of leaves are formed. E. Ball[7] also obtained in *Lupinus albus*, after destroying the central portion of the shoot apex, one or two new apices by divisions of the second tunica layer in a flank position. Contrary to the results of Wardlaw in ferns, we have not observed the transformation of an already visible cotyledon primordium into a new stem apex. Treatment which occurred later than ten days after the discharge of the seeds produced no more twins, because at this time the cotyledon primordia began to differentiate.

The illustrations are based on photographic illustrations; these last will appear in a more comprehensive work to be published later.

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## Displacement Activities in Fiddler Crabs

ACCORDING to Tinbergen[1], a "displacement activity is an activity belonging to the executive motor pattern of an instinct other than the instinct(s) activated", and, according to Bastock, Morris and Moynihan[2], such activities would seem to take place in two quite different situations: "(1) Displacement activities may be performed by an animal in which two or more incompatible drives are strongly activated. Each drive prevents the expression of the other(s). (2) Displacement activities may also be performed by an animal in which one drive is, at the same time, both activated and thwarted."

Displacement activities have been reported for various vertebrates, especially fish and birds. Morris[3], for example, recently described the displacement activities of the zebra finch, *Poephila guttata*.

To the best of my knowledge, no case of a displacement activity has yet been recorded for an invertebrate. However, a recent study of the behaviour of the fiddler crabs (*Uca* spp.) which occupy the mangrove swamps of Inhaca Island, off the coast of Mozambique, revealed a number of instances of displacement feeding.

For normal feeding, male *Uca* crabs use only their spooned minor cheliped, the enlarged major cheliped being held at rest. With the minor cheliped, the crab scoops up from the ground a mixture of sand or mud and organic particles, which is then conveyed to the mouth. The mouthparts separate out the organic particles until, eventually, enough sand has collected to form a pellet, which drops to the ground. The female crabs differ from the males in that they possess no enlarged cheliped, but use their two small chelipeds more or less alternately during the feeding process.

(1) Displacement feeding as a result of a conflict of incompatible drives—the drive to attack and the drive to flee—was noticed in the following four species: *U. annulipes*, *U. chlorophthalmus*, *U. marionis* and *U. urvillei*. While protecting their burrows from male intruders or being threatened by superior males, and especially between bouts of actual fighting (in all of which activities the use of the major cheliped is involved), male crabs were seen to be feeding rather agitatedly. Such individuals appeared to be highly 'nervous', the scooping movements of their minor cheliped being far more frequent and far less deliberate than those of normal feeding. During displacement feeding a negligible quantity of food actually seemed to reach the mouth—not sufficient for any sand pellets to be formed. In the field it was noticed that the majority of individuals of all the species showing displacement activity were males. Females are, generally speaking, rather timid, for—possessing no major cheliped—they are ill-equipped for fighting. If threatened by a male, they can usually manage to escape by scurrying off to disappear down their burrows; that is, in such a case, only their escape-drive is stimulated, so that no tense conflict of drives is involved, and, hence, no displacement activity is produced.

(2) Displacement activities due to the simultaneous activation and thwarting of the same drive were observed in *U. marionis*, *U. urvillei*, *U. annulipes* and *U. chlorophthalmus*, during their respective mating seasons. This type of displacement feeding was particularly noticeable in *U. marionis* and *U. urvillei*, for these species were observed when their breeding season was far advanced. *U. annulipes* and *U. chlorophthalmus*, however, were under observation when their courtship was only in its incipient stages, so that displacement activity was noticed only occasionally. Generally speaking, during the breeding season, the approach of a female frequently stimulated a male, causing him to beckon with his major cheliped several times in quick succession, in a manner characteristic of his species. In *U. marionis* males, especially, such courtship display often appeared to become very intense, with each beckoning individual standing on the very tips of his ambulatories and running a short distance to the left and then to the right, repeatedly, between individual beckoning movements. Frequently a female would appear to respond to such display by leading the male to her burrow and, perhaps, by allowing the male to stroke her carapace. Now and again, however, the display of a male crab was ignored by the female, who either continued to feed quite normally or disappeared temporarily down her burrow. In such a case, if the thwarted male were sufficiently aroused sexually, he would frequently begin to show displacement feeding, until the female concerned took notice of him, either by stopping her feeding or by reappearing from her burrow, or until, perhaps, the approach of another female distracted his attention. Thus, periods of displacement activity were often found alternating with periods of intense courtship display.

Under laboratory conditions, displacement feeding was observed in *U. inversa*. In the field, the burrows of this species are rather widely spaced, with the result that fighting over the ownership of territories is unnecessary, and, therefore, relatively rare. Hence, displacement activities are also at a minimum. However, it appeared that several *U. inversa* individuals, confined to a terrarium too small for their number, became unnaturally aggressive towards one another. Of these, one female was seen to be performing displacement feeding—the one and only case of a displacement activity observed in this particular species. The female concerned appeared to be trapped in a corner, away from her burrow, and completely surrounded by four males. She ran about nervously, trying unsuccessfully to make her escape, and even attempted to climb the vertical sides of the terrarium, falling down again and again. Finally, she began to feed, in a highly 'nervous' fashion, and, since her chelipeds appeared to be scooping up no mud whatsoever, it appears that this must be yet another case of displacement feeding.

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## Cytochemical Research on Coelenterate Nematocysts

A NOTE by T. M. Yanagita and T. Wada[1] suggesting, after C. H. Brown[2], the possible keratin nature of coelenterate nematocysts has directed my attention to the subject. In 1952 I had observed the pronounced metachromatic colour produced by dilute thionin on large nematocysts from a siphonophore, *Halistemma* sp. It is known that the metachromatic colour of a dye, as taken up by a substance, is characteristic of an acidic mucopolysaccharide content, associated or not, with proteins to form mucoproteins[3]. The fact interested me, since I had studied such substances in the envelopes of pagurid and cephalopod spermatophores[4].

Another aspect of the nematocyst's contents has been studied by J. Boisseau[5]—the presumably toxic substance enclosed in the cnidocyst. He concludes that an albumin content is associated with a phenolic compound; the latter differs according to the type of cnidocyst and the species investigated.

In view of these different facts, I undertook to investigate the matter more closely, with the few cytochemical procedures available to me. Two species were chosen: a siphonophore, *Abylopsis tetragona* Ott. (*Halistemma* are not as frequent off the coast of Algiers), and an actinian, *Anemonia sulcata* Penn.

(1) *Abylopsis* has four types of nematocysts localized in the dactylozooid; I shall use Weill's[6] nomenclature to designate them eventually. I ascertained the protein constituent by means of a few colour reactions which are weakly positive (ninhydrin, Sakagushi, Millon, Adamkiewicz). The cystine content was revealed by the lead sulphide reaction. It is positive on every part of all cnidocysts, thereby confirming my predecessors' findings. The phenolic group was studied with the azo and chromaffine reactions and others special to *ortho*diphenols, according to procedures given by Lison[7]. I found that all nematocysts contain a small amount of *ortho*diphenol. This may differ according to the parts of the cyst.

The mucopolysaccharide content was analysed by means of techniques summarized by Lison[7]. The different kinds of cysts react positively to the Bauer test. Staining with toluidine blue gives different results: the invaginated (or discharged) threads and fluid content of the cnidocysts take a strongly metachromatic hue, implying the presence of a sulphomucopolysaccharide compound; the mastigophore capsules alone are to a lesser degree metachromatic too: this would indicate a simple mucopolysaccharide content (as defined by K. Meyer[3]). The other nematocyst capsules are coloured orthochromatically. They can, however, be made to colour metachromatically by treatment with 10 per cent chromic acid. These capsules would thus contain a neutral mucoprotein.

(2) *Anemonia sulcata* has several kinds of nematocysts, localized in different parts of the body. There are, besides, spirocysts in the tentacles, not considered to be true cnidocysts (Weill[6]). The protein content includes arginine, specially abundant in spirocysts, on which it confers basic properties; tryptophan is present in small quantity; cystine can be revealed by the lead sulphide and by the sodium nitroprussate reactions—the latter after reducing the S—S linkage in the amino-acid. The result is more strongly positive on the spirocysts than on the basitrichia or other kinds. The Chevremont and Fredericq test could not be of any use in this case, since it is given by other reducing agents, such as diphenols. It is likely the S—S bridges in the protein account for the sensitivity of certain parts to alkaline sodium sulphide, such as was found by Brown[2] and which I confirmed on the basitrichia capsules. The spirocysts are not wholly soluble.

The presence of an *ortho*diphenol has been identified in each type of nematocyst; the amount is very slight, as shown by the weak chromaffine reaction. The spirocysts contain an amino-*ortho*diphenol instead (giving a positive azo-reaction in acidic medium, as well as in alkaline solution).

The polysaccharide content gives a positive Bauer reaction, but as a rule very faint. Staining by toluidine blue is not strongly metachromatic on basitrichia and the contents of atrichia, since colour is due to the carboxylic groups. These nematocysts seem to be made of simple mucoproteins. But the mastigophores and atrichia capsules are not coloured; neither are the spirocysts, which, being acidophilic, do not take basic dyes. The two former can, however, be made to stain metachromatically after chromic oxidation. This would indicate that they are made up of neutral mucoproteins. The spirocysts remain uncoloured in these conditions; since they are slightly Bauer-positive, I think this indicates a low polysaccharide content linked to a basic protein. I would suggest it is a glycoprotein, as defined by Meyer[3], on account of its low carbohydrate content.

A more detailed account will be published elsewhere.

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## Side-Chain Orientation in Fibrous Proteins

THE specific properties of proteins depend to a large extent upon the composition and arrangement of their side-chains, and a good deal of information has been accumulated recently on the amino-acid sequences of various proteins. Very little is known, however, of the stereochemistry of the side-chain residues and the relations between side-chain configuration and orientation and the specific properties they confer on proteins. This is largely due to the lack of direct evidence, since X-ray diffraction diagrams obtained from fibrous proteins emphasize only the similarities between the configuration of the polypeptide backbone chain, while the very much richer diffraction patterns obtained from crystalline globular proteins have, as yet, only been interpreted in very general terms[1].

In view of the paucity of information concerning side-chain orientation, Elliott's deduction[2] of a marked preference for the side-chain amide groups in crystalline ribonuclease to orient, with the HH direction parallel to the *b* crystallographic axis, is important because of the very direct nature of the experimental evidence. The preferred orientation was deduced from the dichroism exhibited by an absorption band about 5,050 cm.$^{-1}$ in the infra-red spectrum in which the associated transition moment was assumed to be parallel to the HH direction. Elliott also showed[3] that in the spectrum of horse hair dried *in vacuo* an incompletely resolved band near this frequency was dichroic, but precise observation was hampered by an overlapping absorption band about 5,150 cm.$^{-1}$ due to residual water in the specimen.

It has been found that the 5,150 cm.$^{-1}$ absorption band can be completely eliminated from the spectra of fibrous proteins by drying at 105° C. for three hours, thus enabling the 5,050 cm.$^{-1}$ absorption band to be studied in some detail. Fig. 1 shows the spectra of Lincoln wool, silk fibroin, gliadin and human hair extended 90 per cent in steam all dried in the above manner and immersed in hexachlorobutadiene. The assignment of the 5,050 cm.$^{-1}$ band to side-chain amide groups is confirmed by its relative prominence in silk, wool and gliadin, which is in accord with the amide nitrogen contents of the specimens used. Expressed as percentages of the total nitrogen, these were 1·2, 6·8 and 24·2 respectively[4].

The strong perpendicular dichroism of the side-chain amide band in wool, which is also found in unstretched hair, indicates a marked tendency for the $-CONH_2$ groups to be oriented with the line joining the two hydrogen atoms perpendicular to the fibre axis, and this is depicted diagrammatically in Fig. 2. The orientation about the HH line cannot be fixed by this observation alone; but that shown in Fig. 2 would be particularly important in establishing intermolecular hydrogen bonds. In addition, this orientation would appear to permit the formation of hydrogen bonds to the side-chains of two neighbouring polypeptide chains through the agency of a single amide group.

In hair that has been extended 90 per cent in steam the dichroism of the side-chain amide band vanishes, even though the neighbouring peptide absorption band shows considerable dichroism. The loss of dichroism could be due to a re-orientation of the amide group such that the direction of the transition moment is inclined at about 55° to the fibre axis[5]; but it seems more likely to be due to a random orientation of the HH direction in the extended condition.

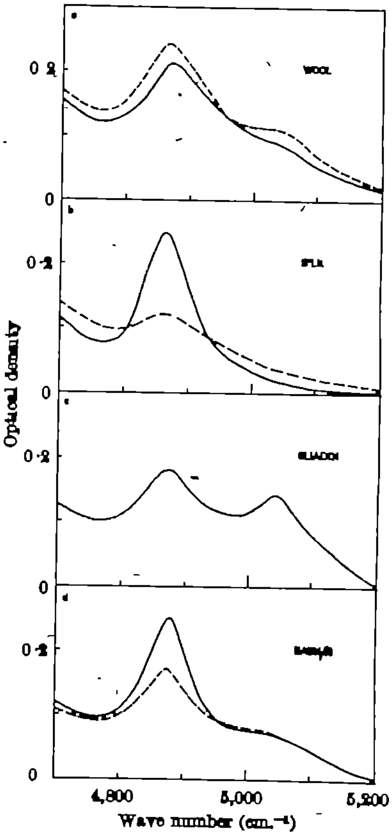

Fig. 1. Infra-red spectra obtained from (*a*) Lincoln wool fibres, (*b*) silk fibroin, (*c*) powdered gliadin and (*d*) human hair stretched 90 per cent in steam. In each case the specimen was dried at 105° C. for 3 hr., to reveal the side-chain amide absorption c. 5,050 cm.$^{-1}$. In *a*, *b* and *d*, the full curve was obtained with the electric vector vibrating parallel to the fibre axis and the broken curve with the electric vector perpendicular

Additional information on the site of the amide side-chains was obtained by allowing oven-dry wool to react with deuterium oxide. The replacement of hydrogen by deuterium causes a considerable reduction in frequency of vibrations involving hydrogen atoms, thus indicating the accessibility of particular groups to deuterium oxide[6]. After 16 hr. immersion at 20° C. the optical density of the peptide band at 4,870 cm.$^{-1}$ was reduced to about one-half of its original value, while the amide band was no longer detectable.

It has been assumed that the fraction inaccessible to deuterium oxide is crystalline, and this forms the basis of a method of determining the crystallinity of wool[7]. If this is correct, the side-chain amide groups

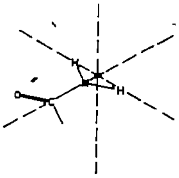

Fig. 2. The relation between the direction of the fibre axis and that of a line joining the two hydrogen atoms of the side-chain amide groups in wool and hair deduced from the perpendicular dichroism of the 5,050 cm.$^{-1}$ absorption band

ust be concentrated in the amorphous regions of the ibre but at points where there is considerable preerred orientation of the molecular chains parallel to he fibre axis.

It is implicitly assumed, in the above method of etermining crystallinity, that there is a uniform istribution of side-chains throughout the crystalline nd amorphous regions. In view of the complete xchange of the amide groups, this assumption does ot appear to be valid and the values of crystallinity btained by this method are probably too low.

Alternatively, it might be argued that amide roups are present in the crystalline regions but are ccessible to deuterium oxide, and this would be onsistent with the infra-red measurements. In this ase the basis of the deuterium exchange method of etermining crystallinity would then be invalidated.

Of the two interpretations the former is the more ttractive, as the amide-containing side-chains are elatively bulky and might be expected, from recent ork on silk[8], to be concentrated in the amorphous egions.

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## Reverse-Shearing Interferometry

THE introduction of the shearing principle in the xamination of optical wave-fronts by interferometry[1] as led to a great simplification of the apparatus equired. Recent developments[2,3] have made possible he construction of compact portable interferometers r the examination of optical systems of large size, nd several instruments are now available from ptical manufacturers. For some purposes, however, is possible to use as a shearing interferometer an ven simpler system which is already in wide use for nother purpose. This is the square prism used in hotometry for dividing a beam of light into two. is composed of two similar right-angled prisms emented at their hypotenuse faces after one face as been coated with a semi-reflecting film. An pplication of this prism to the interferometry of ngth was first described by Kösters[4], but the rism is also very useful as a shearing interferometer.

Two alternative arrangements may be used if the ystem is a reflecting one; these are shown in ig. 1. The source $S$ may be the filament of a small ashlamp bulb, or an illuminated pinhole; in some ases the reflexion of a distant window or lamp in e convex surface of a steel ball will provide a suitble source. The system shown is a concave mirror, , arranged so that the light from $S$ which emerges om the prism is reflected back into the prism. The iginal beam is split into two at the interface during e passage through the prism, and each of these parts split again in the prism after reflexion at the system der test. Thus four beams finally emerge from the prism. Two are directed towards the source $S$, and the position of $M$ is adjusted until they both produce an image of $S$ coincident with $S$. Then the remaining two beams will form two more images of $S$, which coincide, at $S'$. If the eye is placed at $S'$ looking into the prism, two images of the aperture of $M$ are seen. One of these images is a mirror image of the other, and the region in which they overlap is crossed by interference bands. The overlap of the images may be controlled by rotating the prism, and the separation of the bands may be altered by tilting $M$.

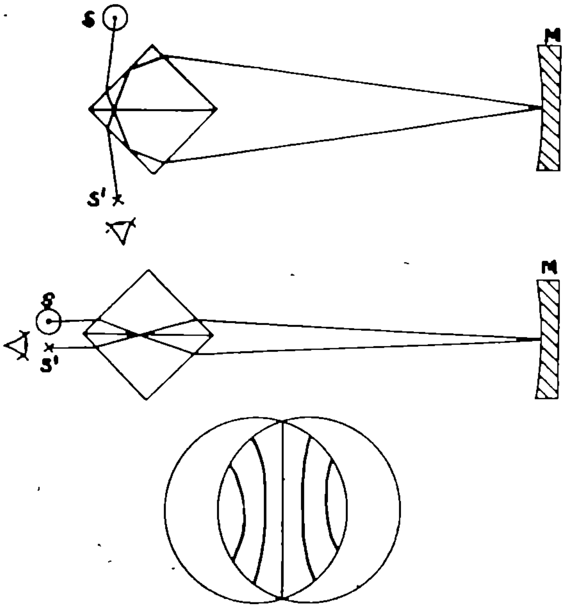

Fig. 1. Two alternative arrangements for using a beam-splitting prism as a shearing interferometer, and an example of a pattern produced by a system with 0 25 wave-length of primary spherical aberration

Systems such as camera lenses, which do not reflect, can be examined by using a second beam-splitting prism to recombine the two beams produced by the first prism; but it is simpler and gives a more sensitive test of aberration to place a mirror behind the lens and to treat the lens and mirror combination as a reflecting system.

When the two images of the aperture of the system appear to coincide (zero shear) the bands should be quite straight. Any lack of straightness shows a lack of mirror symmetry in the wave-front after reflexion at $M$. If the test is repeated for a few meridians, and the bands remain straight in all cases, the surface of $M$ must be a surface of revolution, and Bates's[1] procedure for the analysis of the interferograms obtained by shearing the apertures may be followed. Further, the pattern which is obtained from a reverse-shearing interferometer will be exactly the same as one which could be obtained from a non-reversing interferometer with the same shear.

The main disadvantage in the use of this prism is common to all 'solid' interferometers, and arises from the difficulty of adjusting the band separation in a direction at right angles to the direction of shear. On the other hand, the compactness of the system is noteworthy, and the interferometer remains sensitive to comatic error at zero shear, when all symmetrical aberrations have no effect on the pattern. This latter property has been investigated in more detail and will be reported elsewhere[5].

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this communication is published by permission of the Director of the Laboratory.

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March 24.

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## Embrittlement of Tungsten Wire

THE embrittlement of tungsten wire heaters for oxide cathodes has been a frequent source of trouble to the vacuum-tube engineer. The trouble has persisted despite the many technological advances made in the manufacture of the wire and in its subsequent handling.

In the processing of a heater the wire is coated with a refractory oxide (normally alumina) and the coating fired to hardness in an atmosphere of wet hydrogen at a temperature usually above 1,500° C. It is customary to test the quality of a batch of wire by submitting it to firing tests under somewhat more exacting conditions (of temperature and time) than would be met in normal processing: the singular feature of the type of embrittlement to which we refer is that it frequently occurs in heaters made from wire which on such firing tests has appeared to be of excellent quality.

The purpose of this communication is to direct attention to what is, we believe, one of the major causes of such embrittlement, namely, surface contamination of the tungsten by nickel. We have found that very slight traces of nickel on the tungsten surface can cause embrittlement. The amount of nickel which is significant is extremely small: a film of the order of 10 A. thick on the surface of otherwise good-quality wire can make that wire so brittle that it cannot be handled, and even smaller amounts can materially impair ductility.

Such traces of nickel are readily picked up on the surface of a heater during the normal processes of manufacture. Making use of electrographic techniques, we have found nickel contamination in damaging quantities to arise from such practices as bending the wire around a nickel former, or winding it over nickel rollers or on to nickel-alloy spools. Spot welding of an uncoated heater to nickel wire can splash embrittling quantities of nickel on to the tungsten in patches as far as two inches from the weld.

On heating contaminated wire there is rapid diffusion of the nickel into the tungsten; when this diffusion occurs the wire is embrittled (brittleness is not apparent at temperatures below about 1,200° C.); but if the contaminated surface of the tungsten can be removed before being heat treated, so that no diffusion of nickel takes place, the wire is undamaged.

Work is proceeding to ascertain whether or not the related elements, iron and cobalt, exhibit similar embrittling properties. Preliminary indications are that both metals do so—iron only slightly, and cobalt to a lesser extent than nickel.

We cannot yet offer a theoretical explanation o these phenomena.

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## Large Type II Diamonds

IN an article on "The Problem of the Two Type of Diamond" by Prof. G. B. B. M. Sutherland, D. E Blackwell and W. G. Simeral[1], it is remarked tha "in our experience all large diamonds of gem-ston quality are always type I diamonds". Actually the four largest and finest diamonds we have com across at the Diamond Research Laboratory sinc 1951 were all of type II. Some details are given i Table 1.

Table 1

| Type | Weight in carats | Colour | Origin | Transmittance in ultra-violet | Laminations | Lit. reference |
|---|---|---|---|---|---|---|
| II | 34½ | Pure white | Premier Mine | Down to 2250 A. | Present | *Research*, 4, 131 (1951) |
| IIb | 66 | Pure white | Premier Mine | Down to 2750 A., and probably shorter | Present | *Physica*, 18, 489 (1952) |
| IIa | 160 | Pure white | S.W. Africa | Down to 2375 A. | Present | Laboratory Report No. 94, May 1, 1951 *Gems and Gemmology*, 7, 275 and 287 (1953) |
| IIb | 426½ | Pure white | Premier Mine | Down to 2375 A. | Present | *J. Gemmology*, 4, 300 (1954) |

The difference between types IIa and IIb is tha IIa is an excellent insulator for electricity whereas II is a temperature-sensitive semiconductor. Type II shows, moreover, a green-blue phosphorescence afte having been irradiated with short-wave ultra-viole (resonance line of mercury, about 2536 A.) wherea type IIa does not. None of the diamonds of Table fluoresces in the near ultra-violet, that is, abou 3650 A. At the time when the 34½ carat diamon was examined, the existence of type IIb diamond was still unknown.

The diamonds of Table 1 are all of the finest gem quality, and it is my firm opinion that nearly a the larger gem stones belong to this category. How ever, it is true that not one of the larger gem diamond shows a regular crystal form. Quite a few of the show not only growth triangles but also growt figures of a hexagonal shape.

Finally, it is worth while mentioning that th Premier Mine produces a very much higher percentag of type II diamonds than any other mine.

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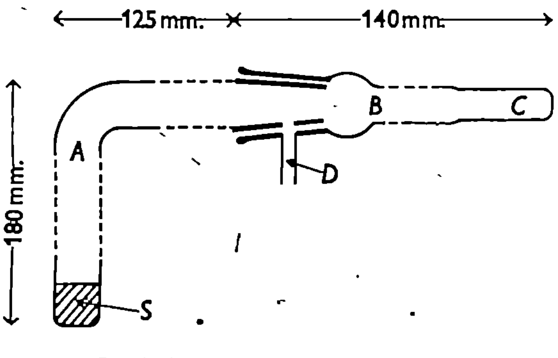
## Effect of Ionizing Radiation on Hæmoglobin and Cytochrome c

THE study of the oxygen-effect in ionizing radiation may elucidate the part which indirect effects play in inhibiting biological cell functions through the action of oxidizing radicals and hydrogen atoms, which are formed from water. In continuation of previous work[1] the following substances have been exposed to X-rays: oxyhæmoglobin ($HbO_2$) in air, hæmoglobin (Hb) in nitrogen, methæmoglobin (Methb) in air and in nitrogen, reduced and oxidized cytochrome c in air and in nitrogen. The concentration of hæmoglobin in phosphate buffer pH 6·0) varied between $1·3 \times 10^{-4}$ and $3·2 \times 10^{-4}$ M and that of cytochrome c (in phosphate buffer pH 7·3) between 0·8 and $2·0 \times 10^{-5}$ M. The X-ray dose varied between 0·8 and 75·0 kr. (190 kVp., no added filtration, dose-rate 1·8 kr./min.). Changes in absorption spectra of the substances examined, which were measured spectrophotometrically, were a measure of the irradiation effect.

The spectra after irradiation were found to be unstable and to alter with time, especially with samples irradiated in nitrogen. This was due to the fact that the irradiated substances had become easily oxidizable, and was most pronounced with cytochrome c. In order, therefore, to prevent changes of the spectra which, although induced by radiation, occurred only subsequent to irradiation, they had either to be fixed in the state obtaining at the end of the irradiation procedure, or oxygen had to be excluded during measurement. The former was done with hæmoglobin by means of carbon monoxide, which combines with the reduced form and prevents further oxidation by molecular oxygen. Reduced cytochrome c, on the other hand, which does not combine with carbon monoxide, cannot be so protected. Experiments with cytochrome c were therefore carried out in a special tube (Fig. 1), which allows irradiation and spectrophotometric measurement to be carried out without exposing the irradiated sample to air.

The design of the tube, which can be evacuated and filled with nitrogen, is self-explanatory. The sample S is irradiated in A and then tipped through B into the optical cell C (which is protected by lead during irradiation). Parts A and B are separated from each other while nitrogen under pressure is applied through D, and B is closed with a ground-in glass stopper. An adaptor to the spectrophotometer, which excludes the light, allows the spectrum to be measured in the ordinary way. The results obtained are briefly as follows.



1. Combined irradiation- and spectrophotometry-tube

(1) *Hæmoglobin.* The primary change depends on the initial state of the material, that is, whether it is oxidized or reduced, and is independent of the presence of oxygen. Thus hæmoglobin becomes oxidized and methæmoglobin becomes reduced. The oxidation of oxyhæmoglobin in air and of hæmoglobin in nitrogen is of about the same order, while reduction of methæmoglobin is greater in nitrogen than in air. The rate of oxidation or reduction increases with increasing X-ray dose; conversely, at a given dose, it increases with decreasing concentration of hæmoglobin. Oxidation or reduction, however, is in neither case directly proportional to the X-ray dose, because of the occurrence of secondary reactions. Thus, for example, methæmoglobin, which becomes reduced during irradiation in nitrogen (presumably by hydrogen atoms), is re-oxidized (presumably by hydroxyl radicals). Moreover, it is not re-oxidized to methæmoglobin but to a green pigment showing a strong band at 615 mμ. The rate of this secondary oxidation is greater in nitrogen than in air, and in both cases it is the greater the lower the concentration of hæmoglobin.

(2) *Cytochrome c.* Like hæmoglobin, ferrocytochrome becomes oxidized both on irradiation in air and in nitrogen—the rate of oxidation being greater in air—and ferricytochrome becomes reduced on irradiation in nitrogen. Unlike hæmoglobin, on the other hand, ferricytochrome does not appear to be affected by irradiation in air at doses up to 35 kr. (denaturation of the protein at high X-ray doses is outside the scope of this work). There is, furthermore, no formation of a green pigment from either ferri- or ferro-cytochrome during or after irradiation in air, nor during irradiation in nitrogen. However, cytochrome irradiated in nitrogen turns rapidly green on admission of oxygen after irradiation. This occurs irrespective of whether the sample had been partially oxidized or reduced during irradiation, and is accompanied by the disappearance of the band of ferrocytochrome at 550 mμ and the appearance of a new band at about 600 mμ. Failure to observe anaerobically irradiated cytochrome without exposing it to molecular oxygen had previously led to the statement[2] that no difference exists between aerobically and anaerobically irradiated ferrocytochrome. This was coupled with theoretical considerations concerning the oxygen effect, which are now no longer tenable.

The catalytic activity of irradiated cytochrome c was finally tested by determining the rate at which it catalyses the oxidation of sodium succinate in an enzymic system (horse kidney preparation) which is otherwise practically devoid of cytochrome c[3]. After a dose of 36 kr. in air, the rate of succinic oxidation was decreased by only 15 per cent, which is accounted for by destruction of the cytochrome (as calculated from the absorption at 550 mμ after addition of sodium hyposulphite). When applying the same dose in nitrogen, the loss of catalytic activity was slightly larger, namely, 35 per cent. It is believed that this additional loss of activity is due to the fraction of cytochrome which had been irreversibly oxidized to a green pigment on admission of oxygen after the irradiation.

The experiments thus show that, while the initial reaction brought about by ionizing radiation is mainly dependent on the state of the material and its ability to react with either oxidizing or reducing agents independently of the presence of oxygen, the initial reaction product may undergo secondary, or even a series of further, changes during irradiation or, as with cytochrome *c*, after irradiation on admission of oxygen to an anaerobically irradiated sample.

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## Paper Electrophoresis of Polyhydric Alcohols

The polyhydric alcohols or polyols are a group of carbohydrates important both biologically and industrially. Apart from laborious column techniques[1], there is no satisfactory micro-method available for the resolution of mixtures of hexitols (sugar alcohols) by themselves or, in particular, in the presence of hexoses.

Several workers[2] have reported on the application of paper chromatography to this problem but have stated that they found the separation of sorbitol, mannitol and dulcitol from one another and from glucose impossible, since their $R_F$ values in a great number of different solvent systems were practically identical. Cassmir and Huygens[3] reported recently that they succeeded in separating sorbitol from some simple sugars by running multiple two-dimensional chromatograms or one-dimensional chromatograms for 150 hours with butanol–benzene–pyridine–water (5 : 1 : 3 : 3)[4] as the solvent system. With a different solvent the separation of sorbitol from mannitol was possible in the same time, but neither sorbitol nor mannitol could be separated from dulcitol.

Michl[5] described the separation by paper electrophoresis of three polyols of widely differing mobilities, namely, ethylene glycol, glycerol and mannitol.

The application of the author's high-voltage technique[6] to the resolution of mixtures of polyols and sugars as sugar-borate complexes proved it to be a powerful tool, even in cases of small differences in mobilities, for example, mannitol and glucose, or sorbitol and fructose. Fig. 1 illustrates some of the results obtained.

*A* shows the clean separation of the three hexitols from one another and the tetritol (erythritol) in three hours at 2,000 V. in 0·05 *M* borate buffer of *p*H 9·2; *B* shows the result obtained by doubling the voltage and reducing the time to one-half. Agreement is quite good with regard to the directly proportional relationship between migration-rates and applied potential gradients. The slight displacement of the two erythritol spots is an effect occasionally noticed, the course of which is suspected to be uneven pressure exerted on the paper strip by the cooling plates, and is at present under investigation. The application of such high potential gradients as 80 V./cm. and current values of up to 10 m.amp./cm. proved to be feasible, although entailing an energy dissipation of up to 200 watts. The temperature of the cooling water (tap water) is significant in this case. The separation of the hexitols from the hexoses glucose, fructose, mannose and sorbose is shown in Fig. 1, *C* and *D*.

Inositol, a cyclitol, although having a slightly lower mobility than glycerol, is not easily separated from it (Fig. 1, *E*). Two important trioses, dihydroxyacetone and glyceraldehyde, though not belonging to the group of polyols, but the detectability of which in mixtures of metabolic products is highly desirable, cannot be separated because their mobilities appear to be similar. These compounds, however, can be separated by paper chromatography using the solvent system *n*-propanol : water : ethyl acetate (7 : 2 : 1)[7] in less than thirty hours, while the separation of adonitol from sorbitol (Fig. 1, *F*) can be achieved in forty hours. The difference between the slightly lower mobility of adonitol, a pentitol, and that of the nearest hexitol, sorbitol, is not sufficient to enable an electrophoretic separation to be effected. Of further interest in Fig. 1, *F* is the great difference in migration-rates between penta-erythritol, carrying no charge, and erythritol. The spreading of the penta-erythritol spot is obviously due to the nature of the compound. Lead tetra-acetate in benzene, according to Buchanan

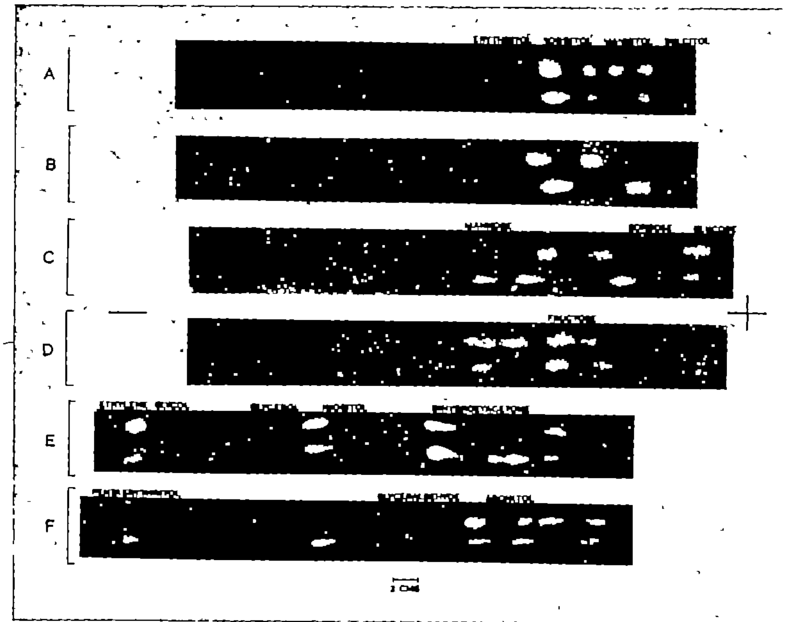

Fig. 1. Electrophoresis of polyhydric alcohols. From left to right. *A*, meso-erythritol, D-sorbitol, D-mannitol, dulcitol; conditions: 40 V./cm., 3 8 m.amp./cm., Whatman No. 3 *MM* 2½ × 22½ in. strip, 0 05 *M* sodium borate solution, *p*H 9 2, 10 μgm. of each compound, except for 20 μgm. of erythritol, applied 4 in. from cathode end, 3 hr.; *B*, erythritol; sorbitol, mannitol; conditions: 80 V./cm., 6 5 m.amp./cm., 20 μgm. of each compound, 1·5 hr., otherwise the same; *C*, mannose, erythritol, sorbitol, mannitol, glucose, sorbose; conditions: 80 V./cm., 8 5 m.amp./cm. 30 μgm. of mannose, 40 μgm. of sorbose and glucose, 1 5 hr.; *D*, mannose, erythritol, sorbitol, mannitol, fructose, sorbose, glucose; 40 V./cm., 3·4 m.amp./cm. 10 μgm. of fructose, 2·5 hr.; *E*, ethylene glycol, glycerol, meso-inositol, dihydroxyacetone, erythritol, sorbitol, mannitol, dulcitol; 80 V./cm., 7 7 m.amp./cm. 50 μgm. of ethylene glycol, 20 μgm. of glycerol, 1 hr.; *F*, penta-erythritol, ethylene glycol, glycerol, erythritol, DL-glyceraldehyde, adonitol, sorbitol, dulcitol; 80 V./cm., 10 m.amp./cm., 80 μgm. of penta-erythritol, 1 25 hr.; spraying reagent: 1 per cent solution of lead tetra-acetate in benzene, giving white spots on brown background

*al.*[3], was found to be the most suitable spraying agent, and was used throughout, as it did not pear to be inhibited by the presence of borate ions, contrast to silver nitrate. Good results have also en obtained with the separations of the glycols and eir derivatives.

Thanks are due to Mr. H. C. S. de Whalley, director research, for encouragement, and the directors of ate and Lyle, Ltd., for permission to publish this mmunication.

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## The Huxley-Wilberforce Debate: a Postscript

THE famous occasion when T. H. Huxley crossed vords with Samuel Wilberforce, at the 1860 Oxford eeting of the British Association, has been often scribed; and recently D. J. Foskett has published[1] uxley's contemporary account of the encounter. here has recently come to light the draft (in a box e in the basement of the Zoology Department of e Imperial College of Science and Technology) of a te sent by Huxley to Wilberforce early in 1861, follows:

> The Athenaeum.
> *Jany 3rd*, 1861.
>
> Professor Huxley presents his compliments to the rd Bishop of Oxford—Believing that his Lordship has great an interest in the ascertainment of the truth as mself, Professor Huxley ventures to draw the attention the Bishop to a paper in the accompanying number the *Natural History Review* "On the Zoological Rela- ons of Man with the Lower Animals".
>
> The Bishop of Oxford will find therein full justification r the diametrical contradiction with which he heard of. Huxley meet certain anatomical statements put rth at the first meeting of Section D, during the late sion of the British Association at Oxford.

Unfortunately, we do not have Wilberforce's reply if any were sent—to this polite but delicately rbed note.

The *Natural History Review* had been taken over Huxley and some friends for publication in gland, having earlier been published in Ireland der the editorship of Edward Perceval Wright, d it was the first number under the new manage- ent which was sent to Wilberforce. "The tone of e Review", Huxley had told Hooker[2], "will be mildly episcopophagous"—a prospect which apparently outweighed the urgings of Darwin[3], Hooker[4] and Lyell[5] that Huxley should not take upon his already heavily burdened shoulders this new editorial duty. Before long, the substance of Huxley's paper was being given in more popular form, as six lectures to working men at the School of Mines in Jermyn Street, under the title "On the Relations of Man to the rest of the Anl. Kingdom"[6]; and after a few lectures Huxley was writing to his wife[7], "My working men stick by me wonderfully, the house being fuller than ever last night. By next Friday evening they will all be convinced that they are monkeys".

The publication of these working-men's lectures in the *Natural History Review* led to an invitation to cover the same ground before the Edinburgh Philosophical Institute. "Fancy unco guid Edinburgh requiring illumination on the subject!" Huxley wrote[8] to his wife. "They know my views, so if they do not like what I shall have to tell them, it is their own fault". Darwin's diplomatic ambiguity, "Light will be thrown on the origin and the history of man", was not for Huxley; as he put it to Hooker[9], "I told them in so many words that I entertain no doubt of the origin of man from the same stock as the apes". On reading an account of the lectures, Darwin wrote[10] jubilantly, "By Jove you have attacked Bigotry in its strong-hold. I thought you would have been mobbed"; and Lyell[11] urged Huxley to tone down some of the passages when he came to publish his little book, "Evidences as to Man's Place in Nature". Huxley accepted some of Lyell's suggestions, but[12] he found it "a great piece of self-denial . . . and I hope I shall be rewarded for the virtue". As he saw more of the proofs, Lyell became really alarmed and wrote[13], "if the worst is in sheets not yet thrown off do let me see it that I may try & suggest something of the suaviter in modo—", adding as a monitory postscript, "I hope you send none of these *dangerous* sheets to press without Mrs. Huxley's imprimatur". However, the book went to press and was a great success. As Huxley wrote to Lord Rosebery some thirty years later[14], "abuse for six or seven years . . . is not of the greatest consequence, when one happens to be in the right & stands to one's guns. But you really cannot imagine what a disreputable person the author of M.P. in N. was in the decade 1860–70—and now the doctrines of that horrid book are taught in the schools".

Grateful acknowledgment is made to the Governing Body of the Imperial College of Science and Technology for permission to quote from the Huxley Papers in its possession.

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[1] *Nature*, 172, 920 (1953).

[2] "Huxley Papers", 2, 67 (July 17, 1860).

[3] "Huxley Papers", 5, 125 (July 20, 1860).

[4] "Huxley Papers", 2, 119 (July 18, 1860).

[5] Lyell, Mrs., "The Life, Letters and Journals of Sir Charles Lyell", 2, 366 (Murray, London, 1881).

[6] "Huxley Papers", Diary, February 21. 1861

[7] Huxley, Leonard, "The Life and Letters of Thomas Henry Huxley", 1, 190; March 22, 1861 (Macmillan, London)

[8] Huxley, Leonard, "The Life and Letters of Thomas Henry Huxley" 1, 192; April 10, 1861 (Macmillan, London).

[9] "Huxley Papers", 2, 112 (January 16, 1862).

[10] "Huxley Papers", 5, 167 (January 14, 1862).

[11] "Huxley Papers", 6, 66 (August 9, 1862).

[12] "Huxley Papers", 30, 41 (August 17, 1862).

[13] "Huxley Papers", 6, 70 (October 1862).

[14] "Huxley Papers" 24, 218 (June 2, 1894).

# FORTHCOMING EVENT

## Saturday, August 27—Friday, September 2

Institute of Medical Laboratory Technology (at the University, Nottingham)—Seventh Triennial Conference.

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Advisory Officer (with an honours degree in agriculture or pure science, and a special interest in grassland work) in Agricultural Botany—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (August 27).

Assistant, Grade B (with a good honours degree in chemistry, and preferably with teaching experience) to teach chemistry of the standard of intermediate science—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (August 27).

Assistant, Grade B (graduate in electrical engineering or with equivalent professional qualifications and appropriate industrial experience, and preferably with experience in the U.H.F. field) in Electrical Engineering—The Registrar, Hatfield Technical College, Roe Green, Hatfield (August 27).

Research Assistant in Pharmacology—The Registrar and Secretary, The University, Bristol (August 27)

Senior Research Student in either Engineering or Metallurgy—The Registrar, University College, Singleton Park, Swansea (August 27).

Senior Research Officer (with a degree in mathematics or one of the natural sciences, and preferably with experience of planning and conducting surveys) to work as one of a team establishing data on which design may be based, with particular responsibilities in the field of studying functional requirements of laboratory and agricultural buildings—The Director, The Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1 (August 31).

Assistant Experimental Officer (with a degree in botany or an allied biological science) in the Department of Plant Breeding, to assist with cytological studies of horticultural crops—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (September 3).

Soil Conservation Officers (graduates in agriculture or agricultural engineering) in the Federal Department of Conservation and Extension, Federation of Rhodesia and Nyasaland—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (September 6).

Lecturer in the Department of Electrical Power Engineering and a Lecturer in the Department of Electronic Engineering—The Registrar, The University, Liverpool (September 10).

Assistant Plant Nutrition Chemist (with a degree in science or chemistry, preferably with honours)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (September 12).

Lecturer in Biology at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Adelaide, September 15).

Lecturer (preferably with special qualifications in organic chemistry) in Chemistry—The Secretary and Registrar, University College of North Wales, Bangor, North Wales (September 15).

Scientific Assistant (M.R.C.V.S. or its equivalent; or a degree in science or in arts, and a knowledge of languages)—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, Weybridge, Surrey (September 15).

Reader in Applied Mathematics at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C 1 (September 21).

Lecturer in Physical Geography at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C 1 (Australia, September 24).

Senior Lecturer in Civil Engineering (Hydraulics), and Senior Lecturer in Civil Engineering at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C 1 (Australia, September 30).

Lecturer in Economic Statistics—The Secretary of Faculties, University Registry, Oxford (October 1).

Assistant, Grade B (with graduate or A.R.I.C. qualifications) in Chemistry—The Principal, Technical College, Queen Street South, Huddersfield.

Assistant Statistician (with a degree in mathematics with statistics or equivalent qualifications, and preferably with an interest in the use of punched-card machines and electronic computing equipment) in the Department of Statistics, to carry out the more advanced type of statistical computations and to supervise the routine statistical work of the computing staff of the Department—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Computer (preferably woman graduate) in the Mathematics Department—The Assistant Secretary, University College, Gower Street, London, W.C.1.

Head of the Department of Chemistry (including Colour Chemistry and Dyeing)—The Principal, Technical College, Queen Street South, Huddersfield.

Laboratory Assistant in the Physics Department—The Bursar, Epsom College, Surrey.

Metallurgist (with a first- or second-class honours degree or equivalent qualification in metallurgy, and several years research experience on non-ferrous metals, preferably including copper and aluminium alloys) at the Ministry of Supply Armament Research and Development Establishment, near Sevenoaks, Kent, for research and development in the field of non-ferrous metallurgy—The Ministry of Lab[redacted] National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.606/5A.

Physicist, Basic grade (honours graduate in physics and interest in a career in medical physics, and preferably with a specialized kno ledge in one of the following fields: electronics, physical chemist radiology)—The Medical Superintendent, Dundee Royal Infirmar Dundee.

Physicist (with experience of electronic techniques) in the Da Faraday Research Laboratory of the Royal Institution, to carry o research on methods of dating archaeological material by means radio-carbon measurements—Sir Lawrence Bragg, F.R.S., The Ro Institution, 21 Albemarle Street, London, W.1.

Physicists (Scientific Officer and Experimental Officer class) the Reactor Physics Division, to study the physical princip underlying a wide variety of nuclear reactors—The Establishme Officer, United Kingdom Atomic Energy Authority, Atomic Ener Research Establishment, Harwell, Didcot, Berks, quoting 2/103/3

Physicists (with an honours degree in physics, Associates of t Institute of Physics, or equivalent qualifications) at Windscale Wor Cumberland (Ref. 1,063), and Dounreay Works, Caithness, Scotla (Ref. 1,064), to be responsible to Group Managers for the efficie operation of the Health Physics and Safety Groups—The Recruitme Officer, United Kingdom Atomic Energy Authority, Industrial Gro Headquarters, Risley, near Warrington, quoting appropriate Ref. N

Research Assistant (graduate in chemistry and preferably interest in, or experience in, physical and colloid chemical techniqu in the Department of Chemistry and Food Technology, for wo on fats or allied substances (phospholipids)—The Secretary, Borou Polytechnic, Borough Road, London, S.E.1.

Senior Experimental Officer (with at least H.S.C. in scien subjects or equivalent qualifications, and experience in inorganic a radiochemical analysis) in the Chemical Engineering Divis to supervise and train staff engaged on analytical problems associat with pilot plant operation—The Establishment Officer, United Kin dom Atomic Energy Authority, Atomic Energy Research Establi ment, Harwell, Didcot, Berks, quoting 2/103/301.

Theoretical Physicist (Principle or Senior Scientific Officer gra (with a first- or second-class honours degree in physics and at le three years postgraduate research experience, preferably in the fi of motion and coagulation of particulate suspensions), to work problems of size distribution in coagulating and dispersing particul suspensions—The Senior Recruitment Officer, Atomic Weapo Research Establishment, Aldermaston, Berks, quoting 726/34.

Zoologist (Senior Scientific Officer or Scientific Officer grad (university graduate with first- or second-class honours), for gene and experimental work on marine plankton—The Director, Mari Station, Millport, Isle of Cumbrae, Scotland.

# REPORTS and other PUBLICATION

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# SCIENTIFIC MAN-POWER IN BRITAIN AND ITS UTILIZATION

THE eighth annual report of the Advisory Council on Scientific Policy, covering the year April 1954–March 1955 (Cmd. 9537. London: H.M.S.O. 4*d.* net) does not, like the previous report, range over the whole field of the Council's work. It discusses five topics; but with the exception of one, the Institute of Seaweed Research, they are all inter-related, and essentially the report is a statement of the Council's views on the nation's resources and the deployment of scientific man-power, to which theme the whole of its fifth report was devoted. Indeed, the Council's inquiry as to whether further research work on seaweed should be encouraged at the Institute of Seaweed Research, and if not, what use could be made of the staff and facilities of the Institute, has also clearly been dominated by considerations of the present shortage of skilled research workers in Britain. This particular inquiry was undertaken at the request of the Development Commission, and the Biology Committee of the Council, while satisfied as to the value of the results obtained and the competence with which the work had been carried out, recommended that experimental work on the mechanical harvesting and drying of seaweed should be terminated, and other arrangements made for the continuation of research on algal chemistry. Research was already advanced far enough to permit reasonably rapid exploitation of seaweed if need arises, but earlier hopes that alginates would serve as a technically and economically desirable source of chemicals have been disappointed. The Committee could suggest no other major subject of research for which the Institute, as constituted, seemed specially suited, and in endorsing these conclusions the Council observes that an Institute with a wider field of interest, or one which forms part of a large research organization, is better adapted to divert its effort into fresh channels when experience indicates that this is desirable.

This comment is sound enough as applied to institutions mainly supported by the State, at least in present circumstances, and it emphasizes the importance of the continuing and periodical review of the work and functions of existing research institutions in relation to national needs. But it also emphasizes the importance of the independent research institution, which can afford to explore lines of investigation not sufficiently promising to justify State support. Again and again such independent bodies have proved the growing points of scientific achievement, and the corollary of any tightening of central control of the work of the State's own research institutions should be a generous and enlightened attitude to the independent institutions able to cover the gaps.

Thus this minor and particular inquiry points to the same need for an imaginative and enterprising direction at the centre, in order that the man-power resources of Britain may be wisely and most efficiently deployed, as does the Advisory Council's examination of the further problems of science teachers and scientific man-power, recruitment to the engineering industry, Colonial research and scientific libraries. On the second topic, its comment is indeed reserved. An inquiry conducted by the Council's Scientific Man-Power Committee revealed considerable differences of opinion within the engineering industry both as to the effect of university expansion on the recruitment of apprentices and as to the value to industry of certain forms of postgraduate work in engineering at the universities. The Council is examining in further detail the issues involved and hopes to report on them later in the year.

Meanwhile, it is sufficient to note that the Advisory Council has already emphasized the important bearing of these matter on educational policy, with which the question of the shortage of science teachers is as closely related as it is with the scientific man-power situation. On that subject the Council's analysis is not, of course, so deep as that of Sir Edward Appleton's committee, although the latter was concerned only with the supply of teachers of science and mathematics in Scotland. The Advisory Council's review, however, is set in a wider context and in itself demonstrates the futility of attempting to deal with problems on departmental lines. The issues and implications are too serious for the shaping of educational policy and scientific policy to be scattered over unrelated departments without a far more determined and imaginative effort at Cabinet level to devise a policy consistent with national needs than has yet been apparent.

The Advisory Council appears to be aware of this, though it might have expressed the matter more forcefully. It recognizes the danger arising if the number of students now graduating in science and mathematics, though more than twice that in 1939, continues to fall short of the current demand for scientists, still less to keep pace with the steady increase in demand. The scale of the scientific effort of Britain, which depends on the numbers and quality of the trained scientists and technologists available, conditions both the effectiveness of the national economy and the security of our defence. Nor can the universities and the colleges of technology play their part unless there is an adequate flow to them of boys and girls who have been introduced to science by teachers capable of revealing its attractions and interests and the careers to which it may lead.

Hence follows the seriousness of the decline in quality of newly recruited science teachers since the War, and of the threatened more serious shortage unless the rate of recruitment rises as the secondary school population increases and as more boys and girls remain at school until the age of university entrance. The latest information which has reached the Advisory Council suggests that the number of graduate science teachers in the schools has risen appreciably during the past two years. Figures quoted for England and Wales show an increase from 14,419 in 1952 to 15,335 in 1954; for maintained grammar schools, the corresponding figures are 7,659 and 7,910, the increases being fairly equal in each year in both cases.

The Advisory Council, while welcoming the acceptance by the Government of the recent proposals of the Burnham Committee, which would give increases of up to £200 per annum for senior masters, does not commit itself as to the adequacy of the proposals, beyond observing that their effect on the recruitment of science teachers should be carefully watched. The Council considers salaries to be of great importance, though this factor has its limits, and will scarcely influence either those with a definite vocation for teaching or those unprepared to consider teaching in any circumstances. Nor is its effect on others likely to be so great as that of the teacher himself on a pupil considering a career, or a widespread and imaginatively conducted campaign to influence public opinion.

For like reasons, deferment of National Service is likely to have but a limited effect in increasing the number of science graduates who take up teaching. The Advisory Council supports the recommendation of the Appleton Committee and of that appointed by the Federation of British Industries, and the Minister of Labour has since announced, on July 28, the indefinite deferment of first-class or second-class honours graduates in science and mathematics who take up teaching in a school maintained or aided by public funds. This is estimated as likely to give a further fifty or more science teachers a year, and is to be welcomed for that reason and as impressing on the country the serious national importance of the problem. It is unlikely, however, to influence many to take up teaching as a career; science graduates already have many other opportunities of finding work the national importance of which carries exemption from National Service in the military sense.

The argument for deferment derives its strength from the lessened risk of waste of man-power that it at least implies, and while the Advisory Council rightly gives no countenance to the suggestion from the Ministry of Education that over the next few years government departments and industry could reduce their recruitment of science graduates so as to increase the size of the pool from which the schools draw their science teachers, it recognizes the importance of seeing that the services of science graduates are fully and appropriately used. The suggestion runs counter, at least in the short-term, to current trends and accepted policy; for example, to the expansion of postgraduate scientific and technological education. The Advisory Council leaves industry to speak for itself in the matter, merely remarking that in general the industries of Britain are under-manned scientifically and that if industry temporarily relaxed its pressure for traine scientists it should do so only in the interests of t scientific man-power problem as a whole, and on t understanding that to do so would assure a great supply of scientists in the future.

So far as official bodies are concerned, the Advisor Council sees little possibility of any reduction in t recruitment of science graduates. It puts the numb of science graduates employed in government an allied research establishments (including the Atom Energy Authority, the research councils, the researc associations of the Department of Scientific an Industrial Research and the Service Department but excluding Service personnel) as less than 10,00 This is about half the number of graduate teache of science (including teachers at technical college and in Scottish schools, but excluding independe schools and the universities). The expansion government scientific staffs has for some time bee strictly limited, and established posts are mostly onl just sufficient to meet the responsibilities of th departments and research organizations concerne The Armed Forces may be an exception, and th Council recommends that their requirements first- and second-class honours graduates for certai posts in the Active Forces should be reviewe to see whether the qualifications demanded a justified.

That recommendation could well be more widel applied, and to a point at which it impinges eve more directly on educational policy. While in bot government departments and in industry publi policy would benefit by the wider use of men an women with scientific training and outlook i administrative positions, that should neither impl not exclude possession of a degree in science. Som economy in the use of science graduates might b secured by the use of graduates in arts, for exampl in posts where no special scientific knowledge required. This would be increasingly possible educational policy ensured that in this modern ag every university graduate acquired some unde standing of the method and achievements science.

The corollary of such recommendations, howeve is a fuller inquiry into the man-power situation. Th Advisory Council makes no reference to the impl cations, for that situation, of the development nuclear energy, of the Government's programmes f the development of rail and road transport, or of th deficiencies of some of the nationalized industries regard to research and the use of trained scientist and technologists. The figures quoted need to be s in the context of the present figures for industry including the nationalized industries as a whol having in mind the under-manning to which th Council refers, and in the light of the intake whic would be required to maintain the employment scientists and technologists even at its presen level.

The Advisory Council also considered a suggestio that the pool from which science teachers are draw might, as a short-term measure, be increased b reducing the number of science graduates who ar cepted for university postgraduate courses. Acadic leaders have in fact on other grounds questioned e desirability of accepting as postgraduate research udents those who do not show clear promise of ility as research workers, and of making postaduate research the exception rather than the rmal rule for an honours graduate. The Advisory ouncil estimates that out of 5,500 first-degree aduates in pure science (including some 500 overas students), about 1,500 men are deferred annually om military service for further university study, of hom some 250 are registered for teachers' training urses. More than half these appear to be working r a higher degree, and about one in three of first-gree science students stay on at the university for n additional two or three years. Of these, some )0 possess awards from a research council granted nder a very rigorous system of selection, and the inistry of Education works to similar standards in nsidering applications for the extension of State holarships. It is not certain, however, that the me standards are invariably applied to students ho are supported by other sources. The Advisory ouncil suggests that if the universities are not pplying over the whole field of graduate science aining the rigorous standards which now govern e postgraduate awards of the research councils and he Ministry of Education, they should be asked to onsider doing so. The Council has already asked the niversity Grants Committee to collect information s to the academic standards of those holding postraduate awards in science.

This is a sound suggestion. It will not, nor is it tended to, reduce the volume of worth-while postraduate research; though it may well eliminate ome of the more futile essays in that field. Nor will make available to the schools the best of the science raduates, or even increase the immediate supply of raduates, since those no longer deferred as research tudents would be liable for immediate National ervice. Their National Service over, however, they ould be seeking posts when the shortage of science eachers is expected to be even more acute, and some t least might become teachers.

This, like most other measures suggested by the dvisory Council, is a short-term measure. As long-erm measures the Council looks to an increase in those eading science at the universities sufficient to meet he needs of all fields of employment, though it uggests that reduction of early specialization in the chools and encouragement at the universities of the tudy of science as part of a general university ducation would greatly help. Inquiries are already n progress, it is stated, into ways of producing non-pecialist graduates with a broad training in science, ho would be suitable for various posts in industry nd the government service, and who would also be ompetent to teach science and mathematics in the chools.

There is another aspect of the man-power situation which is emphasized by the Advisory Council in this eport, and that is in relation to the inadequate olume of research on Colonial problems. Further iscussions with the Colonial Office have confirmed the Advisory Council in its view that the total volume of research in the Colonies is far too small. Only some 450 scientists are at present engaged in Colonial research—little more than one-tenth of the number of scientists employed in the United Kingdom by the Department of Scientific and Industrial Research and the research councils—and of these, less than a hundred are members of the Colonial Research Service. The Advisory Council recognizes that in present circumstances it is difficult to increase the number engaged in this work rapidly, but it expresses the firm opinion that everything possible should be done to increase the man-power available and ensure its better distribution. Pointedly, it expresses the hope that further developments will not be hindered by lack of adequate financial support.

That is a matter to which the Government should be giving attention, though it was not raised in the debate on the Colonial territories in the House of Lords on July 6, nor did Lord Lloyd refer to research in his reply for the Government. The Advisory Council emphasizes the urgent need for more research on long-term problems, such as population trends and food supplies, and reiterates the view as to the need for more plant geneticists and soil scientists in particular. Moreover, while the initiative for starting Colonial research projects generally rests with the Colonial territories themselves, scientific resources are likely to become even more stretched as social and political development quickens and local resources for long-term research may diminish. In this connexion, the Inter-University Council for Higher Education Overseas has pointed out that the development of the Colonial universities has transformed the position of science and scholarship within the Colonies and greatly encouraged research.

That there will thus be need for greater initiative to be taken in London in suggesting subjects for long-term research may be no bad thing, if the arrangements for concerting Colonial research policy are improved and the defects in organization which recent reports on Colonial research seem to suggest are overcome. It would fit in with the general observation which the Advisory Council makes in respect of the Seaweed Research Institute and, in view of the contribution which the Department of Scientific and Industrial Research is already making in certain fields of Colonial research, it may be hoped the committee now investigating the work of the Department will not overlook the possibilities in this respect. Sir Alexander Todd's membership of the committee, in view of his observations on this subject to the Parliamentary and Scientific Committee on July 12, certainly warrants this hope.

Meanwhile, it may be noted that the observations of the Inter-University Council fully endorse all the Advisory Council's remarks on the importance of looking on Colonial research as one special aspect of Britain's research effort and organization. The encouraging picture which the Inter-University Council depicts of expanding research stations and organizations in the Colonial territories, and of scientists in direct and continuous contact with local problems and opportunities who are accumulating a valuable body of local experience which they are linking with the world of organized learning, should not disguise the dependence of this man-power on institutions which are themselves largely fed from Great Britain—and often directly from British institutions. Apart from the fact that it will be a long time before most of the Colonial universities develop strong postgraduate schools from among their own students, the wise deployment of British scientific resources demands that Colonial research be considered as part of the wider problem. The suggestions made by the Inter-University Council for an increasing flow to the Colonial universities of research students and academic staff on sabbatical leave to use the facilities and opportunities now available, like the Advisory Council's proposal for the creation of pools of scientists in all the main fields of Colonial research, should be considered in this context. The latter proposal in particular, which might permit a British institution to send a senior man from its own staff for a few months to start a project, leaving it to the local staff to complete, seems well calculated to secure economy of man-power for many Colonial problems.

The Advisory Council's observations on this point, and particularly its plea for further assistance to the science departments in the new Colonial universities, and for the extension of home-based pools of scientists as indicated above, have a vital bearing on economy of man-power, and also on the efficient use and administration of Colonial Development and Welfare Funds and on educational policy—including the expansion of Colonial universities and university colleges and of higher technological institutes. The same consideration of economy in man-power has determined the Advisory Council's fresh reference to the proposals for a national reference library of science and invention and a national science lending library as part of the proposed 'science centre'. Both schemes are regarded by the Advisory Council as important if not essential for the efficient use of our existing scientific and technical man-power. Both are urgent, and the Advisory Council cannot see practical alternatives to either scheme. Disregard by the Government of the Advisory Council's renewed plea for firm decisions in favour of an early start for both these national library projects as part of a policy of equipping the nation with adequate scientific and technical library facilities can only mean a complete failure to appreciate the over-riding necessity for a concerted policy in education, research and development in order that the scientific and technical resources of Britain may be wisely and fully used.

That is the outstanding impression to be derived from the eighth annual report of the Advisory Council on Scientific Policy, and it was brought out even more emphatically by Sir Alexander Todd in the address to the Parliamentary and Scientific Committee already noted. In that address Sir Alexander estimated the total number of graduate scientists and engineers in the United Kingdom as 0·9 per cent of the working population, compared with 0·5 per
cent in 1939, but with United States figures
0·9 per cent in 1939 and 1·7 per cent in 1950; a
he gave the distribution of 78,000 graduates
mathematics and science in Great Britain as 12 p
cent in Civil Service and allied establishment
25 per cent as teachers in grant-aided schools a
technical colleges; 3 per cent in universities; a
60 per cent, including perhaps 2·5 per cent
independent schools, otherwise employed. He al
said that present shortages of scientists are mo
serious among physicists, chemists, metallurgists a
engineers, and that the demand for graduates
the engineering industry exceeds supply by abo
one-third. Sir Alexander added much more
indicate the lines on which educational policy shou
be shaped to deal with the situation as a whole; b
although his address was freely quoted in the House
Commons on July 21, and Mr. A. H. Albu in particul
quoted further estimates of the need, as distinct fro
the demand, for qualified engineers and scientist
apart from Mr. Albu's suggestion that a compr
hensive review of the situation and the actio
required to meet our rapidly changing needs shou
be the responsibility of one senior Minister, the
was no hint in the debate of the importance
urgent action at a high level. Indeed, the Minist
of Education, Sir David Eccles, agreed with mu
that Mr. Albu had said as to the shortage of scientis
and technicians, and made some wise comments
to the importance of general education and a sen
of values; he also promised a full statement befo
Christmas as to the Government's plans for shapin
the educational system of Britain so as to provide a
alternative and much more broader route than th
leading to a university degree for providing the ve
large number of technicians required to support th
technologists and scientists. Nevertheless, Sir Dav
appeared to be concerned at present chiefly to defe
the dubious decision to institute a new award
technology. Moreover, in declining to include in h
review of technological education the work of th
Royal Technical College, Glasgow, he demonstrat
again the departmental limitations and piecem
approach which have consistently marred th
handling of these and related problems by the prese
Government as well as by its predecessor. There a
indeed sound objections to a Ministry of Scienc
but such proposals will continue to be pressed un
clear evidence is forthcoming that the significance
science and technology in the affairs of State
fully appreciated by the Government, that d
weight is given to them in determining education
economic and defence policy, and that department
prejudices are not allowed to overrule the recon
mendations of the Government's scientific a
technical advisers.

The Advisory Council's report at least leaves
room for doubt as to the urgency or magnitude
the present problems, or that some very considerab
administrative changes are required if belated an
inadequate measures are no longer to waste o
limited existing resources and delay the develo
ment or creation of fresh supplies of man-power
energy.

## THAT INWARD EYE

e Mind and the Eye
Study of the Biologist's Standpoint. By Dr. Agnes
ber. Pp. xi+146. (Cambridge: At the University
ess, 1954.) 16s. net.

HIS review should begin with an apology to the
author of "The Mind and the Eye". Her book
s in the reviewer's hands some months ago; but
cumstances at the time made it impossible to give
the leisurely scrutiny it deserves. Perhaps this
lay has its advantages, for there is now an oppor-
nity to assess the value of the book a little at a
stance, in a better perspective than is generally
orded to a reviewer.

There is something very depressing about con-
nporary biological journals. Paper after paper
ords observations or experiments, analyses them
utiously, and in a timid and tentative way com-
res them with previous observations and experi-
nts on the same theme. That is about all: only
ely does the writer of a research paper disclose to
reader precisely what led him to do the work,
d only rarely does the writer disclose how (in his
w) his work is related to the broad panorama of
logy. There are doubtless sufficient reasons for
se omissions: many writers of papers undertake
research they describe for no other reason than
t their supervisors have 'put them on to it', and
ny editors of journals consider contemplation out
place in science and do not encourage authors to
lulge in it. The result is that apart from a few
orous growing points, the proliferation of bio-
ical research appears to an observer to be formless,
co-ordinated, and to some extent superfluous or at
y rate untimely.

In this perspective, Mrs. Arber's book stands out
a work of genuine scholarship and special time-
ess. It ought to be prescribed reading for every
sh graduate who proposes to begin research, and
ought to be read again by every young research
rker before he sends his first paper to the press.
s. Arber begins by a lucid description of the five
niliar stages of scientific investigation: the
mulation of a problem (a stage sometimes omitted),
collection of data, the interpretation of the data,
testing of the interpretation, and the com-
nication of the results to the scientific world. She
important things to say about all these stages,
l she embellishes her discussion by reference to
losophy and literature and art. How refreshing it
for example, to hear that the choice of a subject
research involves "the art of rejection", and to
told that this art can be compared with the art
the Chinese in designing the empty spaces in their
tures. It is refreshing, too, to be reminded (and
many research students it is to be told for the
t time) that the very observations one makes,
l *a fortiori* one's interpretation of them, are limited
the *Zeitgeist* and by unconscious philosophical
umptions derived from Spinoza.

If only biologists would study Mrs. Arber's chapter
writing up the results of research some of the
*laise* of our research journals might be cured.
nmunication is an essential part of research.
here is no escape," Mrs. Arber says, "from the
npulsive truths that the biologist must write, that
ting is an art, and, moreover, a highly symbolic
." It would be well if these words were frequently
oted in universities, for we are still in the state of mind that we willingly spend a year perfecting a technique, but we are unwilling to spend a week writing the paragraph describing the technique; and so the accuracy of experimentation may be blurred by clumsy communication. In this excellent chapter Mrs. Arber falters (in the reviewer's opinion) only twice: once when she implies that the quality of writing in research papers can be too good, because sensitive idiomatic English is harder to translate into foreign languages than poor writing is; and once when she confuses lucidity with over-simplification, and goes on to make the dubious assertion that the opaque passages in a piece of writing "keep the reader awake". These seem poor excuses for taking the edge off the precision of one's instrument. Cyclotrons and electron microscopes notwithstanding, language remains the chief instrument of the scientist.

Having dealt elegantly and convincingly with these five stages of scientific investigation, Mrs. Arber comes to the main theme of her book, namely, that there is a sixth stage: contemplation, meditation, reflexion on the methods and assumptions and implications of scientific research. With a wealth of reading and contemplation behind her, Mrs. Arber discusses the concept of truth in biology (the subtle difference between *Richtigkeit* and *Wahrheit*); she admits that a biologist cannot be an expert on his philosophical assumptions or on his microscope, but she asserts that he ought to have given thought to both these instruments; she doubts (and the reviewer would join issue with her here) whether Occam's razor is as efficacious in biology as in the physical sciences; and she has very sensible things to say about antitheses in biology: matter and form, form and function, mechanism and teleology. Her last antithesis is the mind and the eye. Is one to agree with Coleridge, who thought it necessary "to emancipate the mind from the despotism of the eye" as a condition of abstract thought? Or does the eye provide the yarn out of which the mind weaves abstract thought? Mrs. Arber subscribes to the view that mental activity and sense impressions are inseparable and that the eye is junior partner to the mind.

This book is an example of scientific criticism worthy to stand beside the best literary criticism of our time. Is it too much to hope that working biologists will take it seriously? If they do, we might expect a notable improvement in the quality of scientific writing.

ERIC ASHBY

## LINEARIZED AERODYNAMICS

Linearized Theory of Steady High-Speed Flow
By Prof. G. N. Ward. (Cambridge Monographs on Mechanics and Applied Mathematics.) Pp. xv+243. (Cambridge: At the University Press, 1955.) 30s. net.

FOR some years, research workers in theoretical aerodynamics have been greatly indebted to Prof. G. N. Ward for the fine series of papers in which he has made a number of fundamental and important contributions to the linearized theory of steady high-speed flow, and they will welcome the appearance of this volume in which the author's researches are expounded in magisterial fashion. The volume is, in fact, a revised and shortened version of an essay submitted in competition for the Adams Prize in the University of Cambridge. Its publication in a certain sense marks the end of an epoch, for the linearized theory has reached the stage of completion, in the sense that it is now possible to formulate and to solve almost all the problems which can be usefully tackled by means of this theory. Further advances inevitably and reluctantly will almost certainly be made by means of non-linear theories.

It is well known that the essence of the linearized theory consists in retaining only those terms which are of the first degree in the disturbance velocities, the pressure excess and the density variation which are produced by the passage of an aircraft or a missile through still air. The enormous advantage of the linearized theory is that it is possible to bring to bear all the methods of classical mathematical physics and, in particular, the powerful methods of potential theory and of wave theory. What makes the subject particularly exciting is that in the supersonic range all the concepts and methods of classical potential theory need considerable revision, and that progress is scarcely possible without employing some mathematical methods equivalent to Hadamard's theory of the finite part of divergent integrals. The use of Heaviside transforms and Fourier integrals can also be employed with great effect. The present volume gives a complete and self-contained account of all the mathematical techniques which are required in the solution of linearized equations and, in particular, of the important integral identities discovered by the author in collaboration with F. Ursell.

After an introductory chapter which carefully analyses all the assumptions involved in the linearization of the equations of motion, the author proceeds to discuss in the two following chapters the general solution of these equations for subsonic flow and for supersonic flow. He then gives a number of corollaries related to the boundary conditions, aerodynamic forces, uniqueness of solution and the interesting flow reversal theories.

The second part of this work is concerned with a number of special methods. First, the subsonic flow past thin bodies is discussed with special reference to the developments of the Prandtl–Glauert rule.

Then the author discusses supersonic flow past nearly plane wings. Here the pioneer work of Evvard is extended so that these problems are reduced to the solution of a number of integral equations of Abel's type. This is followed by a study of conical fields in supersonic flow which follows admirably the exposition given by the author and Prof. S. Goldstein. A whole chapter is then devoted to the application of operational methods, with special reference to the flow past quasi-cylindrical ducts and to axially symmetric free jets.

The final section of this work is concerned with the slender-body theory. First of all, the author summarizes the familiar results for the flow past bodies of revolution, and then discusses the generalization of these results to bodies with arbitrary cross-sections. Here the results are obtained by direct solution of the wave equation and not by the operational methods by which they were originally discovered. To many readers the direct solution of the wave equation will seem to be a distinct advance. These methods are then applied to winged bodies of revolution, giving the effects of wing-body interference.

There can be no doubt that the present volume is a most welcome addition to the series of Cambridge monographs and that it will long continue to have a permanent value as an authoritative account of t linearized theory of steady high-speed flow. ] mathematical difficulties are overlooked, and t physical significance of the mathematical equatio is always kept well in mind. Perhaps some read will put down this volume with a certain sadness— deals so completely with the linearized theory th nothing seems to be left to be attempted by resear workers but a few special problems and the gre challenge of second-order theories and the full no linear equations of compressible flow.

G. TEMPLE

# RESEARCH AT HARWELL

### Atomic Energy Research at Harwell

By K. E. B. Jay. Pp. xii+144+19 plates. (Londo Butterworths Scientific Publications, 1955.) 5s.

As stated in the introduction to the book, th report carries forward the story of the Atom Energy Research Establishment, Harwell, from th point at which it was left in a previous publicatio and also contains some material which, either f reasons of secrecy or lack of space, could not l included in the first account. It is divided into tw parts: the first, written primarily for the no technical reader, deals with the major programm of the Establishment, while the second, for th scientific reader, attempts to treat in more det certain selected aspects of research at Harwell.

If one compares the two parts of the volume, appears that Part 2 rather misses its target. T difficulty of giving in sufficient detail, in such a sho space, an account of the many interesting fund mental researches being carried out at Harwell well-nigh insurmountable, and it might have be better to give a more general description togeth with a list of topics and the appropriate references the published literature.

Part 1, on the other hand, contains a very inte esting and readable account of the major programm in applied research. Beginning with a brief explan tion of the relation between Harwell and the Indu trial Group[2], there follows an excellent account of th progress made in reactor design and of the problem remaining to be solved if electrical power is to produced economically from nuclear energy. Chapt 3 gives a clear picture of the increasing use of radi active isotopes in medicine, research and industr and of the large part played by Harwell in th process. There follow chapters devoted to oth aspects of work at Harwell, to the relations betwe the Establishment and British universities and oth research institutions, while last, and by no mea least, an outline is given of some of the human a administrative problems involved in the running an organization of this size. In addition to diagra where necessary, there is a number of excelle photographs.

The author has contrived to give, in a short spa a good account of what goes on at Harwell, and th publishers are to be congratulated on producing th volume at such a low price. To those who, like t reviewer, believe in getting value for their mone this volume may be safely recommended.

P. J. GRANT

[1] "Harwell—the British Atomic Energy Research Establishme 1946–1951" (London: H.M.S.O., 1952).

[2] "Britain's Atomic Factories", by K. E. B. Jay (London: H.M.S. 1954).

# HIGH-ENERGY NUCLEAR PHYSICS

## PHYSICAL SOCIETY'S SUMMER MEETING

HERE are now three machines in Great Britain which can produce π-mesons in useful numbers. ese are the 1,000-MeV. proton synchrotron at mingham, the 400-MeV. synchro-cyclotron at erpool and the 300-MeV. electron synchrotron at ısgow. All three accelerators have been in suc- sful operation for some time, and the first experi- ntal results are beginning to appear. It was refore timely for the Physical Society to devote whole of its provincial summer meeting, held ring July 5–6, to high-energy nuclear physics. e choice of Liverpool as a meeting place was ticularly appropriate in view of the striking ccess recently achieved there in the extraction of beam from the synchro-cyclotron. Members of Society and visitors had an opportunity during meeting of visiting the Nuclear Research Labor- ry of the University, where, in addition to the -MeV. synchro-cyclotron, a 37-in. cyclotron and -MeV. high-tension accelerator are also in oper- on. The average attendance at the meetings was ut 150, and some seventy members joined in the ference dinner held in the University Staff House July 5.

he scientific programme was preceded by a short iness meeting, during which the president of the ysical Society (Prof. H. S. W. Massey) expressed pleasure at the opportunity offered to the Society visiting Liverpool. In reply to this, Prof. H. W. B. nner welcomed the Society, and in particular a nber of overseas visitors, to what was possibly first conference on work with high-energy chines outside the United States. The subsequent ers and discussions left little doubt that high- rgy physics is now a flourishing subject in Great tain. It was particularly interesting to note that high-energy accelerators are being used by ups of workers from many laboratories, and that laboration of this sort is likely to increase. In the sent report, only the names of those actually senting the papers are given, although those of ir co-workers were in general scrupulously ounced at the meeting.

he papers presented on the first day were all cerned with the interaction of high-energy trons and protons with matter. Several papers cribed work carried out at Harwell, where the -MeV. synchro-cyclotron, although not useful for eson production, was the first high-energy elerator to start working in Britain, and has been d for a large number of precise experiments in high-energy field. T. C. Randle (Atomic Energy earch Establishment, Harwell) described a new ermination of the angular distribution in $(n,p)$ ttering at 130 MeV., which clearly shows a marked mmetry between backward and forward scatter- . T. C. Griffith (University College, London) later cribed another determination of the differential s-section for $(n,p)$ scattering using the neutron m of the Harwell cyclotron with photographic- lsion recording of the recoil protons. His results er the angular range 57½–82½° in the laboratory tem and agree with those of other workers within limits of error. Some observations of the charged ticles emitted by carbon under neutron bombardment were obtained in the course of this work. P. Hillman (Harwell) reported on the observation of polarization in the scattering of 100-MeV. neutrons by free protons. This is an extremely difficult experiment, but good evidence for a real effect was presented, and the chairman (Prof. H. S. W. Massey) emphasized its importance for a proper analysis of nucleon-scattering work. Another interesting and informative experiment of a similar nature using the 100-MeV. neutrons from the Harwell machine was described by R. Wilson (Oxford). He and his colleagues have been able to observe the Coulomb scattering of neutrons, due to the motion of the neutron magnetic moment in the electric field of the nucleus. This scattering was predicted by Schwinger and is observable only at forward angles of less than 1°. In this region, interference between the Coulomb and nuclear scattering gives a polarization effect and enables the polarization of the initial neutron beam to be demonstrated. J. M. Dickson (Harwell) described polarization effects observed at angles between 3° and 20° in the scattering of polarized protons by carbon, aluminium, copper and silver. The effect of the interference between Coulomb and nuclear scattering in the asymmetry was very clearly shown. Both the $(p,p)$ and the $(n,p)$ experiments were remarkable for the angular precision achieved. Later in the meeting, A. Roberts (Rochester, U.S.A., and U.S. Office of Naval Research, London) reported on earlier $(n,p)$ polarization experiments at Rochester which are in agreement with the Harwell results, and cover a wider energy range. He also described $(p,p)$ polarization work and showed how the polarization produced in the scattering of protons by carbon is zero near the first diffraction minimum.

L. Riddiford (Birmingham) described the results of a study of the $(p,p)$ interaction at about 650 MeV. using protons accelerated in the Birmingham synchrotron. At this energy the differential cross-section for elastic scattering may be influenced by the possibility of meson production, and a forward peak might be expected, in contrast with the isotropic distribution obtained at lower energies. The results for 131 events, which were obtained with a diffusion cloud chamber filled with hydrogen to a pressure of 25 atmospheres and operating in a magnetic field of 13 k.gauss show this feature. Of the inelastic events in hydrogen, forty-five examples of $\pi^+$-meson production and nine examples of $\pi^0$-meson production were identified. Angular correlation measurements made for the cases of $\pi^+$-meson production were in agreement with the hypothesis of an excited state of the nucleon–meson system corresponding to the $T = 3/2$ resonance observed in meson–nucleon scattering. W. O. Lock (Birmingham) reported on a similar study using 950-MeV. protons from the Birmingham machine. Collisions with hydrogen were obtained and recorded in nuclear emulsions, and the events were studied independently at Birmingham, Belfast and Glasgow. In this work a marked deviation from isotropy was also seen at forward angles, including a dip near 0°, which may still be due to poor statistics. The experiment gives a cross-section for $(p,p)$ elastic scattering at 950 MeV. of 15·5 ± 3 mb.; no evidence for appreciable polarization of the beam scattered out of the synchrotron at 4° was found. In the same exposures 'quasi-elastic' collisions of the incident proton with bound protons in the heavier nuclei of the emulsion are recorded, and identification and analysis of these events was described by W. M. Gibson (Belfast).

Some discussion took place on the effort spent in analysing experiments made with photographic plates and diffusion cloud chambers. The great experimental advantages conferred by the availability of a continuous, intense and homogeneous external beam were clearly brought out in a paper by J. R. Holt (Liverpool) on the elastic scattering of protons by hydrogen at 380 MeV. The differential cross-section at 90° was found by coincidence counting using the carbon–polythene difference method; and a result of 3·63 millibarns, with an accuracy of about 1 per cent, was obtained. The excellent conditions available at Liverpool for precision high-energy experiments in the 400 MeV. region were well shown in this work. Another example of the type of work now possible at Liverpool was given by A. Ashmore, who presented the results of measurements of neutron total cross-sections for a number of elements using the transmission method with a scintillation telescope.

Towards the end of the first day, Prof. Massey reviewed progress in high-energy scattering and polarization phenomena, referring in particular to the very precise work which has now been reported from the 660-MeV. Moscow synchro-cyclotron. He stressed the fact that advances in experimental technique have been extremely rapid, and that it is now possible to envisage triple- and quadruple-scattering experiments which could determine uniquely the unknown parameters in the general nucleon–nucleon scattering matrix.

The second day of the meeting was devoted to miscellaneous topics. The Glasgow electron synchrotron was described by W. Macfarlane; it now produces 4 × $10^{10}$ equivalent quanta per min. for a pulse-rate of 5 per sec. and an energy of 340 MeV., which appears to be better than the performance of comparable American machines. The beam has been collimated to ¼ in. diameter at 125 cm. from the synchrotron. Arrangements for monitoring the beam with a pair spectrometer were described and some excellent expansion-chamber pictures of photon-induced stars in air were shown. The Glasgow synchrotron will be used in part for a study of the photoproduction of π-mesons, and E. H. Bellamy reported preliminary observations on the ratio of $\pi^+$- to $\pi^-$-mesons produced in calcium; nuclear emulsion detectors were used, and the ratio was found for three energy ranges. R. G. Moorhouse (Glasgow) reported on new calculations on the photoproduction of mesons, referring in particular to the effect of *E2* transitions on the angular distribution of mesons.

Several papers were devoted to the properties of π-mesons. S. W. Barnes (Rochester, U.S.A.) described measurements of the absolute differential cross-section for the elastic scattering of $\pi^+$-mesons by protons at centre-of-mass angles of 43° and 90°. The meson energy was 43 MeV. and a liquid hydrogen target was used, with ring-shaped crystals to define and detect the scattered mesons. By combining the two measurements with an earlier and less accurate determination at 180°, the following values for the *s*- and *p*-wave phase-shifts in the isotopic spin state $T = 3/2$ for a meson energy of 43 MeV. were obtained: $\alpha_3 = -4\cdot3°$; $\alpha_{33} = +4\cdot4°$; $\alpha_{31} = -1\cdot35°$. Roberts (Rochester, U.S.A.) in a later paper poin out that in a scattering experiment the effects π-mesons in more than one state of orbital mot with respect to the scattering centre are usua superimposed. In a $\pi^-$-mesonic atom, however, which a $\pi^-$-meson exists for a finite time in a B orbit about the central nucleus, pure states of orbi motion exist. The electromagnetic transitions in su an atom thus directly relate the energies of sta such as 1*s*, 2*p*, 2*s*, 3*p*. The Coulomb energies of th states can be calculated very accurately, and nuclear shift of the energy-levels can then be dedu from experimental observation of the mesonic X-ra Dr. Roberts described an accurate determination the 2*p* – 1*s* transition energy ($K_\alpha$ and $K_\beta$) in mesonic *K*-series of oxygen; 40-MeV. $\pi^-$-mes were brought to rest in oxygen, and the X-rays, energy 164 ± 4 keV., were detected in a sodi iodide crystal. An upward nuclear shift of the level was established, showing that there is repuls in the *s*-state of motion between a meson and nucleus. The nuclear shift has also been determi for other atoms by workers at the Carnegie Institu Pittsburgh; unfortunately, it has not yet b possible to measure it for hydrogen. Some sim observations of the 2*p* – 1*s* transition energy μ-mesonic atoms were reported by F. D. S. Butem (Harwell), whose work was carried out using μ-mes produced by the decay of π-mesons from the Liv pool cyclotron. For copper a value of 1·55 MeV. v obtained for the unresolved doublet and for l 5·84 MeV. These values agree with the earlier w of Fitch and Rainwater and lead to the expressi $R = 1\cdot19 \times 10^{-13} A^{1/3}$ for the electromagnetic rad of a nucleus of mass number *A*.

J. M. Cassels (Liverpool) spoke on total cro section measurements with positive and negat π-mesons from the Liverpool cyclotron. It is ho soon to exploit the intense external beam of machine as a source of high-energy $\pi^+$-mesons, wh are usually difficult to extract from orbital accel ators; but in this work an internal target and same channel (with reversed cyclotron fields) w used for both $\pi^+$- and $\pi^-$-mesons. The meson ene was 85 MeV., and total cross-sections were found the transmission method using a scintillation coun telescope. Observations of the loss cross-section w made with different angles of acceptance for the fi crystal, so that the loss due to Coulomb and diffract scattering (counted as elastic processes) could distinguished from that due to nuclear absorpt (counted as inelastic processes). The results presen were:

| Nucleus | Absorption cross-section (millibarns) $\pi^-$ | $\pi^+$ | Error (per cen |
|---|---|---|---|
| Carbon | 367 | 283 | 8 |
| Aluminium | 684 | 563 | |
| Copper | 1,420 | 960 | |
| Cadmium | 2,190 | 1,440 | |
| Lead | 3,400 | 2,280 | 5 |

The difference between the $\pi^+$- and $\pi^-$-absorp cross-sections for the heavier nuclei may be explai by a simple Coulomb effect, but this is not adequ to interpret the results for carbon. The nuc radius for lead deduced from the observed cr sections is 95 × $10^{-13}$ cm., compared with a valu 7·2 × $10^{-13}$ cm. estimated otherwise, so that the l

cleus appears completely black to both types of
arged π-meson at an energy of 85 MeV.

Some details of the interaction of high-energy
otons with complex nuclei were presented by
rkers from Birmingham. W. E. Burcham and J. L.
monds described a measurement of the absolute
ss-section for the $^{12}C(p,pn)^{11}C$ reaction with proton
ergies between 250 and 950 MeV. The cross-section
carbon-11 production falls off slowly over this
ergy-range to a value of 20·5 ± 1·1 millibarns
950 MeV. The ratio of sodium-24 and fluorine-18
ivities from aluminium bombarded by high-energy
otons to carbon-11 activity from polythene bom-
rded by the same protons was also found for the
ne range of energies using the internal beam of the
rmingham synchrotron. D. L. Anderson described
pecial type of photographic emulsion camera which
s been installed in the vacuum system of the
rmingham machine. The magnetic field of the
chine was used for resolution, and the energy
tribution of protons scattered inelastically from
bon was obtained. For low proton energies the
ults are consistent with a Gaussian distribution of
ernal momentum in the carbon nucleus.

The day's proceedings included two technical
pers of particular interest. K. J. Le Couteur
verpool) described the calculations which he had
de on the Tuck–Teng system of beam extraction.
ese calculations were the basis of the design of the
ler and regenerator fields installed in the Liverpool
lotron. When tried, it was found that the system
aved as anticipated, and that it was possible to
ft the circulating beam laterally a large distance
one turn. About one-fifth of the circulating beam
s made to enter a magnetic channel and 3 per
t of the internal beam, with an energy of 380 ±
MeV., was obtained at the end of the channel.
ter concentration with a focusing magnet, 2 per
t of the internal beam was measured on a target
about 1 in. diameter at a distance of 40 ft. from
cyclotron. The resulting flux of 4 × $10^{10}$ protons
cm.$^2$ per sec. is about a thousand times better
n has been obtained on other machines, and has
n a major contribution to the efficient utilization
existing high-energy accelerators. The accelerators
the future must, however, reach much higher
rgies than any at present attained, and the
velopment of new ideas in this subject was reviewed
W. Walkinshaw (Harwell). The application of
principle of alternating-gradient focusing to
chrotron-type accelerators has been thoroughly
estigated and underlies the design of the 25-GeV.
chines now under construction at Geneva and at
okhaven. The great expense of these machines
, however, stimulated several groups to consider
rnative designs, and those proposed by the Mid-
stern Universities Research Association of the
ited States (*M.U.R.A.* group) were discussed in
ne detail. These envisage a magnet which is
ited by direct current and are described as *FFAG*
ed-field alternating-gradient) machines. Essen-
lly, fields of special shape are used to confine a
ge range of momentum within a small range of
ius. Typical design figures were presented. There
also the possibility of a fixed-field alternating-
dient constant-frequency cyclotron for an energy
perhaps 2 GeV. with a current of perhaps 100 micro-
peres. The remarkable possibilities for experiment
ned up by such designs make it essential to
nplete detailed studies of their practicability and
t as early as possible.

W. E. BURCHAM

# FOOD MICROBIOLOGY AND PUBLIC HEALTH

A ONE-AND-A-HALF day symposium on "Food Microbiology and Public Health" formed part of the summer conference organized by the Society for Applied Bacteriology, held in Cambridge during July 3–6. Sixteen papers were contributed by authorities in various aspects of the subject from different parts of the world, and the chairmen at the three sessions were the president of the Society, Mr. S. B. Thomas (Aberystwyth), Colonel H. J. Bensted (Colindale) and Dr. G. S. Wilson (London). Several of the contributors described individual outbreaks of bacterial food poisoning and traced so far as possible the likely sources of the trouble. The whole tone of the meeting was directed not to the dangers of food poisoning in itself, but to the dangers arising from ineffective processing, careless handling or unsatisfactory storage conditions.

The first section of the symposium dealt with milk and synthetic cream products, and K. W. Newell (Colindale) described an outbreak of infection in several families arising from eating chocolate éclairs. Fæcal coli and a few *Salmonella paratyphi* were found in the cake mixture and also in the mixing machine; but the principal contamination was *Salm. thompson*, traced to a single delivery of an unusual pack of Chinese frozen eggs, from which two other strains were also isolated, *pullorum* and *aberdeen*. Describing the method of sampling and of isolating the contaminants, Betty Hobbs and Muriel Smith (Colindale) considered that incubation in selenite medium followed by plating on Leifson medium containing 1 per cent of sucrose is the most satisfactory method. In reply to questions, Dr. Hobbs said that these organisms can survive for more than a year in the frozen state, and that *Salm. pullorum* cannot be used as an indicator organism, partly because no really satisfactory isolation media have yet been devised.

Custard was the next topic discussed, and R. M. Fry and Joan Boissard (Cambridge) described a sudden outbreak of sore throat, pyrexia and collapse in one section of an army camp following an evening meal which included this comestible. Most of the cases were reported within 48 hr. of taking the meal, and nearly all of the throat swabs yielded cultures of *Streptococcus pyogenes*, Type 9. The incidence of infection pointed to one cauldron of custard handled by one particular cook as the source of the trouble. Doubts were expressed at first concerning this finding, because the material had been handled hot; but it was shown in the laboratory that, although the bulk of material might be at a high temperature, the skin of the custard was relatively cool and so would allow survival of infected droplets falling on the surface.

Emphasis was placed on the importance of the correct handling of dried milk by H. B. Hawley and Margaret Benjamin (Yeovil), because growth of bacteria, and especially of staphylococci, can take place readily at certain stages of processing. They described the design of a suitable drying plant, and said that growth takes place particularly at the 'evaporated milk' stage. For this reason, regular daily cleaning of the plant is essential. The staphylococcal species in the dried milk are different from those in the original milk, pointing to human or air-borne contamination gaining access during processing. Coliforms die out quickly in the dried powder, but micrococci are relatively resistant. Betty Hobbs (Colindale) quoted eight outbreaks of staphylococcal food poisoning occurring during the summer of 1953, all of which were traced to 'cream' made with dried milk. Growth of staphylococci in the cream was relatively slow, hence the poisoning must have been due to the heat-resistant toxins remaining in the dried milk. Seven of the outbreaks were from milks processed by one manufacturer, and the infection was always found in batches made towards the end of each day, a point which underlines the importance of regular daily cleaning of plant.

In a paper on faecal bacteria occurring in citrus juices, Prof. M. D. Appleman (University of California) said that interest was aroused because of the increasing consumption of unpasteurized juices. Although the juices are at pH 4 (approximately), a number of types of micro-organism can survive, and even grow, to cause spoilage. High counts invariably mean that unsound fruits have been used or that they have been handled carelessly. Although coliforms occur with some frequency, faecal streptococci appear to be the best organisms for indicating general contamination. A recorded contribution from M. W. Wilson and E. F. Mackenzie (Melbourne) described first the methods used in the State of Victoria for identifying carriers and isolating cases, and then went on to discuss in detail several outbreaks, generally occurring in young persons, of *Salmonella* infections of the *senftenberg* type. All were traced to confections containing desiccated coconut supplied from Papua and distributed by two wholesalers in Victoria. Several *Salmonella* species were isolated, including *Salm. oranienburg*, *potsdam* and *senftenberg*, originating obviously from the ecological conditions obtaining in one factory in particular. In the subsequent discussion it was stated that the heat resistances of the different *Salmonella* types vary considerably. The query was also raised that, although a certain heat treatment may have been applied, what was the actual temperature attained by the particles, and what was the moisture content ?; these factors would affect the lethal efficiency of the heating.

In the section devoted to meats and fish, J. M. Shewan and J. Liston (Aberdeen) discussed food poisonings caused by fish. The normal bacterial flora are non-pathogenic, and generally fish is stored sufficiently cool to prevent undue bacterial growth; but occasional pathogens are found in fish living in polluted waters. Type *E* botulism occurs in fish taken near Continental ports, but it has not been found in British waters. Particularly susceptible is the mackerel–tunny group, and poisoning seems to be due to histidine being converted to histamine during ripening. Tropical fish are much more poisonous than temperate ones, the poisons usually being of the neurotoxin or histamine type. Turning to fresh meats, the conference heard a paper by H. Lundback (Stockholm) on two extensive *Salmonella* outbreaks occurring in 1953, one being due to *Salm. typhimurium*. This had its source in one slaughterhouse in southern Sweden from which pork meat was found to be more heavily infected than veal. It was not possible to determine on the evidence available whether the infection was of animal or human origin. Fifteen per cent of the staff were found to be carriers at one stage.

M. Ingram and Ella Barnes (Cambridge) reported that feeding antibiotics to animals may alter significantly the microbial flora found in the g
eliminating, for example, the streptococci and c
tridia, and this may improve the quality of cert
meats and reduce spoilage. This has been shown
be the case after feeding with aureomycin and t
less extent with neomycin. Only the yeasts
resistant, but this can be overcome. Dipping free
killed meat in an antibiotic solution improves
keeping quality. Although this method is of
doubted advantage, there remain the toxicity
the medico–legal aspects to be considered.

As might be expected, cooked meats are equa
if not more, susceptible to bacterial infection,
A. A. Miller and F. Ramsden (Preston) descri
two fairly large outbreaks of *Salmonella* infecti
occurring some two years ago from consuming m
pies. In both outbreaks, *Salm. morbificans* was
cause, the infections being of animal origin. S
sequent investigations showed that inadequate bak
was the reason for the spread of the infection ; it
also made clear that adequate precautions must
taken after baking to prevent the access of infecti
for example, when adding the gelatin filler.
Buttiaux and H. Beerens (Lille) discussed
incidence of gas-forming *Clostridia* in canned me
and found ninety such infections from 109 c
examined. *Cl. welchii* occurred most frequen
followed by *Cl. bifermentans*, and all originated fr
semi-preserved meats or processed meats inadequat
heated. Using a 'micro-ham' medium, recommen
for isolating the cultures, pH was found not to
significant in preventing growth ; 4 per cent of
was ineffective, but higher concentrations were ;
nitrite and nitrate were ineffective at 0·02 per c
and 0·1 per cent, respectively.

In the last section of the symposium, concern
with bacteria causing food poisoning, Prof. S. Ha
(Oslo) discussed the role of aerobic spore-form
Four outbreaks in Oslo were traced to *Bacillus cer*
occurring in dessert sauces. Although, in every ca
the infection was very high, it was not detec
organoleptically. The poisoning is not an infect
but an intoxication, and the symptoms are similar
*Cl. welchii* poisoning. According to Joan Tay
(Colindale), it is possible that some outbreaks may
due to mixed infections such as that of *Proteus*
*Bact. coli*. Coliforms themselves are not genera
pathogenic, but in this connexion the host may
important. In Britain they form 8 per cent of
cases of 'known cause'. Considering the colifo
group generally, special serological types of *Bact.*
have been identified with certain infections, and
the remaining organisms, *Ps. pyocyanea*, *Proteus*
the paracolons, the evidence against them is mai
circumstantial. B. Moore (Exeter) said that va
cases have been proved of food poisoning due
*Streptococcus faecalis*, of which there appear to be t
types, one with a short incubation period and o
with a longer one. In all cases a very heavy infect
is necessary to produce the symptoms, and fr
laboratory tests with experimental animals
medium and the age of the culture are important
determining toxicity. Type *E* botulism, first detec
in 1936, has been the cause of several outbreaks
the Continent ; it has never been detected in Brita
H. O. Pedersen (Frederiksberg) said that infection
associated exclusively with fish, the toxin be
produced only if the organism is incubated bel
37° C. The organism has been found in various s
and sea muds, particularly those in harbours, hen
the significance of fish in conveying infection. It l

rtain cultural peculiarities and the spores are readily led by mild heat.

The full papers of the symposium will appear in forthcoming issue of the *Journal of Applied cteriology*.

# ROTECTION AGAINST IONIZING RADIATIONS

[T]HE rapidly widening range of applications of atomic energy and artificial radioactivity and the creasing concern and speculation on the part of e general public concerning the biological effects of nizing radiations make the publication of the latest commendations of the International Commission on adiological Protection* an event of major importce. The Commission functions under the auspices the International Congress of Radiology, which ld its seventh meeting in Copenhagen in 1953.

The history of radiation protection extends back far as 1921, to the inauguration in the United ngdom of the British X-ray and Radium Protection mmittee working under the auspices of the British stitute of Radiology, and in the United States the Röntgen Ray Protection Committee. The rmation of these and other national committees led the first International Commission on Radiological otection in 1928. Since that time the Commission s met at regular intervals, and its expanding sphere interest may be judged by comparing the present -page report with the last recommendations issued, 1950, comprising some eight pages in print. The itish X-ray and Radium Protection Committee has cently handed over its responsibility to other mmittees meeting under the auspices of the inistry of Health and the Medical Research Council, d these bodies have set up a joint Radiological otection Service to advise users in the United ingdom on all matters relating to protection.

The present Commission includes members from n nations and has five sub-committees dealing spectively with the permissible dose for external diation, the permissible dose for internal radiation, otection against X-rays up to three million volts, otection against X-rays above three million volts d against heavy particles, and the disposal of dioactive wastes and handling of radioactive isopes. The report gives the recommendations of the st four of these; the report of the sub-committee the handling and disposal of radioactive materials ill be published later as an addendum.

In formulating its recommendations, the Commison recognizes that any significant departure from e environmental conditions in which man has olved may strictly entail some hazard. Since no diation-level above the natural background due to rrestrial radioactivity and cosmic rays is absolutely fe, the problem is to choose a practical level that volves a negligible risk. The concept invoked re is that of a "maximum permissible weekly dose" radiation or a "maximum permissible body burden" a radioisotope such that if exposure at this level ere continued indefinitely, no appreciable bodily jury would be expected to result during the lifetime the exposed individual. The recommendations are primarily intended to apply to the occupational exposure of personnel forming only a small fraction of the community, and in such circumstances genetic changes affecting the race as a whole are not considered the limiting factor. The report suggests a reduction of all permissible levels by a factor of 10 to take account of possible genetic effects where exposure of a large population is involved.

Past recommendations of the Commission have been chiefly concerned with the establishment of a maximum permissible weekly dose in rontgen units for whole-body exposure to X- or γ-radiation, and in 1950 this was fixed at 0·3 r./week. The sub-committee on the permissible dose for external radiation does not now recommend any change in this basic value for X- and γ-rays up to 3 MeV., which remains at 0·3 r./week, corresponding approximately to an absorbed dose in soft tissue of 0·3 rad/week. Maximum permissible levels for other types of ionizing radiation are also considered.

Some confusion may result from the multiplicity of units used in the report for the expression of radiation dose or radiation absorption in tissue. This arises in part from the fact that shortly before its publication the International Commission on Radiological Units recommended that the rad should be used wherever possible as the unit of absorbed radiation dose. This unit is equal to an energy absorption of 100 ergs/gram. Because of the varying biological effectiveness of different types of radiation, it is found necessary to introduce a further unit—the rem—which is defined on p. 19 as "the absorbed dose of any ionizing radiation which has the same biological effectiveness as 1 rad of X-radiation . . ." This appears to be at variance with previous definitions of the rem as that dose which has the same biological effectiveness as 1 rontgen of X-rays. The use of the rem might have been avoided had the Commission chosen to recommend that the maximum permissible dose for heavy ionizing particles should be that for X- or γ-rays divided by the relative biological effectiveness of the radiation in question. It must be pointed out that the relative biological effectiveness for any given radiation may depend on the type of biological effect studied.

On p. 17 it is assumed that the tissue dose in rads is approximately numerically equal to the dose in rontgens in the tissue concerned. It should perhaps be emphasized that this assumption is only valid in soft tissue where the mean atomic number is nearly equal to that of air. Some clarification of these issues would be welcome in future recommendations of the Commission.

Radiobiological studies have demonstrated that certain organs of the body—notably the skin, blood-forming organs, gonads and eyes—are particularly vulnerable to radiation damage. Special consideration is therefore necessary with highly non-uniform distributions of radiation dose such as may be encountered in exposure to particulate radiation. For this purpose, the concept of the 'critical organ' is introduced; by this is implied the organ of the body which under the conditions of the exposure receives the dose that results in the greatest bodily damage. The criterion used in establishing maximum permissible levels is that the dose absorbed by the critical organ shall not exceed 0·3 rad/week of X- or γ-rays or an equivalent amount of other radiation.

The idea of the 'critical organ' is fundamental to the report of the sub-committee on the permissible dose for internal radiation, which considers the hazards due to ingestion or inhalation of radioactive materials. Taking account of the non-uniform distribution of radioactive material in the body, maximum permissible levels of concentration in air and drinking water are quoted for ninety-one isotopes or mixtures of isotopes. For most of these, the criterion used is that of the absorbed dose in the critical organ, the calculations being based on a "standard man" in whom all characteristics are chosen to be those representative of the average man. In the case of α-emitting radioisotopes that become localized in bone, however, the levels are based on a direct comparison with radium. A large accumulation of human experience is available regarding the effects of ingested radium in man, and the maximum permissible body burden of this element has long been fixed at 0·1 μc.

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* Recommendations of the International Commission on Radioical Protection (Revised December 1, 1954). British Journal of diology Supplement No. 6. Pp. x+92 (London: British Institute Radiology, 1955.) 10s. 6d. with paper cover, 12s. 6d. with cloth cover.

With many other isotopes, human data are usually completely lacking, and distribution and turnover must be estimated in other ways, for example, from the results of animal experiments. The sub-committee acknowledges that these calculations are often only approximate. Moreover, the figure of 0·3 rad/week applies properly to whole-body radiation, and its extension to partial-body irradiation of a critical organ may entail a considerable safety factor—a factor which may, however, be offset by irregularities in the distribution of radioactivity in the tissues of the critical organ itself, especially at the histological level. It is probable that many of the values quoted in this section may have to be revised as more detailed data become available regarding the effects of partial body irradiation and the non-uniform distribution of radioisotopes in tissue. Meanwhile, they form a valuable working guide for persons working with radioactive materials, though some may regret that the data were not presented in a more abbreviated and simplified form.

In the report of the sub-committee on protection against X-rays up to 3 MeV., detailed recommendations are given for the planning, surveying and monitoring of new X-ray installations. Principles to be followed in establishing general working conditions in such installations are outlined and the special requirements of medical diagnostic, medical therapeutic, and non-medical units are discussed separately. The hazards arising from non-useful sources of X-rays (cathode ray oscillographs, television tubes, transmitting valves, etc.) are also discussed. A valuable appendix provides data on the absorption of X-radiation in various shielding materials, and the protective-barrier requirements of different types of installation.

Finally, the sub-committee on protection against X-rays above 3 MeV. and against heavy particles recommends a maximum permissible weekly dose of 0·3 rad/week for X-rays above 3 MeV., and 0·03 rad/week for neutrons in the energy range 0·025 eV.–10 MeV., assuming a relative biological effectiveness of 10 for neutrons in the critical organ—in this case the eyes. Values of neutron flux corresponding to the maximum permissible dosage rate at different energy levels, and relative biological effectiveness figures for different types of particulate radiation are specified.

The report is an impressive example of international co-operation and should receive the serious attention of all who are concerned in the production, handling, and use of radioactive materials and machines producing ionizing radiations. E. H. BELCHER

# OBITUARIES

## Prof. G. F. Shirras

PROF. GEORGE FINDLAY SHIRRAS, who died o June 23, came of an Aberdeen business family, an was educated at Robert Gordon's College in Aberdeen and at the University of Aberdeen, where h distinguished himself outstandingly in economic Choosing an Indian career, he joined the India Educational Service, and at the early age of twenty-four he became professor of economics in Dacc College and was elected a Fellow of the University o Calcutta. For thirty years thereafter he held a succession of posts, doubling some of them. Durin 1910–13 he served in the Finance Department of th Government of India, and during 1914–21 he wa director of statistics, as well as reader in economic in the University of Calcutta. He next spent fiv years as director of the Labour Office of the Bomba Government, and thereafter he was principal an professor of economics in Gujarat College, Universit of Bombay, until he retired in 1939. He then undertook the headship of the Economics Department i University College, Exeter, for the period of the Wa He worked for a time in the Control Commissio for Germany as controller-general of the Financ Division.

Work more to his taste awaited him elsewhere. H held the professorship of economics for a year i Trinity College, Dublin, and in the following yea he worked as visiting professor and lecturer i several American universities, notably at Illinoi Florida and Cornell Universities.

Shirras wrote and published on a large scale an with authoritative effect in the field of statistic Two weighty books sprang from his Indian experienc —"Indian Finance and Banking" and "The Scienc of Public Finance", and also "Some Aspects o Indian Commerce and Industry". Others of h publications were "Federal Finance in Peace an War" and "Planning towards Recovery". He unde took research and wrote on Sir Isaac Newton, bein attracted by Newton's work at the Mint, and h contributed to the "Encyclopædia Britannica". book entitled "The Burden of British Taxation" cam out in 1943.

His enthusiastic spirit conceded nothing t advancing age or to his status of retirement. H may truly be said to have been the victim of h arduous concentration on work and his inten interest in problems and people. He was alert an responsive, whatever the occasion or the company lucid and engaging in speech and gifted in writin He wrote, moreover, a scrupulously clear and gracef hand. Large-headed, of striking features, an virtually bald, he had a rare distinction of appea ance. Outside economics, his chief study was th Bible, especially the Psalms, and the Saints. Born Presbyterian, he became an Anglican, and officiat frequently and acceptably as a lay preacher.

He died prematurely, it may justly be said, a litt before his seventieth birthday. He died, as he wou have wished, in harness, on his way to take pa in the conference of the International Statistic Institute at Rio de Janeiro.

Shirras married Amy Zara, the only daughter the late George McWatters, who survives him. O his two sons, Major Richard Shirras and Maj Douglas Shirras, the latter was killed while servi in France with the Seaforth Highlanders.

## Dr. Stanley Smith

DR. STANLEY SMITH was born at Middlesbrough n March 7, 1883, and educated at Darlington rammar School. On leaving school he worked in e chemical laboratory of the Darlington Forge Co., ut in 1904 he entered Armstrong (now King's) ollege, Newcastle on Tyne, where he graduated in 907, and took his M.Sc. and D.Sc. degrees in 1909 nd 1915, respectively.

Inspired by Prof. G. A. Lebour, Stanley Smith arried out investigations on the coalfields of North- mberland and the Carboniferous Limestone of the lls, his resulting paper (1911) on "The Faunal uccession of the Upper Bernician" being still a andard work. But, of greater importance, this esearch led him to take up the study of the Palæozoic orals, in which he thereafter specialized. Election a fellowship at Armstrong College in 1910 took im to Clare College, Cambridge, where he graduated 1912. His first paper on corals (1913), on onto- enesis and local variations in *Aulophyllum*, set the attern for all his future work, for he insisted, as lways, on the need for basing the revision of genera nd species on the re-examination of the type speci- ens or, if they were unavailable, of topotypes. In is masterly paper on *Lonsdaleia* (1916), Stanley mith wrote, "Inconstancy of detail, but conservation the general plan, is the most characteristic feature the skeletal morphology of Rugose genera", a atement repeatedly validated by later work. A ream of papers followed, either by him alone or in llaboration; these quickly established his world- ide reputation as the leading authority on Palæozoic orals. Of peculiar interest was his description (1930) Valentian corals from Shropshire and Montgomery- ire, for, apart from H. A. Nicholson and R. Ether- lge's classic monograph of the Silurian fossils of the iryan area, no extensive coral fauna of similar age ad been previously described. All his papers were arked by careful observation, honest interpretation, nd polished presentation. They have acted as odels for almost all Palæozoic coral research since, nd, to quote a correspondent, "have really placed alæozoic coral work on its feet".

From 1913 Stanley Smith spent much time during acations at the British Museum (Natural History), om which sprang his long association with Dr. W. D. ang. Their collaboration resulted not only in veral important works revising an extensive range coral genera, but also in their enunciation (1930) of e concept of genomorphs, which has since been plied to other groups of fossils. The Museum blished in 1940 the "Index of Palæozoic Coral enera", of which Stanley Smith was a part-author.

His investigations into the geology of the Bristol ea led to two major stratigraphical contributions, amely, his recognition of Tremadocian Shales in the ortworth inlier of Gloucestershire (1933), and his rrelation of the high Viséan fauna of the Tanhouse eds of Yate with the upper part of the $P_2$ zone 941). With G. A. Kellaway he also described the ly British Jurassic stromatoporoids known (1938), hile earlier (1923) the Geological Survey had pub- hed his important report on the lead and zinc ores Northumberland and Alston Moor. The award him by the Geological Society of London of the yell Medal in 1947 for his palæontological and ratigraphical researches was richly deserved.

Stanley Smith was also knowledgeable in Greek d Roman antiquities. For some years he had been engaged with Mr. D. E. Eichholz, of the University of Bristol, on a new translation of Theophrastus's well-known treatise. His part was to interpret afresh Theophrastus's geological references and records, and to this he brought the same care and enthusiasm that characterized everything he undertook.

Stanley Smith spent his life in the university world. After appointments at Aberystwyth (1913–20), Bedford College for Women (1920–21), and Toronto (1921–22), he became assistant lecturer in geology in the University of Bristol (1922) and retired as reader in palæontology in 1948. He played a full part in local scientific societies, and had been president of the South-Western Naturalists' Union, of which he was honorary secretary for many years.

To work closely with Stanley Smith was to discover a gentle, generous nature, and a lively sense of humour which was always kindly. He was an indefatigable worker, to whom the problem of the moment was all-absorbing. He freely gave of his knowledge, though always in the humble spirit which was one of his great traits. He never lost his innate modesty nor his charming, old-world courtesy, and he would exercise the greatest patience in trying to understand another's point of view. Above all, he was a very loyal colleague and friend.

During the last few years of his life, Stanley Smith suffered from a painful affliction of his back; but despite this he kept at his research work to the end. He died peacefully on July 1, 1955, after a heart attack. His wife, whom he married in 1924, survives him.

H. DIGHTON THOMAS

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## Dr. J. B. Christopherson, C.B.E.

JOHN BRIAN CHRISTOPHERSON, familiarly known as 'Christo' to his friends, who died on July 21 at the age of eighty-seven, will be remembered for the varied and exciting career which he led as well as for the scientific work that he achieved. He will go down in medical history as the man who introduced the cure of bilharziasis (schistosomiasis) by intravenous injections of tartar emetic.

He had a good family and scientific background, being educated at Clifton College, Caius College, Cambridge, and St. Bartholomew's Hospital, London. He qualified in 1893 and soon afterwards was elected assistant surgeon to the Albert Dock Hospital under Mr. (afterwards Sir) James Cantlie, and he remained in London until 1901. Christopherson was therefore associated with the beginnings of the London School of Tropical Medicine and came under the influence of Sir Patrick Manson. In 1897 he took his final F.R.C.S. and eventually was elected F.R.C.P. in 1913. He was therefore doubly highly qualified. In 1901 he was swept into uniform and went to the South African War, becoming surgeon to the Imperial Yeomanry base hospital. After this experience, he joined in June 1902 the newly created Sudan Medical Service, first as the private doctor to the Sirdar, afterwards becoming director of medical services of the Sudan Government. Five years later he resigned this appointment and became director of the civil hospitals in Khartoum and Omdurman. He had now direct charge of clinical cases and made the most of the rich material under his care.

His career was once more broken by war, when he accompanied Sir James and Lady Berry's Red Cross Unit to Serbia as a surgeon. There he witnessed the break-up of Serbia and was taken prisoner by the

Austro-Hungarian armies. He was, however, soon rescued, and chivalrously released by Slatin Pasha, the Inspector General of the Sudan, who as an Austrian subject had stayed behind in his native country at the outbreak of war.

Early in 1916 Christopherson was in France as the secretary to the War Office Commission on Medical Establishments. Later in that year he was back in Khartoum, where he found several cases of kala-azar who were also infected with bilharziasis—*Schistosoma haematobium*. Having learned of Sir Leonard Rogers's discovery of the specificity of antimony (tartar emetic) in the treatment of kala-azar in Calcutta in 1914, he followed suit, but was surprised to see the schistosome eggs disappear also from the urine, until the cases were cured of both diseases. He also made the pregnant observation, which has since been many times confirmed, that the appearance of the eggs is changed by antimony and that they no longer hatch in water. To Christopherson must therefore go the credit for this notable discovery.

On his return to England after the War, Christopherson was in charge of the bilharzia clinic of the Ministry of Pensions and cured many ex-Service men He then became a specialist in pulmonary disease and physician to the London Chest Hospital, wa also physician for tropical diseases to the Roya Masonic Hospital and took an interest in the tropica diseases section of the Royal Society of Medicine More than twenty years ago he retired to his country home, where he devoted himself to horticulture Christopherson was a sympathetic and friendly person whose great joy was to help others. He had severa endearing and attractive mannerisms; but when occasion warranted he could be tough and firm.

P. Manson-Bahr

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# NEWS and VIEWS

## Presentation to Prof. F. J. M. Stratton, F.R.S.

On August 23, in the rooms of the Royal Astronomical Society, the president, Sir Harold Jeffreys, presented to Prof. F. J. M. Stratton a copy of "Vistas in Astronomy" at a special conversazione. Those present included foreign astronomers visiting the United Kingdom prior to the ninth General Assembly of the International Astronomical Union. On the same occasion, Prof. H. C. van de Hulst, of Leyden, received the Eddington Medal for 1955. It was originally the occasion of Prof. Stratton's seventieth birthday, after his retirement from the chair of astrophysics at Cambridge, that gave the inspiration for "Vistas in Astronomy", intended as a tribute from his former colleagues, students, friends and admirers everywhere. As publication plans progressed, and when the efforts of the editor, Dr. Arthur Beer, to obtain contributions from leading representatives of all nations met with such encouragement and an increasing number of acceptances, it became clear that this was to be something much more than a *Festschrift*. The final outcome is the present work: a generous and thorough cross-section through the whole of contemporary astronomy and its allied sciences, always emphasizing the lines along which research is particularly active at the moment, its new techniques and methods and their interaction with theoretical developments. These two volumes could be compared to the "Handbuch der Astrophysik", published in Germany before the War, although the present work is much wider in scope. It can rarely, if ever, have happened before that so many leading scholars in a single discipline have co-operated in one book on such a wide international scale; indeed, 215 authors from twenty-six nations have joined to produce 192 contributions. That this was possible is a fitting tribute to the international spirit which has permeated Prof. Stratton's life-work in and for astronomy. Practically every country in the world with an active astronomical life has contributed.

## Physical Chemistry at Sheffield: Prof. George Porter

Dr. George Porter, who has been appointed to the newly established chair of physical chemistry in the University of Sheffield, is distinguished for his pioneering contributions in the field of flash photolysis and kinetic spectroscopy. He was Ackroyd Scholar of the University of Leeds, and after graduating in 1941 entered the Royal Navy, with which h served throughout the War as a specialist in the field of radar; he was demobilized in 1945 with the rank of lieutenant. He resumed his studies in the Laboratory of Physical Chemistry at Cambridge, where in due course he was awarded the degree of Ph.D. fo his work on the development of the method and technique of flash photolysis. The application of this powerful method to the study of primary photochemical reactions, to the measurement of very rapid reactions between atoms and free radicals, and th reactions of explosion and combustion, has resulted in a large amount of new and important work published during the past seven years. Dr. Porter was appointed demonstrator in physical chemistry a Cambridge in 1949 and assistant director of research in 1953. He was elected to a fellowship at Emmanue College in 1952. In 1954 he joined the British Rayo Research Association as assistant director, where he was associated with the launching of the new laboratories recently opened by H.R.H. the Duke o Edinburgh. His many friends in Cambridge and th academic world at large will welcome his return t university life, and wish him every success in th building of his new research department.

## United Kingdom Agricultural and Food Representatives in Canada: Mr. Gilbert S. Lawri

Mr. Gilbert S. Lawrie, senior inspector in the Department of Agriculture for Scotland, has bee appointed agricultural and food adviser to the Hig Commissioner for the United Kingdom in Ottawa, in succession to Mr. W. F. Darke, who has complete his tour of duty in Canada. Mr. Lawrie, who thirty-nine years old, was educated at Georg Watson's Boys College, the University of Edinburg and the East of Scotland College of Agriculture. H academic awards include the Stevens Scholarship in agriculture and the Wardlaw–Ramsay Memori Prize and Medal for the most distinguished studen He was president of the Edinburgh University Agricultural Society and leader of the College of Agriculture livestock judging team. His practical experience includes two years work on arable, stock an dairy farms, eleven years on work closely connected with practical farming, and a short period on th taff of Boghall Experimental Farm. For two years e obtained commercial experience with a well-known rm of Scottish seedsmen. During the War he served the Middle East and Mediterranean countries, and as appointed deputy assistant director of supplies ith executive and advisory responsibilities con- ected with the production, purchase, storage and istribution of agricultural commodities and the dministration of extensive War Department farms Palestine and Syria. In 1946 Mr. Lawrie returned Britain and joined the Department of Agriculture r Scotland, where he has served for the past nine ears.

## se of Radioactive Cæsium for Cancer Treatment

THE United Kingdom Atomic Energy Authority nnounces that a new kind of teletherapy source for reatment of deep-seated cancer is being made avail- ble for use at the Royal Marsden Hospital, London. he principles of such treatment are not new, but his is the first time that radioactive cæsium recovered om 'waste' fission products has been used for this urpose. The source itself is a cæsium salt enclosed a metal cylinder about one inch in diameter and ree inches long. It has an activity of 1,000 curies quivalent to that produced by a thousand grams f radium). The extraction, refinement and pre- aration of the source in its capsule was undertaken r the Industrial Group by the Research and evelopment Branch at the Atomic Energy Factory t Windscale, since the raw materials are stored ere. The process is remotely operated within cells aving concrete walls several feet thick, and the salt finally melted at a red heat into the metal capsule. he initial rate of production of these sources will be e to two a month. With the exception of a single perimental source made in the United States, no her country is making cæsium on this scale. The ggestion for utilizing radioactive cæsium, which s a useful life of some scores of years, from atomic le 'waste' arose about 1952 at Harwell, and the otope Division there suggested that it might be itable for cancer therapy. The general proposal to ake these sources was announced at a Hospital hysicists' Association meeting in London in Novem- r 1954, and the first hospitals to use the sources ill be the Royal Marsden and Royal South Hants. ese hospitals have each designed their own special erapy head to contain the sources; other hospitals ay use a head designed by the Isotope Division at arwell to suit the cæsium sources. Two of these ads were exhibited at the International Conference the Peaceful Uses of Atomic Energy at Geneva.

## ience Museum Collection: Supervoltage Machines for X-Ray Therapy

THE Science Museum, London, has recently thered together in its Atomic Physics Collection a all group of exhibits relating to linear electron- celerators. Although for purely-research purposes e cyclic accelerators such as the betatron and nchrotron are the most widely used for the pro- ction of penetrating X-rays for hospital radio- erapy, the travelling-wave linear electron-acceler- r has great advantages and is being installed in increasing number of hospitals in Great Britain. e Science Museum exhibits comprise sectioned rts of an actual accelerator, presented by Mullard, d.; a most ingenious mechanical model illus- ting the principle of the travelling-wave acceler- r, lent by the Metropolitan-Vickers Electrical Co., Ltd.; several diagrams showing the construction and operation of these accelerators; and a group of photographs showing them in use in the Hammersmith Hospital, London, and in the Megavolt Treatment Unit at Newcastle upon Tyne. Other exhibits in this field recently placed on view in the Museum are a betatron presented by the Clarendon Laboratory, Oxford, a model of the Philips cascade generator at the Cavendish Laboratory, Cambridge, and a mechanical model illustrating its principle lent by the Westinghouse Brake and Signal Co.

## Rockefeller Grant for Genetics Research at University College, London

THE Rockefeller Foundation has made a grant of 30,000 dollars to the Galton Laboratory of University College, London, for furthering research in genetics, this grant being an extension of a similar one which has been given to the Laboratory since 1946. The work at the Galton Laboratory is exclusively concerned with human genetics, particular attention being paid to certain specific aspects. In the identification of the effects of genes in homozygous and heterozygous form by biochemical methods, precise techniques are being developed which enable the presence or absence of a gene to be established with minimal chance of error; these principles are being successfully applied to the urinary excretion of cystine and of β-amino-*iso*-butyric acid. Work on the gradual extension of knowledge concerning the human chromosome map is concerned with pairs of conditions located on the same chromosome, which have recently been discovered by members of the staff; examples are, first, the linkage between elliptocytosis and the *Rh* locus and, secondly, that between the 'nail-patella' syndrome and the *ABO* locus. For the ascertainment of the part played by genes in morphological and metrical traits, both normal and abnormal, noticeable at birth, special attention is being paid to fœtal malformations of specific types, including mongolism; the genetical contribution of the mother to weight of the child at birth is being confirmed. Finally, existing methods, and new ones, are being applied to the statistical and mathematical analysis of human genetical data, special attention being paid to the precise ascertainment of gene frequencies and the exact measurement of linkages.

## Photobiology Group

A PHOTOBIOLOGY Group has been recently established in Great Britain "for the purpose of bringing together biologists, chemists and physicists with an interest in this field, to further scientific discussion in this country and to explore the possibilities of international co-operation". The members of the organizing committee are: *Chairman*, Dr. M. H. Pirenne; *Vice-Chairman*, Prof. J. A. V. Butler; *Secretary*, Dr. Edna M. F. Roe; with Dr. Ph. Bauwens, Dr. E. J. Bowen, Dr. R. Hill, Dr. A. D. Lees and Dr. N. Uri. The first meeting of the Group will be held on October 3, 10 a.m.–6 p.m., at Bedford College, Regents Park, London, N.W.1, when four papers will be read: light absorption and energy transfer (Dr. E. J. Bowen); the present state of photosynthesis research (Dr. R. Hill); photosensitive pigment in the retina (Dr. W. A. H. Rushton); and basic principles in the measurement of light energy (J. S. Preston). Those wishing to attend the meeting should write before September 19 to Dr. Edna M. F. Roe, Chester Beatty Research Institute, Royal Cancer Hospital, Fulham Road, London, S.W.3, from whom further particulars of the Group and its membership can be obtained.

### *The Anthropologist*: New Indian Journal

In the India of to-day many diverse populations are being brought into contact with each other. The network of communications extends to the remotest areas, and tribal cultures at all levels are meeting Western civilization at an increasing rate. This has led to an equally increasing activity in the field of anthropology both by non-Indians and Indians. A welcome is to be extended, therefore, to *The Anthropologist*, a biannual journal edited by the Department of Anthropology of the University of Delhi (Rs. 6 a year or Rs. 3.8 a copy). Although the managing director is Dr. P. C. Biswas of Delhi, the editorial board is not restricted to his Department. Among others, it includes B. S. Guha, director of the Department of Anthropology of the Indian Museum in Calcutta, and the first article in the first number is by Ernst C. Büchi of that Department. Incidentally, this is a most valuable contribution to our knowledge of the blood-group secretor factors in India, a demonstration that the secretor status will become important in recognizing the varied composition of mixed Indian communities. The same number of the journal contains a study of juvenile delinquents by P. C. Biswas, anthropometric studies of the Bhotias by S. C. Tiwari, a cultural essay on the Naiks by J. D. Mehra and papers on fingerprint patterns and blood groups. The second number has now appeared and continues along these varied lines, with contributions by Büchi, notably one on the question of sickling in Indian aboriginals, by G. R. Gayre from Saugar, S. C. Dube from Hyderabad and by the Delhi group. We can look forward to a stimulating contribution from India in this field.

### Risks to Wild Life of Agricultural Chemicals

There has naturally been some concern in Great Britain lest the widespread use of chemicals to destroy pests and weeds should be a source of undesirable or even dangerous secondary effects. The risks run by operatives handling such substances and the possibility of harm from eating food exposed to them have already been discussed in two earlier reports ("Toxic Chemicals in Agriculture", 1951; and "Toxic Chemicals in Agriculture: Residues in Food", 1953). A third report, "Toxic Chemicals in Agriculture: Risks to Wild Life", has now been published (pp. 31. London: H.M.S.O.; 1*s*. 6*d*. net). According to evidence collected from a large number of organizations and individuals and some field-experiments carried out to gain information of a more precise nature, it seems that casualties to mammals and birds (including game) due to sprays are probably small. The substances most likely to be harmful are organophosphorus insecticides applied to brassicas in late summer, arsenical compounds used for potato haulm destruction, dinitro weed-killers applied in spring, and DDT insecticides applied to orchards, carrots and peas. Details of some actual fatalities that have occurred are given, and precautionary methods suggested. Danger to insects is probably much greater but more difficult to evaluate. Effects of sprays on honey bees have received special attention in view of the increasing losses reported, and closer co-operation is urged between beekeepers, farmers and spraying contractors. The inquiry has brought to light the need for research and investigation, and among lines of work suggested are the effect on bird of killing large numbers of insects and the extent t which seed production of sprayed crops is reduced b the death of pollinating insects.

### Rubber Research Institute of Malaya

In the current annual report of the Rubbe Research Institute of Malaya for 1952 (Kuala Lumpur 1954), an account is given of the fourth year o operation of the five-year programme of expansio of the organization and work of the Institute. Th present report contains an introduction by th Director and accounts of the work of the severa Divisions—Soils, Botany, Pathology and Chemistry—each subdivided into research and advisory sections An account is also given of the Smallholders Advisory Service. Work on the rubber tree include breeding and selection, a study of tapping systems various soil investigations, cultivation and manuring and the control of diseases and pests. Work on th product begins from the moment of tapping an continues through all the subsequent processes, tha is, it includes the collection and treatment of late and its processing through to the final product fo export. These studies are in the hands of the Chemica Division. Fuller accounts of the experimental wor of the Institute are to be found in its *Journal*, th annual reports being intended to fulfil a mor general purpose.

### Observatory Department, Mauritius: Report fo 1953

The report of the Observatory Department of th Colony of Mauritius for the year 1953 (pp. 16. Por Louis: Government Printer, 1954) describes th general functions of the Department under variou headings, including provisions of meteorologica services for the government departments, loca authorities, the press and general public, agricultura and commercial interests, the Armed Services, th merchant navy and civil aviation; warnings o tropical cyclones; research; and other activitie Besides the Royal Alfred Observatory, the Department also maintains a number of stations a Pamplemousses, Vacoas, Plaisance Airfield, Agalega St. Brandon and other places. In addition to th director, E. G. Davy, there are an assistant directo and thirty-four others on the staff. Descriptions ar given of the inspections and visits, buildings, meteorological instruments, magnetic instruments and othe equipment, etc. It is interesting to notice tha towards the end of 1953 research work was in progress on the influence of rainfall on the rates o growth and maturity of the sugar cane. As th Colony's income depends almost entirely on agricultural products, the Department devotes mos attention to agricultural meteorology. During 195 progress in reorganizing and extending the Department was more substantial than had been possible t report in previous post-war years. This is chiefl attributed to the provision of adequate accommodation at the Vacoas headquarters, the filling o one of the posts of assistant meteorologist, and th increasing experience of observers appointed in 194 and 1950. Further funds for building having becom available and hopes of filling all staff vacancies i 1954 being entertained, the report ends on th optimistic note that "the prospects at the end o 1953 were brighter than they have been for a numbe of years".

## Abstracts of Papers on Radio Engineering

The amount of literature published in the field of radio and electronics is nowadays so vast that any aid to abstracts and references in the subject is very welcome. As a contribution to this end, the British Institution of Radio Engineers has recently published a booklet entitled "Abstracts of Papers which have appeared in the *Journal of the British Institution of Radio Engineers* over the Past 15 Years" (pp. 48; 1955; from the Institution, 9 Bedford Square, London, W.C.1; 2*s.* post paid). Fourteen volumes of this *Journal* have been published during this period, and the papers abstracted include those presented at the latest convention of the Institution held in 1954. The abstracts, which number nearly four hundred, are arranged according to the Universal Decimal Classification system, and the use of the booklet is facilitated by the table of contents and index to authors.

## The Night Sky in September

Full moon occurs on Sept. 2d. 07h. 59m., U.T., and new moon on Sept. 16d. 06h. 19m. The following conjunctions with the moon take place: Sept. 14d. 0h., Jupiter 5° N.; Sept. 18d. 12h., Mercury 2° N.; Sept. 20d. 16h., Saturn 5° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Spica on Sept. 21d. 02h., Mercury 1° S. Mercury is too close to the sun for observation during September, and the same applies to Venus, which is in superior conjunction on September 1. Mars rises about 4h. 40m. throughout September, and during the early part of the month it is close to ρ Leonis, from which its eastward movement takes it south of σ Leonis about September 24. At the end of the month it is west of β Virginis and soon afterwards moves into the constellation Virgo. Jupiter rises at 3h. 15m., 2h. 35m. and 1h. 55m. on September 1, 15 and 30, respectively, and is conspicuous in the constellation Cancer, in which it moves eastward into Leo. Saturn has an eastward movement in Libra and sets at 21h., 20h. 10m. and 19h. 10m. on September 1, 15 and 30, respectively; its change of position is easily noticed as it moves from east of α Libræ to midway between α and γ Libræ towards the end of the month. There is no occultation of stars as bright as magnitude 6 during the month. Autumnal equinox occurs on Sept. 23d. 20h.

## Announcements

H.M. The Queen will open the new buildings of the School of Veterinary Medicine, University of Cambridge, on October 20.

It is announced that Imperial Chemical Industries fellowships for research in the University of Cambridge have been awarded to Drs. B. H. Briggs and R. I. T. Cromartie (Clare College); P. W. E. Grensted (Christ's College); and O. M. Phillips (Trinity College).

The Research Fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About £700 a year is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants should be submitted by November 15 on the appropriate form, obtainable from the General Secretary of the Society at Burlington House, Piccadilly, London, W.1.

The Massachusetts Institute of Technology is offering a small number of scholarships to British graduates in science and technology (not architecture or town planning) to enable them to attend the summer session of the Institute during June 4–September 25, 1956. Candidates must be less than twenty-eight years of age and have done at least two years work in either industrial or academic research since graduating. Application forms, to be returned by October 14, can be obtained from the Cultural Affairs Officer, American Embassy, Room 302, 41 Grosvenor Square, London, W.1.

The Institute of Metal Finishing has decided to revive in a modified form the William James Memorial Prize, founded in memory of its first honorary treasurer. The competition will be in the form of an essay on any aspect of metal finishing or related subject, and will comprise two sections: essays of a theoretical or technical point of view, for which competitors must not be more than twenty-five years old; and essays based on practical knowledge or experience (no age limit). Two prizes of 10 and 5 guineas, respectively, will be awarded in each section. Essays should be 1,000–5,000 words in length and may be illustrated. They should be sent not later than October 31 to the Honorary Secretary, Institute of Metal Finishing, 32 Great Ormond Street, London, W.C.1.

The Photoelectric Spectrometry Group is carrying out a survey of the demand (in Great Britain) for solvents for spectroscopic purposes, with particular reference to the purity required at specified minimum wave-lengths and the quantities used. A questionnaire has been prepared and is ready for distribution to as wide a field of solvent users as possible. Copies of the questionnaire can be obtained from the assistant honorary secretary of the Group, K. A. Macdonald, 56 Arbury Road, Cambridge.

The Metal Physics Committee of the Institute of Metals is organizing a one-day symposium on "The Mechanism of Phase Transformations in Metals", to be held in the Royal Institution, Albemarle Street, London, W.1, on November 9. The morning session will be devoted to transformations of the nucleation and growth type, and the afternoon session to martensitic transformations. Eighteen papers will be read. Non-members of the Institute may attend the meeting, registration forms being obtainable from the secretary of the Institute, Lieut.-Colonel S. C. Guillan, 4 Grosvenor Gardens, London, S.W.1.

A symposium on "Cavitation in Hydrodynamics" will be held at the National Physical Laboratory during September 14–17. There will be sessions on factors governing the inception of cavitation, experimental techniques, scale-effect factors, effects on hydrodynamic performance and cavitation damage. The opening paper will be a survey by Mr. P. Eisenberg, of the U.S. Office of Naval Research. Further particulars can be obtained from the Director, National Physical Laboratory, Teddington, Middlesex.

Erratum. In "Definition of the Second of Time" on p. 282 of *Nature* of August 13, it is stated, "If the position of the Moon at any time can be determined to 0·05 sec., a period of four years would be necessary to obtain an accuracy of 1 in $10^9$ in time and frequency derived from astronomical observation". 0·05 sec. should read 0·05″.

# CHEMICAL RESEARCH LABORATORY, TEDDINGTON

## REPORT FOR 1954

UNDER the title "Chemistry Research 1954"* are comprised the report of the Chemistry Research Board, signed by the chairman, Prof. E. L. Hirst, and the report of the director of the Chemical Research Laboratory, Teddington, Dr. D. D. Pratt. To these are appended lists of committees of the Board, publications and patents in 1954, staff of the Laboratory on December 31, 1954, metals held by the Pure Metals Committee, standard substances available, and organisms deposited in the National Collection of Industrial Bacteria since publication of the catalogue. Considerable expansion in work on the purification of metals and elements required as semiconductors has been approved by the Board, and, in emphasizing the value of such special services as the provision of standard organic compounds, pure metals and cultures of industrial bacteria, the Board comments on the necessity of providing sufficient staff to prevent reduction of the general research programme. The Board has also recommended commencement of research on the purification of the five elements in addition to gallium and germanium, of interest as semiconductors—antimony, indium, selenium, tellurium and silicon. As part of an investigation on the preparation of the pure rare-earth metals, the separation of the rare earths is being studied using ion-exchange methods. On the recommendation of the Pure Metals Committee, investigations were also in progress on the preparation of pure boron at the Imperial College of Science and Technology, London, and of pure chromium at the National Physical Laboratory, Teddington. The Board's report also notes the provision by the Laboratory of highly purified benzene to a university team acquiring data on compressibility, and pure *p*-xylene to another group working on the thermodynamics of solutions, while joint work with the National Physical Laboratory, now concluded, has made benzoic acid of certified calorific value commercially available.

Other work noted in the Board's report includes the promise of zone melting as a technique for purifying organic compounds, and the pharmacological properties of 4-hydroxy*iso*phthalic acid, available as a by-product in the reaction of carbon dioxide with sodium phenoxide; the value of the chromatographic procedures worked out for the detection and determination of copper, cobalt, niobium and tantalum in geochemical prospecting; the quantitative separation of such metals as copper, cobalt, nickel and iron by elution from a cation-exchange resin by means of an organic solvent mixture; and the use of ion-exchange membranes in an electrolytic cell for separation of ions. Studies on the applications and fundamental characteristics of membranes exhibiting molecular selectivity have been extended to include an examination of the preparation and properties of ion-selective membranes, and encouraging progress has been made towards an understanding of the processes underlying the preparation of polyvinyl alcohol membrane of graded molecular selectivity. A new series o membranes prepared from methoxymethyl nylo promises to find application in industrial dialysis. I is possible that the technique used in the continuou culture apparatus, transferred from Porton to th Laboratory, may be used for increasing the efficienc of some industrial fermentation processes. A laboratory method has been developed for the productio of hydrogen sulphide from sulphated raw sewag sludge; this method could be economically attractiv at a time of sulphur shortage. The use of wast chromate to stop the evolution of hydrogen sulphid from a wet clay pit polluted with refuse at Ne Malden, Surrey, may be of wider application in refus disposal and in the recovery of derelict areas.

The staff of the Chemical Research Laborator numbered 183 at the end of the year, and there wer some twelve guest workers, many of whom came t study special techniques used by the Laboratory The stock of pure metals held by the Laboratory wa increased to twenty-nine by the addition of cerium molybdenum and tungsten, and the addition o naphthalene, 2-methylnaphthalene and *iso*propylbenzene brought the number of reference specimen of organic compounds to forty-four, from which 59 samples were supplied during the year. Depositio of eighty new strains brought the total in the Nationa Collection of Industrial Bacteria to 750, and durin the year 895 cultures were supplied, 522 to researc and educational and 373 to industrial establishment

The director's report again stresses the extent of th advisory work on corrosion problems, on which som 240 requests for advice were received during th year. Many of these were concerned with corrosio by fresh water as in heating systems, in hydrauli systems, and of copper pipes carrying supply waters but the largest number of inquiries was concerne with methods of combating corrosion by sea-wate Problems of corrosion in other environments include that in oil-fired cracking units handling acetic acid an acetone, and in stainless-steel equipment in contac with the oxidation products of acetic and formi acids at high temperatures. Advice was also give on methods of film stripping and the preparation o samples for electron diffraction examination, and th use of capacitance methods for the examination o protective coatings and of radioactive tracers i studying inhibitor mechanism.

Advice was given to a rural district council confronted with a serious financial problem in th cathodic protection of more than a hundred miles o cast-iron water mains, and as a result of a survey i was possible to indicate those sections which require protection, thus saving a considerable part of th cost. Another inquiry was concerned with th external protection of small-diameter mains used fo carrying the various spray fluids for pest control o fruit farms; encouraging results were obtained wit cathodic protection. Many inquiries were concerne with the protection of materials and articles agains corrosion in storage and transit. Advice was give on overcoming corrosion troubles in complete watches intended for export; on the possible effect of vapour-phase inhibitors in stress corrosion and in steam lines in tobacco-manufacturing plant; on the pitting of stainless steel orifice plates stored between gaskets of impregnated-asbestos; the use of *cyclo*hexylamine carbonate as an inhibitor in the upper part of oil storage tanks at Aden and for the protection of boilers, the effect of different finishes on aluminium, on the adhesion of mastics to greenhouse frames, and the accelerated production of a green patina on the Australian War Memorial at Canberra.

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* Department of Scientific and Industrial Research. Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory, for the Year 1954. Pp. iv+71. (London: H.M.S.O., 1955.) 3s. net.

Samples of preparations containing 'Gammexane', divinyl ether, casein, γ-picoline, mesitylene pseudocumene, chlorocresols, substituted anisoles and other substances were examined with the infra-red spectrometer for various firms; many requests continued to be received for information and advice on distillation techniques, determination of freezing-point, methods of analysis and physico-chemical constants, and the Laboratory's high-pressure equipment was frequently used in preparative work by industrial firms and academic workers. Much advice was given on the construction and use of the osmometers and thermostat baths developed in the Laboratory for the determination of the molecular weights of polymers and on the application of ion-exchange processes to industrial problems, while many requests for assistance are now being received by the Radiochemical Group.

During the year the Corrosion of Metals Group suspended work on the use of radioactive tracers in the study of the mechanism of corrosion inhibitors and on the electrical study of boiler corrosion, and the study of boiler corrosion was intensified. The corrosion of mild steel in boiling sodium chloride was being examined, and an investigation into the corrosion of mild-steel tubes in Scotch marine boilers was continued. A systematic attempt was being made to correlate the influence of the rate of movement on the corrosion of metals immersed in neutral solutions and natural waters with other factors, especially the temperature and composition of the solution, while a survey was being made of the corrosion-inhibitive properties, with reference to abraded mild steel, of sodium salts of organic acids related to benzoic acid. An electrochemical method has been used to determine the degree of continuity of the protective coating on the inside of water mains. Work on underground and microbiological corrosion was concentrated on examinations of corroded pipes, electrical power cables and soil samples, but further work is required before a practical method of applying tannins to prevent bacterial corrosion of steel can be developed. Other work has been concerned with the effect of silicon on surface films on stainless steels, and new work has been started on wrapping materials for preventing the tarnishing of silver and copper, for which purpose incorporation of chromates of copper, lead, zinc, *cyclo*hexylamine and other amines, copper and lead phosphates, lead nitrite, chromic sulphate and chlorophyll in the paper wrapping has proved particularly effective.

Research in the Inorganic Group has again been mainly concentrated on the examination of flash coaster wastes for selenium and its recovery and on the preparation of elements and derivatives to a high degree of purity. Recovery of selenium by sublimation under oxidizing conditions, with the formation of the dioxide which condenses to a crystalline solid, has the advantage of separation and purification in one step. Extraction of selenium with sodium cyanide has the advantage that it can be applied direct to washed sludges, and the resulting solution when acidified deposits red, amorphous selenium. Many procedures have been examined in the search for satisfactory methods for the microdetermination of carbon, hydrogen and fluorine.

The Radiochemical Group has given special attention to the use of ion-exchange resins for the recovery of metals from solution, particularly the recovery of gold and associated metals from cyanide solution with 'Amberlite *IRA*-400'. Considerable improvements have been made in the chromatographic technique for the separation of niobium and tantalum, and details have been worked out for the determination of rhodium, platinum and palladium, using a paper-strip technique with a solvent mixture of methyl *iso*butyl ketone and hydrochloric acid. A study of the elution of nickel and copper with organic solvents from the cation-exchanger 'Zeocarb 225' showed that an analytical separation could be obtained using acetone containing a controlled amount of water and hydrochloric acid for the elution of copper.

In the Organic Group, purification work on large batches of hydrocarbons, cresols, xylenols and butidenes has been pressed further. In preliminary experiments on the zone-melting of naphthalene containing 0·2 per cent anthracene, the passage of eight zones reduced the anthracene content in half the charge to less than 1/10,000th of its original value. The critical temperature of acetylene has been determined as 35·18° C. by observations of the disappearance of the menisci in sealed tubes immersed in a water-bath. Some nine hundred infra-red spectra were measured during the year, as well as some thermodynamic properties of very dilute aqueous solutions of methylpyridines, ethylpyridines and pyridine at 25° and 40° by a transpiration technique in an attempt to establish why certain of these bases exhibit closed-loop solubility curves. Preliminary results indicate that 4-hydroxy*iso*phthalic acid is less toxic and more effective than aspirin, and at least as effective as aspirin, in counteracting fevers in rabbits caused by a preparation of pyrogen from *Proteus vulgaris*. A study of the reaction of phosgene with ethylene oxide has been extended to epichlorohydrin, propylene oxide, 2 : 3-epoxybutane (*trans*), styrene oxide, *cyclo*hexane oxide and di*iso*butylene oxide. Further derivatives of resorcinol have been investigated in relation to condensation polymerization with formaldehyde, and attempts made to introduce the arsenic acid group into a chloromethylated polystyrene, while the reaction of carbon monoxide with lithium aluminium hydride solutions has been re-investigated using carbon-14 monoxide.

The High Polymers Group concentrated its attention on the same main themes as in 1953, and has made further progress in the investigation of the complexing behaviour of amphoteric resins based on cross-linked polystyrene. A bibliography has been prepared containing approximately four thousand references to the preparation, properties and applications of ion-exchange resins. Factors controlling the semi-permeability of polyvinyl alcohol membranes continued to be studied.

The Microbiological Group continued its fundamental studies on sulphate-reducing bacteria in four main directions: the intermediates formed during the oxidation of simple carbon compounds such as malate; a preliminary study of a polysaccharide formed by these bacteria; the function of their cytochrome in the cell metabolism; and the concentration, purification and identification of various cell pigments. The bacterial cytochrome extracted from large quantities of acetone-dried cells appears to be quite distinct in properties from any cytochrome hitherto described. Studies on the breakdown of phthalic acid by a Gram-negative aerobic rod (NCIB 8334) isolated from an industrial percolating filter indicate that attack does not follow the degradative pathway via *cis-cis*-muconic acid described for several other aromatic compounds. Mutation studies have been started with this organism to obtain strains with a block in the metabolic pathway of phthalate oxidation.

## BIOLOGICAL AND MICROBIOLOGICAL METHODS OF ESTIMATING VITAMIN $B_{12}$

A CONFERENCE on "Biological and Microbiological Methods of Estimating Vitamin $B_{12}$", organized by the Biological Methods Group of the Society for Analytical Chemistry, was held on May 13 in the lecture hall of the Royal Society for Tropical Medicine and Hygiene at Manson House, Portland Place, London. In his opening remarks, the chairman, Dr. L. J. Harris (Dunn Nutritional Laboratory, Cambridge), reviewed briefly the development of the present knowledge of vitamin $B_{12}$, from the discovery by Minot and Murphy in 1926 that pernicious anæmia could be controlled by the use of a liver preparation, to the isolation from liver of the curative principle—vitamin $B_{12}$—by two separate groups of workers, one in Britain and the other in the United States. In the United States the isolation was greatly speeded up by the application of a microbiological control technique, based on the finding that the clinical activity of liver preparations was closely paralleled by their activity for a strain of *Lactobacillus lactis*, which had been shown by Shorb to require an unidentified growth-factor present in liver. Both the *Lb. lactis* factor and the anti-pernicious anæmia principle were later identified with vitamin $B_{12}$.

During recent years, the *Lb. lactis* assay has been largely superseded by improved microbiological techniques, employing a variety of test micro-organisms. In addition, the biological techniques with chicks and rats have been developed and improved. All these different techniques are attended by the inevitable problems of specificity of test, and in some cases of completeness of extraction. Dr. Harris then posed the question: How far do the different methods of assay measure the same thing?

In the unavoidable absence of Mr. F. A. Robinson, his introductory paper was read by Mr. M. E. H. Fitzgerald (Allen and Hanbury, Ltd.). Mr. Fitzgerald pointed out the fundamental difficulties which can complicate the microbiological assay methods. The presence in natural materials of compounds closely related to vitamin $B_{12}$, inactive for higher animals and differently active for different test micro-organisms, can give misleading results. In some of the assays non-specific responses are caused by reducing substances, deoxyribosides or methionine. Then again, in some materials—milk and blood serum, for example—the vitamin is present in a bound form, unavailable to the test micro-organisms. Generally the vitamin can be liberated by heating or enzyme proteolysis in the presence of cyanide. Bu heating with cyanide does not in all instances releas free cyanocobalamin. Mr. Fitzgerald pointed ou that liver contains alkali-stable compounds that ar active for the test micro-organisms, and among thes may be an alkali-stable form of vitamin $B_{12}$.

A survey of published and unpublished value obtained for liver and liver extracts suggests th presence in them of a form of vitamin $B_{12}$ active fo *Lb. leichmannii* but not for *Escherichia coli*. Furthermore, it appears that neither organism responds t some clinically effective forms of vitamin $B_{12}$.

Dr. R. H. Girdwood (Department of Medicine University of Edinburgh) considered the measurement of vitamin $B_{12}$ in the blood serum, and describe in some detail his technique of assay with *Lb. leichmannii*. By this method, normal values rang between 130 and 750 μμgm. vitamin $B_{12}$/ml. Althoug to the clinician vitamin $B_{12}$ deficiency is usually synonymous with megaloblastic anæmia, a low serum vitamin $B_{12}$-level may precede the development o anæmia. Dr. Girdwood suggested that probably the best way to measure serum vitamin $B_{12}$-levels is to use both the *Lb. leichmannii* and *Euglena gracilis* assays.

The next speaker, Dr. D. H. Shrimpton (Rowett Research Institute, Aberdeenshire), discussed the problems of measuring vitamin $B_{12}$ in animal feeding-stuffs, using *Lb. leichmannii* and *Ochromonas malhamensis* as test micro-organisms. In general, enzymic extraction procedures are unnecessary, and may in fact introduce non-specific growth stimulants. Autoclaving the test material with water at pH 4·8 in the presence of a trace of cyanide is usually sufficient to liberate the vitamin quantitatively.

The *Lb. leichmannii* assay is subject to interference by deoxyribosides and by a variety of vitamin $B_{12}$-like compounds. In practice, in the tube assays, interference by deoxyribosides is only rarely encountered, except with materials very low in vitamin $B_{12}$ and rich in nuclear material. Similarly the vitamin $B_{12}$-like compounds are of limited occurrence, being largely confined to natural materials that have been subjected to microbial fermentation.

*Ochromonas malhamensis* closely resembles the higher animals in the specificity of its requirement for vitamin $B_{12}$. But in practice the activity measured by micro-organisms is not necessarily a reliable prediction of the gross vitamin $B_{12}$-activity of feeding-stuffs for higher animals. In fact, the results of a comparison of chick and microbiological assays of a variety of feeding-stuffs indicate that, in general, the less specific micro-organism, *Lb. leichmannii*, approximates more closely to the findings by chick assay. This agreement is possibly fortuitous, but is nevertheless useful at the present stage of development of methods for assessing vitamin $B_{12}$ activity.

Dr. Margaret E. Gregory (National Institute for Research in Dairying, University of Reading) described the measurement of vitamin $B_{12}$ in milk. Three test micro-organisms—*Ochromonas malhamensis*, *Lb. leichmannii* and *Esch. coli*—give closely similar results when used for assaying the vitamin in the milk of several animal species. For routine use, *Lb. leichmannii* is preferred as test organism, largely because no shaking machine is needed with it. A further advantage is that with turbid extracts the growth responses can be measured titrimetrically.

Vitamin $B_{12}$ occurs in milk, mainly as cobalamin, in protein-bound form. In cow's milk the vitamin can be liberated simply by diluting the milk with water and heating at $p$H 4·8 in the presence of a trace of cyanide. In human and pig milk this simple procedure is inadequate, and it is necessary to liberate the vitamin by treatment with cyanide-activated papain.

In the next paper, Dr. Marie E. Coates (National Institute for Research in Dairying, University of Reading) discussed the biological techniques for the assay of vitamin $B_{12}$. It is generally necessary to deplete the reserves of the test animals, either by restricting the vitamin $B_{12}$ intake of the dams or by the inclusion of stress factors in the diet. The chick is probably a more suitable test animal than the rat; but both are likely to over-estimate the potency of crude materials containing unidentified growth factors unrelated to vitamin $B_{12}$. The presence of vitamin $B_{12}$-like compounds does not greatly complicate the biological assays. Only the recently discovered vitamin $B_{12}$III is active, and that only to the extent of one-twentieth of the activity of vitamin $B_{12}$. Although biological assays give a measure of the physiological availability for the test species, there is evidence that some of the naturally occurring bound forms of the vitamin present in one species may be poorly utilized by animals of other species.

The final paper of the conference was read by Dr. W. R. Pitney (Postgraduate Medical School, London), who considered the assay of vitamin $B_{12}$ in blood serum, using *Euglena gracilis* as test organism. The assay is very highly sensitive, and only small volumes of serum are required. It is probable that, with serum, *Euglena* is specific for vitamin $B_{12}$. Earlier reports of non-specific stimulants in occasional samples of serum may well have been due to contamination of glassware with vitamin $B_{12}$. Assays on 560 samples of serum have shown a coefficient of variation of 20 per cent, a degree of accuracy more than sufficient for clinical purposes.

*Euglena* assay shows that vitamin $B_{12}$ in human serum is mostly bound to protein, and this finding is confirmed by dialysis and electrophoresis. Vitamin $B_{12}$ in liver homogenates is assayed as 'free', but behaves on dialysis and electrophoresis as 'bound'. It is probable that vitamin $B_{12}$ occurs in two bound forms in biological materials—a firmly bound form in serum in which the vitamin is unavailable to *Euglena* without preliminary heating, and a looser combination in tissues.

# NON-DESTRUCTIVE TESTING GROUP OF THE INSTITUTE OF PHYSICS

## SUMMER MEETING

THE summer meeting of the Non-Destructive Testing Group of the Institute of Physics was held during June 22–25 in the Royal Technical College, Glasgow. On the evening of the first day, Sir Andrew McCance gave an address in which he traced the progress made, in his lifetime, by the introduction of physical methods into industry, and he emphasized the increase in speed and accuracy which has been achieved by the establishment of non-destructive techniques. He directed attention to the fact that future progress in the testing of materials is dependent upon the systematic investigation of physical phenomena, and he exemplified his argument by reference to the study of damping capacity. Later during the meeting Sir Andrew arranged for members to visit the Lanarkshire Steel Company and the Dalzell Research Laboratory, both of which are at Motherwell.

The first paper of the meeting, by Mr. T. S. Wylie (Department of Natural Philosophy, Royal Technical College, Glasgow), dealt with the course of training in radiography which forms part, albeit a small part, of the four-year course in applied physics at the College. Mr. Wylie showed how great is the care needed in planning the training so as to provide adequate instruction and experience when the time allotted to radiography can be no more than that covered by ten lectures and forty hours of work in the laboratory. He reported on the analysis, which he has carried out, of the requirements for a course in radiography, and explained, by reference to a number of charts and tables, how he has established a course in which the progress of the lectures is closely integrated with the progress of the experimental work and from which all unnecessary detail has been eliminated. During his lecture, and again in the discussion which followed, Mr. Wylie stated that he had found lack of knowledge of foundry practice on the part of students one of the biggest handicaps in the study of radiography; he stressed the need for students to spend time working in a foundry.

The importance of radiography to the shipbuilder has long been recognized, and Mr. Duffy (Clyde Shipbuilders' Association) explained how, at the time of the change from the use of riveted joints to welded joints, the Clyde shipbuilders combined together to operate an organized district scheme for the radiographic inspection of welded structures. He described the way in which this scheme operates and gave details of the equipment which is made available by it for inspection purposes. Owing to the difficulty of moving around ships with large X-ray units, the use of isotope sources for site work is preferred; and in this connexion Mr. Duffy remarked that, because of the portability of isotopes, their use shows considerable economy over that of X-ray units, even though longer exposure times are required.

Mr. Duffy dealt with the precautions necessary to protect personnel from radiation and high-tension equipment on site inspection. He then directed attention to the impossibility of carrying out a one hundred per cent inspection of the welds on a ship, and stated that the main object of radiographic examination in shipbuilding is that of testing the welder rather than the weld. Radiography is best used as a test for control of weld quality, and nobody should be allowed to make a single weld on a ship before his ability has been assessed by radiographing test plates welded by him. Mr. Duffy concluded his paper by describing the types of defects found in welds and by showing how radiographic examination enables wrong welding procedures to be detected.

Although the capital expenditure involved in the purchase of industrial boilers is large, this expenditure is small compared with the cost of the fuel consumed by the boilers. Boilermakers are, therefore, always trying to increase the thermal efficiency of their products, and this is done by designing boilers to operate at higher temperatures and pressures. The paper by Mr. W. E. Marskell (Babcock and Wilcox, Ltd.) was therefore concerned with the establishment of a system of non-destructive testing which would ensure the safe working of boilers. He emphasized the importance of radiography and gave examples of the use of X-rays and $\gamma$-rays. Much attention was given in the paper to the increasing use of ultrasonic testing, its appeal being attributed to its sensitivity to the detection of small defects, its cheapness and to the fact that by its use no precautions need to be taken for the protection of personnel. Mention was made of magnetic testing, particularly in connexion with the detection of sub-surface faults in butt-welded pipes.

The lecture by Dr. R. W. B. Stephens (Imperial College of Science and Technology, London) was concerned with the physical principles underlying the establishment of non-destructive testing techniques. He confined his attention to surface properties and reviewed those properties which are, or could be, used as a means of detecting 'geometrical defects' (surface cracks and lack of flatness) and of studying the surface structure of materials. The difficulty of defining exactly what is meant by a surface was mentioned, and attention was directed to the care which must be exercised to ensure that the process of surface examination does not in itself involve a change in the conditions of the surface (for example, cutting sets up mechanical strains; polishing may destroy crystallinity). Dr. Stephens's treatment of his subject included a review of the optical properties of surfaces with reference to their application as a basis for the development of non-destructive testing methods; and an appraisal of the effectiveness, for the examination of surfaces, of magnetic and electrostatic fields, eddy currents, mechanical waves (Rayleigh waves), surface (electrical) resistance, heat flow, electron emission and spectroscopic examination.

Dr. D. Tabor (Department of Physical Chemistry, Cambridge) began his lecture on the physical meaning of indentation and scratch hardness by describing the nature and area of contact between two surfaces. He then went on to define 'hardness' as the resistance of a material to deformation and to describe the methods of measuring hardness. He showed that values of indentation hardness provide a measure of the plastic properties of materials and not of their elastic properties. By means of an elementary examination of stress–strain curves, he defined the term work-hardening index, and, with reference to the Vickers and the Brinell hardness, he derived the simple relationships between hardness and yield strength for materials which do, and do not, work-harden. Dr. Tabor then turned his attention to the subject of scratch hardness. He referred to the first scratch-hardness scale formulated in 1824 by the geologist Mohs, and he discussed the establishment of scratch-hardness scales as well as the conditions under which one surface will scratch another. He explained the fact that under high hydrostatic pressure brittle materials become ductile, and showed that the scratch hardness and the frictional behaviour of brittle materials are dependent upon their plastic properties and not upon their brittle properties.

Mr. H. L. Carson (British Welding Research Association) gave an assessment of ultrasonic techniques, with special reference to welds, in which he traced the development of weld inspection by ultrasonics. He made a critical survey of the methods of injecting ultrasonic beams into welded materials and paid particular attention to probe design, the coupling between the probe and material under inspection, the monitoring of the contact between the probe and the material by use of subsidiary crystals, and the choice of direction of the ultrasonic beam relative to the position and orientation of the weld. The value of the use of shear waves for weld inspection was emphasized and, with reference to particular cases Mr. Carson showed when single probes and double probes should be used.

The problem of assessing the significance of defects was stated as presenting the greatest difficulty associated with ultrasonic inspection of welds. It is frequently not possible to decide whether the cathode-ray tube trace, showing the presence of a defect, is indicative of a serious defect or not. In this connexion, Mr. Carson pointed out the necessity for some form of instrument standardization and criticized the present standard test-block procedure which has been established for this purpose.

In their paper on problems in the interpretation of ultrasonic tests on steel, Mr. I. M. MacKenzie and Mr. R. Kennedy (Colvilles, Ltd., Motherwell) directed attention to the shortcomings of such tests as a means of inspecting steel. While they recognized the valuable contribution made to inspection by ultrasonic methods, they were able to point to many examples where ultrasonic tests have yielded erroneous indications and, although these examples were of an exceptional nature, it was easy to appreciate that the exceptions tend to undermine the confidence which the steel-maker must have in his testing procedure. Mr. MacKenzie and Mr. Kennedy left no doubt in the minds of the physicists in the audience that improvements in ultrasonic testing are essential and that these improvements can only be achieved by intensive effort on the part of physicists working in close collaboration with metallurgists and engineers.

Preliminary experimental work to determine the uses to which neutron radiography can be put is being carried out at the Atomic Energy Research Establishment, Harwell, and Dr. J. Thewlis and Mr. R. T. P. Derbyshire described the progress which has been made so far at the Establishment. An introductory account was given of the properties of thermal neutrons, from which it was seen that there are striking differences in the absorption, by materials, of X-rays and neutrons (for example, water has a high absorption coefficient for neutrons, whereas lead is relatively transparent to them), and, although the highly penetrating character of neutrons should make them suitable for radiography, their negligible photographic effect is a handicap to their use. The experimental work described was concerned mainly with the construction and performance of intermediate screens which have been devised for overcoming this difficulty, and a series of radiographs obtained with the apparatus described was shown with the object of illustrating the kind of application to which neutron radiography can be put. The most effective source of neutrons is a nuclear reactor; but Dr. Thewlis described a number of other sources which could be installed and used in industry if neutron radiography is ever required.

The final paper, by Dr. E. G. Stanford (Aluminium Laboratories, Ltd., Banbury), dealt with the scope of non-destructive testing. Tests are made on materials to check their dimensions, to detect the presence of defects and to determine their properties, and in his paper Dr. Stanford enumerated the tests devised for these purposes. Testing procedure involves the examination of specimens taken from a material or the examination, by non-destructive methods, of the material itself. Tests made on specimens may involve the destruction of the specimen, a change in the material of the specimen without its shape being destroyed, or no change whatever in the specimen. The field of non-destructive testing should cover all tests except those in which the specimen is destroyed.

Engineers are usually obliged to attach most importance to those properties which are determined from tests in which the specimen is destroyed. This means that the actual material which goes into service is not tested. As advances take place in engineering design, and materials are required to operate under increasingly severe conditions, it is becoming essential to know that the material put into service has the properties quoted from tests on specimens taken from it. Non-destructive tests should therefore be developed which will give this information, and the means of establishing such tests will come by three lines of study: how those properties determined by non-destructive tests vary with the constitution and structure of materials; how these properties can be used to identify changes in constitution and structure; and how to relate changes in constitution and structure to those properties which are determined by destructive tests.

# APPLICATIONS OF ULTRASONICS

## CONFERENCE IN MARSEILLES

THERE have been a number of conferences on various aspects of ultrasonics during the past few years, and that held in Marseilles during May 23–28, under the auspices of the Centre National de Recherches Scientifiques, was devoted to applied ultrasonics, though some papers on fundamental aspects were also read. The conference was subdivided into four sections comprising physical, chemical and medicobiological applications and transducers. Most papers fell into the first and third divisions. Prof. F. Canac (66 rue St. Sebastian, Marseille), the organizer of the conference, expects to publish in a book all the papers presented, and they may also appear as a special volume of *Acustica*.

The scientific part of the meeting opened with an account of the pioneer work of Langevin and Florisson in the use of ultrasonics for underwater detection, recalled by Prof. F. Canac, and then Prof. A. Giacomini presented statistics of the different types of applications during the past twenty years. About fifty sectional lectures and papers were read, of which it is only possible here to mention those which involve recent applications in industry and the like.

R. G. Busnel and M. Degrois showed an interesting film of the actions produced in a liquid under pressure when small cavitation bubbles appear in the liquid and the familiar geyser rises from the free surface. At higher pressures the latter disappears, particularly when the pressure is diminishing, and the cavitation nuclei coalesce leaving a flat free surface. No explanation was offered for these experiments, and as only one frequency was tried it is not possible to determine whether resonant vibrations of the cavity bubbles are concerned.

Prof. E. Meyer showed some interesting experiments with ultrasonics in a large box, imitating on a small scale the distribution of the sound amplitude throughout an auditorium due to a steady audible source. It was possible, by varying the form of protuberances applied to a wall and by having the other walls either hard or absorbent, to study the diffusive properties of the box for the ultrasonics. Dr. E. G. Richardson gave an account of the incidence of ultrasonics in recent aeronautical research, dealing in particular with the high-frequency output of jet engines and relaxations in substitute vapours used in supersonic wind-tunnels. The former was also the theme of an investigation by Mlle. M. Merle, who used small jets in the laboratory.

L. Bergmann described an apparatus for quickly giving warning of the presence of an explosive mixture in a room, by the use of an ultrasonic interferometer, while C. Florisson and R. Esche and collaborators described apparatus for coagulating and generating, respectively, aerosols of fine dispersion; these are of importance in chemical industry and the practice of medicine. In the same field V. Gavreau described the development of ultrasonic whistles which can be applied to—among other things—the coagulation of smoke.

A considerable number of papers occupied the medical and biological section, mainly emanating from Germany, where this type of application is much developed. Applications of ultrasonics in this field ranged from the treatment of nervous diseases and cancer to promoting the germination of wheat and killing of bacteria. To some of these a specific effect of frequency (or of wave-length) was attributed; but in many applications, apart from the concentration of energy to be obtained, it seems that vibrations over quite a gamut of frequency can be effectively employed (this is also true of the formation of emulsions, as M. Degrois and his colleagues showed).

After thirty years of experience of ultrasonics in applied biology, it is not yet definite how far the effects are thermal and how far mechanical, but Dr. J. Stetler gave an interesting lecture on this problem, describing some careful experiments in which he sought to distinguish these two effects by using first continuous waves and then reiterated pulses of different lengths. In the fourth section, it is only possible to cite a lecture by C. F. Brockelsby, in which he gave many data for the development of magneto-striction generators of high power.

# INSTITUTE FOR SCIENTIFIC RESEARCH IN CENTRAL AFRICA

## REPORT FOR 1952

THE fifth annual report of the Institute for Scientific Research in Central Africa, Leopoldville, Belgian Congo, covering the year 1952 has recently been published*. Besides the administrative reports, among which that of the director, L. van den Berghe, gives a summary of the scientific work of the Institute during the year, it includes V. G. Dethier's paper on the biting response of tsetse flies, a bibliography of *Plasmodium berghei* by I. H. Vincke and M. Lips, an account by the director of the laboratories of the Institute at the Scientific Research Centre at Kivu, Lwiro, and a long account of the medical mycology of the Belgian Congo by R. Vanbreuseghem. A bibliography of papers published during the year by members of the Institute's staff or associated investigators is amplified by abstracts of the papers.

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* Institut pour la Recherche Scientifique en Afrique Centrale (I.R.S.A.C.): Cinquième Rapport Annuel. Pp. 377. (From the Institute's Offices in Brussels, 1955.)

Among investigations in progress noted by the director in his report are an entomological inventory of the different natural regions as a prelude to a study of their fauna and a study of the entomological fauna of the remains of the primary forests still existing in Ruanda-Urundi; investigations on the cycle of trypanosomes; and studies of climatic and technical problems in tropical habitation. Other studies have related to the control of malaria among children in the plain of Ruzizi and the territory of Uvira, the transmission of trypanosomiasis by *Glossina brevipalpis* on the River Malagarasi, the use of electrophoretic diagrams in nutrition studies, such as in a case of kwashiorkor, morphometric studies of the lakes of Bulera, Luhondo, Mohasi, Mugesera, Bilala, Sake and Bugwero, in Ruandi, including also plankton studies and the study of the littoral fauna. Therapeutic studies of kwashiorkor, studies of the incidence of goitre in Ruanda, of the sensory physiology of the tsetse, a physico-chemical and hydrobiological study of Lake Gileppe, near Verviers, and of the variation with altitude of the potential gradient of the sun have also been made, and biochemical methods applied to the determination of proteins, protein fractions, lipids and cholesterol of blood.

Intraspecific variations among *Hyperolius viridiflavus* and *H. lateralis* have been studied in Ruanda and Urundi; *Schoutedenella mossoensis* sp. n. du Mosso, probably a new race of *Hyperolius cinnamomeoventri*, a Congo species encountered for the first time in Ruanda in the valley of the Akanyaru, was captured as well as three other species not previously captured in Ruanda-Urundi: *Atractaspis bibroni rostrata*, *Hyperolius oxyrhynchus* and *Schoutedenella lameerei*. An inventory and ecological study were made of some arthropods of the Great Lakes, and a study of the indigenous political organization of the kingdom of Ruanda was completed for presentation as a thesis. An inquiry into the migrations and biology of the fish of a river torrent in the Tanganyika basin, studies of the syncline of Itombwe between Lakes Kivu and Tanganyika and of the frequency of the sickle-cell trait, examination of anthropometric practices in Ruanda-Urundi, the prehistoric industry of the plain of the Lemba, anæmia in states of malnutrition and paludism in mammals and the invertebrate hosts are also noted, as well as the reorganization of the system of demographic inquiry in Ruanda-Urundi.

# HOP PICKING BY MACHINE

SINCE the Second World War, shortage of labour for picking hops by hand has forced English growers in increasing numbers to turn to the use of picking machines. In 1947 it was estimated that not more than eight machines were in use; the figure had increased to more than a hundred machines in 1954 and a further hundred machines are on order for 1955. These machines are mainly large stationary types which are best suited to the needs of growers of larger acreages. Smaller machines are being produced for the smaller growers, so it is probable that within a few years English hops will be picked mainly by machine.

These developments have been kept under observation by the Department of Hop Research of Wye College, Kent. Each year from 1949 until 1953 inclusive, the Department, with encouragement and financial help from the Agricultural Research Council, has organized surveys of picking machines at work on the farms of commercial growers. The results of these surveys have been published in detail in the annual reports of the Department for the years 1950–53 inclusive. At the request of the Hops Marketing Board, the findings of the surveys have been summarized in an article by G. P. Chater and Miss C. L. Jary*.

The main point emerging from the surveys is the importance of intelligent and efficient management; the best of picking machines will give poor results if badly managed.

The concept of machine picking as a factory process is a valid one. From plant to pocket the hops pass along a production line, and, as in all mechanized industries, good management based on a clear understanding of the process as a whole is essential if a good final sample of dried hops is to be produced.

The chief disadvantage of all picking machines is the amount of breakage they cause to the hop cones. Such breakage makes for difficulties in subsequent cleaning and drying and may lead to wastage of hop material in general and of resins in particular. The subject of resin-loss is a controversial one. An investigation is nearing completion at Wye in which a series of forty-two pairs of pocket samples from the 1954 crop is being examined. Each pair consists of hops of the same variety and from the same farm, one sample of each pair being hand picked and the other machine picked. Preliminary results show that in thirty-five of the forty-two pairs of samples the hand-picked hops appear to have more resin than the machine-picked ones; in the remaining seven pairs the machine-picked hops appear to have a higher resin content than the hand-picked samples.

One of the most important objects of future research on machine picking must be to reduce damage to the cones. In addition to preventing wastage and improving drying performance, such reduction in the breakage of cones would reduce the risk of resin-loss. Future research in England may also have to pay attention to the cleaning of machine picked hops. In the United States, picking machines have been in general use for some ten years and more than 90 per cent of the crop there is now picked by machine. American growers are now producing by machine-picking large quantities of dried hops with less than 2 per-cent by weight of leaf and stem. Data collected in the Wye College surveys suggest that English machine-picked hops have from 3 per cent to 12 per cent of leaf and stem and that hand-picked hops have 3–6 per cent; such information is too scanty to permit of large generalizations. It is possible, moreover, that the relative cleanness of American machine-picked hops is achieved by tolerating a degree of wastage of broken hops that could not be accepted at present in England. This aspect of machine picking would appear to merit investigation.

In the Wye College surveys the approach was that of the hop grower rather than that of the agricultural engineer. This approach was the only one permitted by the circumstances and has yielded valuable results. It has, however, obvious limitations, and the time has come for research on picking machines, and on the related problem of the drying of machine picked hops, to be taken up by a team of agricultural engineers.

If research on the machine becomes the responsibility of the agricultural engineer, the growing o ops for the machine remains the responsibility of he hop grower.

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* Obtainable from the Secretary, Wye College, Ashford, Kent. 1.

The correct interpretation of the results of all this vork demands more knowledge of how the hop plant grows than is at present available. It is hoped that t may soon be found possible to appoint a plant hysiologist at Wye College to make a detailed study f the pattern of growth of the hop plant.

## THE HANDICAPPED CHILD

IN a school population of approximately 5,970,000 in England and Wales, 16,719 were pupils known o school medical officers to be physically handiapped. The most frequently recorded conditions esponsible for the handicap included heart disease 4,453), cerebral palsy (2,954), deformities and mputations of the limbs (2,053), poliomyelitis (2,001), uberculosis (1,766) and spina bifida (543). It is stimated that only about one child in every thousand s too severely handicapped to become entirely selfupporting and to be able to live a full life. The ncreasing emphasis of recent years upon the advisbility of keeping such children at home has added onsiderably to the responsibility involved in the are of these children. It is not only in the case of he deaf child that there is often more than one atient. Indeed, there are often three, for both arents as well as the child have to be considered. o handicapped child can achieve the optimum enjoyment of life unless the parents are prepared to carry ut to the full the instructions of their medical advisers.

The family doctor's responsibility in dealing with hese unfortunate children is threefold. In the first lace he must be on the look-out for any handicap o that he can detect it at the earliest possible age nd refer the child to a specialist for advice as to hat can be done to overcome, or at least ameliorate, he disability. Secondly, he must know of the rganizations, voluntary and statutory, which are vailable to help such children. Thirdly, there is the upervision and care of the child in the home.

All these aspects are dealt with in a remarkably ood issue of *The Practitioner* (174, No. 1042; April 955), which includes articles by specialists on hildren's disabilities.

## BREEDING BEHAVIOUR OF THE AMERICAN COOT

SOME peculiarities in the breeding behaviour of the American coot (*Fulica americana*) have been escribed by G. W. Gullion (*Auk*, 71; October 1954). The bird is probably always monogamous in its exual behaviour. If one mate disappears during the esting season, a second mate may be accepted ithin forty-eight hours. Among the resident coots ith secure territories, pairing seems to be as permanent as the life of the birds or their ability to aintain a territory.

Coots breed in a habitat which contains abundant esting material, and they use this material freely constructing floating structures associated with reeding. These structures are bulky, and since aterials seldom present a procurement problem, ey are not built for permanence but must be lded to repeatedly while in use. Eggs are seldom id in more than two of the eight or nine structures which are usually built. The other structures are utilized for resting, roosting and brooding sites.

Three types of structures built by coots—a display platform, the egg nest and a brood nest—follow one another in a definite sequence, and breeding events can be reliably predicted by their appearance. Certain modes of construction permit the identification of a nest type even before it is placed in use.

Copulation normally, perhaps always, takes place on a display platform. There is little or no precopulatory display or chase, and the two birds resume normal activity within two or three minutes following copulation. Eggs may appear before the nest is completed and are laid daily in the very early hours of the morning. The nest is completed and lined by the time the clutch is complete.

Incubation is continuous and is shared by both sexes, the male probably doing the greater share of it.

When deposition of the clutch is just beginning the female incubates all night, but otherwise the male incubates from dusk to dawn; the female always takes about a four-hour shift at dawn and then shifts of about one-hour duration follow until sunset. Young coots are quite helpless until a day or so old and require prolonged parental care. The male parent does most of the brooding during the staggered hatching period, while the female brings food to the nestlings and takes the older ones away to feed and brood. Later, the parents divide the brood during feeding and brooding.

## CHLOROPLAST STRUCTURE

IN a study of the structure and swelling properties of the chloroplasts of *Nitella cristata*, F. V. Mercer, A. J. Hodge, A. B. Hope and J. D. McLean have made some new and interesting observations and stated some tentative conclusions (*Austral. J. Biol. Sci.*, 8, 1, 1; 1955). Electron-microscope studies of ultra-thin sections have shown that the normal chloroplast consists of about 40–100 lamellæ *c.* 70 A. apart, enclosed by an external membrane *c.* 70 A. thickness. Grana do not occur. The space within the chloroplast not occupied by the lamellæ is filled with a granular material resembling the cytoplasm. The chloroplast often contains a considerable number of osmiophilic globules *c.* 0·1μ in diameter lying between the lamellæ, their staining reaction with osmic acid indicating that they are probably lipoidal.

Numerous small osmiophilic bodies *c.* 100 A. or less in diameter are associated with the lamellæ. Starch grains, when present, occur between the lamellæ and appear to be enclosed within by a membrane. During swelling in hypotonic solutions, chloroplasts change in shape from disk to sphere to cylinder. Swelling results from the formation of vacuoles between the external membrane and the rest of the chloroplast (blebs), by increase in interlamellar spacing and by the formation of vacuoles between the lamellæ. The interlamellar vacuoles form by the lamellæ rounding up and coalescing to enclose the granular interlamellar material. Quantitative results for the volume : osmotic pressure relations, the volume : *p*H relations, the surface charge, and the apparent free space for potassium chloride show that swelling is an osmotic process. The osmotic gradients arise from (*a*) a Donnan system associated with the interlamellar material, and (*b*) from diffusible solutes present in the interlamellar solution. The high values for the apparent free space and the volume : *p*H relations indicate that the chloroplast membrane is differentially permeable, not semi-permeable. The degree of swelling of chloroplasts in solutions is controlled by the osmotic pressure and pH of the solution, the differential permeability of the chloroplast membrane and lamellæ, and the cohesive forces maintaining the structure of the membrane an lamellæ. By analogy, it is suggested that tl mechanism controlling the water relations of mit chondria, which also possess lamellar structur bounded by a thin membrane, may be similar t that of the chloroplasts.

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# POTASSIUM–ARGON AGES OF SOME LEWISIAN AND FENNOSCANDIAN PEGMATITES

By Prof. ARTHUR HOLMES, F.R.S.
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THE apparent ages, determined by the potassium–argon method, of ten samples collected from pegmatites, varying in composition from potash-rich granite to practically pure potash-feldspar, are presented in Table 1. Omitting three 'ages' which fall below 1,000 million years, for reasons stated below, the average age of the Lewisian pegmatites investigated is 1,090 ± 70 million years. Microcline from the Arendal district of southern Norway has nearly the same age, whereas a Svecofennian pegmatite in Finland is found to be about 1,800 million years old.

The age of each specimen, $t$, was calculated from the equation

$$t = \frac{1}{(1+R)\lambda_\beta} \cdot \ln\left(1 + \frac{1+R}{R} \cdot \frac{{}^{40}\text{A}}{{}^{40}\text{K}}\right) \text{ years,}$$

which, on substituting the data here adopted, becomes

$$t = 4{\cdot}202 \log_{10} (1 + 12{\cdot}24\ {}^{40}\text{A}/{}^{40}\text{K}) \times 10^9 \text{ years.}$$

$R$ is the branching ratio, defined as the ratio of the rate of orbital electron capture to the rate of β-emission. For $R$ two values have recently been published, 0·089 ± 0·003 [1] and 0·085 ± 0·005 [2]. The first value is adopted here because it has been further substantiated by recent work at the University of Toronto upon nine samples of potassium minerals from pegmatites already dated by accompanying uranium minerals and ranging in age from 330 to 2,600 m.y.

For $\lambda_\beta$, the transformation constant for β-emission, a value of $0{\cdot}503 \times 10^{-9}$ y.$^{-1}$ has been obtained from eleven of the most recent counting experiments[2].

$^{40}$A is the mass of radiogenic argon-40 present per gram of sample as determined by a procedure which has already been described[3]. At least two determinations were made on all samples except 1159-*A*. All argon samples were analysed by a mass spectrometer. In no case did the abundance of argon-36 indicate the presence of more than 8 per cent atmospheric argon. Corrections were made for this; but even the largest correction lowered the resulting age by only 2 per cent. The uncertainty shown is the standard deviation of individual measurements.

$^{40}$K is the mass of potassium-40 per gram of sample. It was calculated from potash analyses by adopting Nier's value for the isotopic abundances of potassium[4]. Reuterswärd[5] has obtained a value for the abundance of potassium-40 that agrees to within 1 per cent with Nier's result. At least two analyses were made for all the Scottish samples. The analysts were W. H. Herdsman (Glasgow), who used a gravimetric method; and the Chemical Research Laboratory, Teddington, W. R. Inman (Canadian Bureau of Mines, Ottawa) and K. Watson (University of Toronto), who used flame photometers. The age were calculated from the mean values. The No wegian sample was analysed by W. R. Inman an W. H. Herdsman, and the Finnish samples by H. I Wiik (Geological Survey of Finland).

The experimental results are listed in Table I The limits of uncertainty given for the ages are base upon an estimated mean probable error of 10 pe cent in the value of $^{40}$A/$^{40}$K, which in all cases i greater than the combined error due to the argo and potassium determinations.

1243-*A*. White perthitic microcline, with sporadi inclusions of quartz, collected by Mr. Martin Kürste from a 16-ft. wide pegmatite trending east-north east across the anorthosite of the eastern slopes o Roneval, South Harris. The rocks of this region hav been described by Jehu and Craig[6], the petrolog and geological history by Davidson[7], and the pegmatites, as sources of alkali feldspar, by Robertson[8]

1244-*A*. Pink perthitic microcline with irregula streaks of quartz and muscovite, collected by Dr R. M. Craig[9] from the north-east-trending Northto pegmatite near Chaipaval, South Harris. For detaile description and maps see Robertson[8].

1159-*A*. Pink perthitic microcline, with inclusion of quartz and streaks of sericite, collected by Dr R. M. Craig[9] from a north-east-trending pegmatit on the islet of Shillay in the Sound of Harris, abou six miles west of the south-west coast of Sout Harris. The locality is shown at the extreme top o Plate IV of Jehu and Craig's paper[6].

1173-*A* and 1242-*A*. These were specimens from collection made by Dr. R. Campbell[10] from a pegmatite north of Rhiconich, extending west-north west from Cnoc an Tuir towards the north-east shor of Loch Inchard. The locality is in west Sutherland about 13 miles south of Cape Wrath, and is show on Fig. 6 of Robertson's report[8], on p. 12 of whic the pegmatite is fully described. Although th original specimens looked much alike and consiste of pink microcline, buff albite-oligoclase, quartz an micas, microscopic examination revealed that whereas the second was almost ideally fresh, the fir was richer in quartz and had been intensely altere by sericitization, chloritization and introduction o ferruginous matter along cracks, cleavages and inter granular boundaries. Since such alteration woul inevitably promote leakage of argon, the relativel low age yielded by 1173-*A* is not surprising.

1160-*A*. Pink perthitic microcline with inclusion of quartz, collected by Prof. D. B. McIntyre from 100-ft. wide pegmatite at Badcall Quay, about a mil north-west of Laxford Bridge at the head of Loc

Table 1

| Toronto No. | Locality | Radiogenic $^{40}$A % by wt. × 10$^{4}$ | No. of runs | K$_2$O % by wt. | K$_2$O analyst | $\frac{^{40}A}{^{40}K}$ | Apparent age (m.y.) |
|---|---|---|---|---|---|---|---|
| | Outer Hebrides (Lewisian) | | | | | | |
| 1243-A | Roneval, South Harris | 9·12 ± 0·06 | 2 | 12·5 ± 0·1<br>13·02 ± 0·16<br>12·77 | Watson<br>Inman<br>C. R. L. | 0·0707 | 1,140 ± 70 |
| 1244-A | Chaipaval, South Harris | 7·67 ± 0·04 | 4 | 11·7 ± 0·4<br>11·02 | Inman<br>Herdsman | 0·0682 | 1,110 ± 70 |
| 1159-A | Shillay, Sound of Harris | 6·70 | 1 | 10·2 ± 0·4<br>10·45 | Watson<br>Herdsman | 0·0643 | 1,060 ± 70 |
| | N.W. Sutherland (Lewisian) | | | | | | |
| 1173-A | N. of Rhiconich, Loch Inchard | 3·01 ± 0·06 | 2 | 5·38 ± 0·02<br>5·52 ± 0·13 | Watson<br>Inman | 0·0546 | 930 ± 70 |
| 1242-A | N. of Rhiconich, Loch Inchard | 6·73 ± 0·06 | 2 | 9·88 ± 0·07<br>10·22 | Watson<br>C. R. L. | 0·0664 | 1,090 ± 70 |
| 1160-A | Badcall Quay, Loch Laxford | 6·29 ± 0·10 | 2 | 9·7 ± 0·3<br>9·66 | Watson<br>Herdsman | 0·0643 | 1,060 ± 70 |
| 1250-A | Geodh' Eanruig, W.S.W. of Scourie Hotel | 6·00 ± 0·16 | 3 | 12·32 ± 0·1<br>11·21 | Inman<br>Herdsman | 0·0506 | 880 ± 60 |
| 1251-A | Cnoc an Fhir Bhreige, S. of Scourie | 4·78 ± 0·14 | 3 | 11·09 ± 0·1<br>9·93 | Inman<br>Herdsman | 0·0445 | 800 ± 60 |
| 1174-A | Arendal District, Southern Norway S. of Langesundfjord | 7·55 ± 0·05 | 2 | 12·62<br>12·02 | Inman<br>Herdsman | 0·0607 | 1,020 ± 70 |
| 1140-A to 1153-A | South-west Finland (Svecofennian) Varala Quarry, Kangasala | 15·3 ± 0·3 | 6 | 11·06 ± 0·1 | Wiik | 0·138 | 1,810 ± 120 |

axford. The locality is *G*, Fig. 6, of Robertson's eport[8].

1250-*A*. Perthitic orthoclase, somewhat sheared nd showing undulose extinction, collected by Dr. . Sutton and Dr. Janet Watson from a north-west-ending pegmatite at Geodh' Eanruig, about a mile est-south-west of Scourie Hotel and 5½ miles south-est of Badcall Quay. The relatively low argon ontent of this specimen may possibly be due to the eating effect of a thin basic dyke of unknown age hich cuts the pegmatite.

1251-*A*. Perthitic microcline collected by Dr. J. utton and Dr. Janet Watson from a north-west-ending pegmatite about 500 yards west of Cnoc an hir Bhreige (west of Badcall village and two miles uth of Scourie). This and the two foregoing pegatites are mapped on Plate XX of Sutton and atson's paper[11]. The low age found for 1251-*A* ay perhaps be accounted for in the same way as at of 1250-*A*, as Dr. Sutton informs us that a lerite dyke of unknown age is seen very close to e pegmatite and appears to cut across it.

Excluding the three samples from which loss of gon is suspected, the average age found is about 090 ± 70 m.y. So far, the only European age terminations of this order are those dating the gmatites of the Arendal district of Norway, tending north-east–south-west from Langesundord to Kristiansand, where the geological sequence s a general resemblance to that of Harris, as dicated in Table 2. The Cape Wrath to Scourie quence is also similar, save for the intervention of suite of north-west dykes which has enabled Sutton d Watson[11] to establish the existence of two sets structures and metamorphisms in the Lewisian oks, distinguished as 'Scourian' and 'Laxfordian'. For this reason it cannot yet be regarded as certain that Scourian rocks are represented in the Harris and Arendal successions, as Table 2 suggests. The dated pegmatites, however, all appear to be late Laxfordian.

1174-*A* is a massive pink microcline (Currie Collection, Grant Institute) from a pegmatite of the Arendal suite, south of Langesundfjord. The age obtained, 1,020 ± 70 m.y., agrees within the limits of error both with the Lewisian ages here recorded and with the isotopic age (lead method) of 1,090 m.y. given by Nier[13] for one of the many cleveites from the Arendal district analysed by Mme. E. Gleditsch. This very important check suggests that the Laxfordian and Arendal orogenies were at least approximately contemporaneous. The Grenville pegmatites in Canada are also of about the same age, and here, too, they have been consistently dated by both uranium and potassium minerals[5,13].

Until recently, the Arendal district was regarded as part of the Svecofennian orogenic belt (Bugge[14]), and the age, 1,090 m.y., was thought to be representative for the late pegmatites of that belt, particularly as some of the uncorrected chemical ages of radioactive minerals from southern Finland had been found to be of the same order (Lokka[15]). It was therefore a surprise when the argon method applied to some potash feldspars collected by Dr. A. Kahma from the Varala pegmatite, about 30 km. east-south-east of Tampere in south-west Finland, yielded an age of 1,810 ± 120 m.y. Shortly afterwards, however, Parwell and Wickman[16] announced a number of uncorrected chemical ages, varying from 1,700 to 1,810 m.y., for uranium-bearing minerals from late Svecofennian pegmatites in the neighbourhood of Stockholm. Isotopic analyses of the respective leads

Table 2

| South Harris (ref. 7) | Cape Wrath—Scourie (ref. 11) | Arendal, Norway (ref. 12) |
|---|---|---|
| —<br>Pegmatites<br>Foliated granites (to N.)<br>Migmatization<br>—<br>High-grade metamorphism—<br>migmatites, charnockites and eclogites<br>Anorthosite-norite and ultrabasic intrusions<br>Meta-sedimentary series | Late granite (Laxford)<br>Pegmatites<br>Laxfordian foliated granites<br>Laxfordian metamorphism and granitization<br>Intrusion of N.W. basic dykes<br>Scourian metamorphism—<br>migmatites and charnockites<br>Basic and ultrabasic intrusions<br>Meta-sedimentary series | Late granite (Grimstad)<br>Pegmatites<br>Synkinematic granites<br>—<br>High-grade metamorphism—<br>arendalites (migmatic charnockites)<br>Hyperitic intrusions<br>Meta-sedimentary series |

are in progress; but meanwhile the above convergence of evidence suggests that the Svecofennian pegmatites are very much older than those of the Arendal, Lewisian and Grenville provinces.

Apart from some of the potash determinations, the experimental results recorded in Table 1 were carried out at the University of Toronto with equipment for which grants were received from the National Research Council, Geological Survey of Canada, Research Council of Ontario and Imperial Oil, Ltd. We are indebted to Dr. G. L. Cumming and Dr. R. D. Russell, who made the mass spectrometer analyses; to Mr. K. Watson, Mr. W. R. Inman, Mr. H. B. Wiik and the Chemical Research Laboratory for potash analyses; and to the Carnegie Trust for the Universities of Scotland for a grant from which the cost of the Herdsman potash analyses was defrayed. Most of the specimens were specially collected for this investigation, and our thanks are extended to the various geologists who have co operated in this joint enterprise.

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# A CORRELATION BETWEEN THE RATES OF UNIMOLECULAR PYROLYSIS OF ALKYL HALIDES IN THE GASEOUS PHASE AND S<sub>N</sub>1 RATES IN SOLUTION

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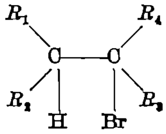
IT has been found that for molecules of the type



the major factor determining the rate of unimolecular dehydrobromination is the environment of the C—Br bond. The following relative rates (Table 1*a*) and activation energies (Table 1*b*) for a series of bromides in which the C—Br and C—H bonds range from primary to secondary to tertiary amply demonstrate this fact.

Table 1*a*

| C—H | C—Br *p* | C—Br *s* | C—Br *t* |
|---|---|---|---|
| *p* | 1 (ref. 1) | 170 (ref. 4) | 32,000 (ref. 6) |
| *s* | 3·5 (ref. 2) | 380 (ref. 5) | 46,000 (ref. 7) |
| *t* | 6·3 (ref. 3) | — | 130,000 (ref. 8) |

Table 1*b*

| C—H | C—Br *p* | C—Br *s* | C—Br *t* |
|---|---|---|---|
| *p* | 53·9 | 47·8 | 42·2 |
| *s* | 50·7 | 43·8 | 40·5 |
| *t* | 50·4 | — | 39·0 |

In Table 1*a*, the rates are given relative to ethyl bromide (taken as 1) at 380° C., and Table 1*b* shows the corresponding activation energies (in kcal.). The small effect of variations in the C—H bond type is shown again by the work of one of us (P. J. T.) on 4-bromo-pentene-1, for which, despite the allylic weakening of the C—H bond concerned in the elimination, the rate is comparable to that of *sec*-butyl bromide.

That no simple relationship exists between the activation energy for the elimination of HX ($E_{HX}$) and the homolytic bond dissociation energy $D(R$–X is shown in Table 2.

Table 2

| | $C_2H_5Br$ | *sec*-$C_3H_7Br$ | *tert*-$C_4H_9Br$ |
|---|---|---|---|
| $E_{H\text{-}Br}$ | 53·9 | 47·8 | 42·2 |
| $D(R\text{-}Br)$ (ref. 12) | 67·2 | 67·6 | 63·8 |
| $D(R^+Br^-)$ (ref. 13) | 183·7 | 156·3 | 140·3 |
| Rate ratio | 1 | 170 | 32,000 |

| | $C_2H_5Cl$ | *sec*-$C_3H_7Cl$ | *tert*-$C_4H_9Cl$ |
|---|---|---|---|
| $E_{H\text{-}Cl}$ | 60·8 (ref. 9) | 50·5 (ref. 10) | 41·4 (ref. 1 |
| $D(R\text{—}Cl)$ (ref. 12) | 80·9 | 82·2 | 78·3 |
| $D(R^+Cl^-)$ (ref. 13) | 192·8 | 166·3 | 150·2 |
| Rate ratio | 1 | 178 | 19,500 |

Also included are the heterolytic bond dissociati energies $D(R^+X^-)$, that is, those for the proce

$$RX \rightarrow R^+ + X^-$$

in the gaseous phase. These latter two sets of figur when compared with the rates relative to the eth compounds or the activation energies allow two co clusions to be drawn. The first is that a comm mechanism is involved in the dehydrohalogenati of the bromides and of the chlorides. The second that, while there is no correlation between t energies or free energies of activation and the hom lytic bond dissociation energies, there is a cle correlation with the heterolytic bond dissociati energies.

A possible explanation of the strong dependen of the rate upon the nature of the carbon atom the C—X bond lies in the assumption that activati consists primarily of an elongation with polarizati of the C—Br bond with some assistance from polarized C—H bond. That homolytic C—H fissi is not part of the rate-determining process is sho by the observation that 4-bromo-pentene-1 deco poses at about the same rate as *sec*-butyl bromid despite the fact that a β-allylic hydrogen atom nvolved and that a conjugated pentadiene is formed n the reaction.

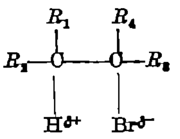
The polybromo ethanes form another interesting eries of compounds. Thus it has been established y P. T. Good (unpublished work) that whereas thylidene bromide decomposes faster than ethyl romide, with ethylene dibromide the reverse is true. Partial confirmation of this behaviour is given by he work of Barton and Howlett[9], who observed that he rate of decomposition of ethylidene chloride is reater than that of ethyl chloride. Further halogen ubstitution on an α-carbon atom increases the rate, whereas such substitution on a β-carbon atom lecreases it.

Thus, the following rate relationships have been bserved for the elimination of hydrogen bromide :

$$(CH_3)_3C.Br > (CH_3)_2CHBr > CH_3CH_2.Br$$
$$CH_3CHBr_2 > CH_3CH_2Br > CH_2Br.CH_2Br$$

The first is well known to be the order characteristic of $S_N1$ or $E1$ rates in solution, and the second is the heoretical order, not yet verified, for unimolecular ates in a polar solvent. A qualitative analogy thus xists between $S_N1$ or $E1$ rates in solution and the unimolecular rate of elimination of hydrogen bromide. The behaviour of the first series with respect to the $S_N1$ and $E1$ mechanism has been explained in terms of the electron-releasing power of the methyl groups ttached to the α-carbon atom which facilitates the ormation of Br⁻. The role of the polar solvent in uch a mechanism is essentially the stabilization of he highly polar transition state.

It is now suggested that the β-hydrogen atom in he unimolecular elimination mechanism plays somewhat the same part as the solvent in the $S_N1$ and $E1$ mechanisms of reactions in solution. Thus the ransition state may be represented by :



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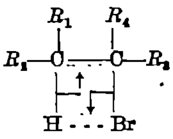

he β-hydrogen atom stabilizing the potential Br⁻, ust as the solvent does in solution. The situation nay be represented graphically, as in Fig. 1. Curve a) represents the potential energy for dissociation nto $R^+$ and Br⁻, from an excited electronic state ; urve (b), the dissociation into atoms from the ground tate. Curve (c) represents the hypothetical stabilzation of the $C^+Br^-$ system by the β-hydrogen atom, eading eventually to an olefin and hydrogen bromide. As a result of the intersection of curves (b) and (c), a plitting will occur, leading in particular to curve (d), which represents the reaction path.

Further confirmation of the views advanced here comes from qualitative observations on the system $CH_3OCHClCH_3$. This substance[14] undergoes reaction nder $S_N1$ conditions more rapidly than *tert*-butyl hloride by a factor of at least $10^6$. In the gas phase, lecomposition sets in some 50° lower than for *tert*-utyl chloride.

It is suggested that the ideas developed here may e applied to other gas-phase eliminations. Although nly *tert*-butyl and *tert*-amyl alcohols[15] have so far een investigated, it is interesting to note that Brearley, Kistiakowsky and Stauffer observed that, or both the chlorides and the alcohols, the ratio of he rates of the *tert*-amyl to that of the *tert*-butyl compound was 2·35. In the case of the bromides, the ratio in the range of temperatures experimentally studied (~ 250° C.) was 2·34. The close agreement in the three cases is strongly suggestive of a common mechanism. Further, at 25° C., in '80 per cent' aqueous ethanol, the observed ratios of first-order constants (*tert*-amyl/*tert*-butyl) are for the chlorides 1·76 ; bromides, 1·57 ; and iodides, 1·93[16]. This provides additional evidence of the analogy between the $S_N1$ and $E1$ mechanism and the unimolecular elimination of hydrogen chloride and hydrogen bromide. Although the position with respect to the iodides is far from clear, the results are capable of interpretation on the basis of competitive mechanisms, one involving the fission of the C—I bond, the other involving elimination of hydrogen iodide.

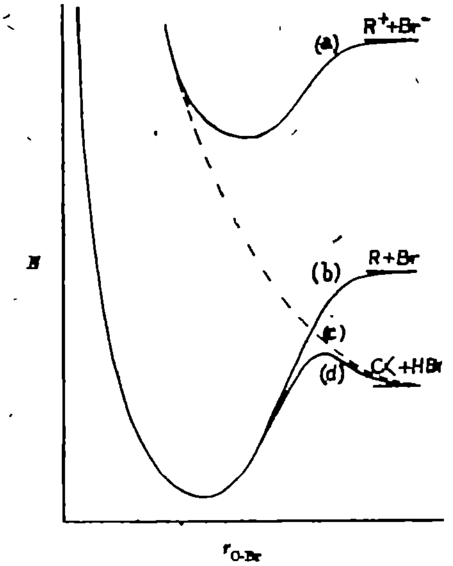

Fig. 1

Our present conclusion from this work, which is being extended, is that important modification is needed in the current view that all gas reactions are in principle homolytic, and accordingly require concepts of mechanisms and of structural effects which are strongly differentiated from those applying to heterolytic reactions in polar solvents.

We wish to thank Profs. E. D. Hughes and C. K. Ingold, and Dr. P. B. de la Mare and Mr. C. A. Vernon for many helpful discussions. We also acknowledge with thanks the communication of results, prior to publication, by Mr. P. T. Good.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Paramagnetic Resonance Absorption of Ferrihaemoglobin and Ferrimyoglobin Derivatives

MAGNETIC susceptibility measurements on ferrous and ferric haemoprotein complexes have led to the bonding of the iron being classified as 'essentially ionic' or 'essentially covalent', as with other co-ordination compounds containing elements of the first transition series[1]. Ferrohaemoglobin, acidic ferrihaemoglobin and its fluoride complex are in the first category, oxy- and carbonmonoxy-ferrohaemoglobin and the azide and cyanide complexes of ferrihaemoglobin are in the second. The electronic state of the iron has accordingly been thought strictly comparable to that in the Fe$^{2+}$ and Fe$^{3+}$ aquo-ions and that in the Fe(CN)$_6^{4-}$ and Fe(CN)$_6^{3-}$ complex ions respectively, since the corresponding magnetic susceptibilities are very similar.

Another manifestation of the magnetic properties is revealed by paramagnetic resonance absorption measurements from which $g$-values may be obtained, quantities related to the magnetic moment, the magnitudes of which for a compound of a first transition element depend not only upon the quantum number $S$ but also the total orbital quantum number $L$ and the symmetry around the ion. The ferric ion, which is in an orbitally singlet state ($L = 0$), has[2] one $g$-value of 2·0. Acidic ferrihaemoglobin and its fluoride complex, in which the iron has hitherto been assumed to be bound by essentially ionic bonds on the basis of paramagnetic susceptibility measurements, were therefore expected also to have $g$-values of 2·0. Using wet solid specimens, measurements at liquid-air and liquid-hydrogen temperatures have, however, given identical $g$-values of 5·90 ± 0·05 for both derivatives; these are very similar to that obtained for haemin[3].

Since the observation of such high $g$-values in polycrystalline specimens was quite unexpected, the measurements were repeated at as many frequencies as possible in order to check that zero-field splitting was not responsible for the position of the line. Determinations were made at 3·2 cm., 1·25 cm., 1·0 cm., 8 mm. and 6 mm. wave-lengths, and the results are summarized in Fig. 1. The fact that all the points for both haemin and acidic ferrihaemoglobin lie on straight lines passing through the origin show conclusively that true $g$-values are being measured. A slight asymmetry in the shape of the line was noted which indicates that the $g$-value spreads to somewhat lower values; but from intensity considerations this variation would appear to be small. It is hoped to carry out measurements on single crystals to obtain the precise values for the variation. It is quite clear, however, that the electronic state of the iron is entirely different in these 'ionic' complexes from that of the gaseous or aquated Fe$^{3+}$ ion.

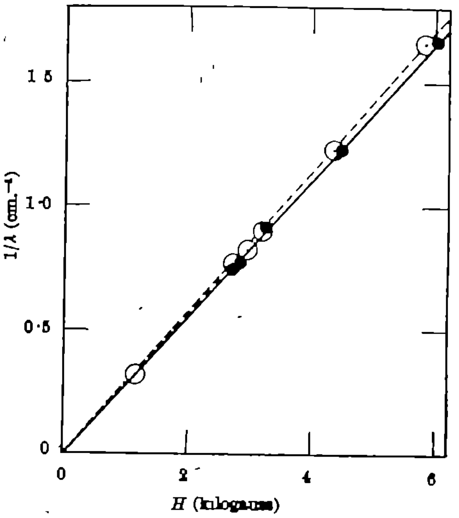

Fig. 1. Plots of reciprocal wave-length against magnetic field for haemin (ref. 3) (open circles) and acidic metmyoglobin (full circles), from which $g$-values of 6·00 ± 0·05 and 5·90 ± 0·05 respectively have been obtained

Measurements have also been made on the azide and cyanide complexes of ferrihaemoglobin, in which the bonding of the iron is classified as essentially covalent. A well-defined variation of $g$-value from 2·2 to 2·8 was obtained for the former, but the latter gave very weak absorption. No measurements have yet been made in the range $g < 2$, but the results for the azide complex show that there is a significant quantitative difference between a 'covalent' haemoprotein complex and a 'covalent' inorganic co-ordination complex such as the ferricyanide ion, which has $g$-values[4] along the three axes of 0·94, 2·18 and 2·30.

Very similar absorption was observed for the corresponding ferrimyoglobin derivatives, and identical $g$-values were obtained. These results show, in a more direct manner than the magnetic susceptibility values, that no appreciable intramolecular interaction, in the sense of a coupling between the magnetic moments, occurs between the iron atoms in the recrystallized ferrihaemoglobin used for these measurements.

*Note added in proof.* Preliminary measurements on single crystals of acidic ferrihaemoglobin, kindly supplied by Dr. V. Ingram, of the Cavendish Laboratory, indicate that the high $g$-value of about 6 corresponds to $g_{\perp}$, that is, in the plane of the haem. The asymmetry of the line reported above is due to a $g_{//}$ value, that is, along the axis perpendicular to the haem, of less than 3, probably about 2·5.

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## Anomalous X-Ray Scattering at Wave-lengths far from an Absorption Edge

IT has been predicted recently[1] that the anomalous attering of X-rays found close to an absorption dge would make direct Fourier synthesis methods pplicable to non-centrosymmetrical crystals. In his procedure isomorphous substitution would be tilized for the determination of the absolute values f the phase angles of the scattered radiation; the hase angles are simply calculated from the structure ector triangle with sides $F_1$, $F_2$ and $F_1 - F_2$, where $_1$ and $F_2$ denote the structure factors of the two somorphous compounds while $F_1 - F_2$ is the difference in contribution of the heavy and light atom. he signs of the phase angles should then in principle e determinable from the effect of anomalous scattering on the intensities.

In the course of experiments designed to test the sefulness of the above scheme, the very interesting bservation has been made that anomalous scattering ffects can be observed at wave-lengths far from the bsorption edges of any heavy atom in the crystal. he amino-acid l-tyrosine was selected as the unnown test structure to be used, in the form of the somorphous hydrochloride and hydrobromide. The vell-formed crystals obtained were assigned to the on-centrosymmetric monoclinic $P2_1$ space group. ero-layer Geiger counter observations with monohromatized copper radiation were collected from ylindrically ground specimens with either the *a* or *b* rystal axis parallel to the cylinder axis. The unexpected finding was made that $I_{0kl} \neq I_{0\bar{k}\bar{l}}$; the observed difference averaged about 8 per cent but eached 50 per cent in an extreme case. Some typical omparisons are made in Table 1.

Table 1

| | Tyrosine hydrochloride ($\Delta f'' = 0\cdot83$) | | | Tyrosine hydrobromide ($\Delta f'' = 1\cdot1$) | | |
|---|---|---|---|---|---|---|
| *hkl* | $F_{0kl}$ | $F_{0\bar{k}\bar{l}}$ | $\Delta(F'')_{\text{calc.}}$ | $F_{0kl}$ | $F_{0\bar{k}\bar{l}}$ | $\Delta(F'')_{\text{calc.}}$ |
| 020 | 570 | 641 | 66 | 725 | 895 | 110 |
| 002 | 73 | 73 | 0 | 439 | 459 | 0 |
| 011 | 220 | 207 | 21 | 98 | 59 | 31 |
| 041 | 354 | 298 | 47 | 1,330 | 1,240 | 50 |
| 052 | 93 | 113 | 23 | 665 | 691 | 31 |
| 035 | 178 | 147 | 30 | 195 | 189 | 40 |
| 016 | 221 | 231 | 17 | 320 | 341 | 23 |
| 055 | 2 5 | 5 8 | 0 | 22 2 | 22 9 | 0 |
| 027 | 288 | 269 | 26 | 960 | 876 | 22 |
| 0.2.11 | 100 | 108 | 0 | 610 | 610 | 0 |

t is noteworthy that $I_{00l} = I_{00\bar{l}}$ for the [100] zone neasurements and $I_{h0l} = I_{\bar{h}0\bar{l}}$ for the entire [010] one.

Tests were then made on a number of other rystals, which quickly established that the above ondition was observed only when a heavy atom and polar axis were involved. Tests were made with nolybdenum and with chromium radiation, and non-equivalences of the same order of magnitude were ound. A final decisive experiment was carried out vith rubidium hydrogen tartrate[2], a compound for vhich similar intensity differences with exciting adiation have been found and have been explained s due to anomalous scattering. This compound gave on-equivalent intensities with chromium radiation vhich were parallel in every respect, but smaller in nagnitude than those observed with exciting adiation.

The magnitude of the effect is great enough to allow t to be seen clearly on photographs in the case of some eflexions. The surprisingly large effect observed for tyrosine hydrobromide with copper radiation must clearly be due to excitation of the *L*-electrons even though the absorption edge is at $\lambda \cong 8$ A., since the *K* absorption edge at $\lambda \cong 0\cdot92$ A. cannot contribute. Assuming all eight *L*-electrons contribute, a prediction of the magnitude of the effect on the basis of Hönl's[3] calculations leads to satisfactory agreement with experiment. Table 1 gives such a comparison; a value of $\Delta f''$, the imaginary component of the bromine scattering amplitude, of 1·1 was used. In the case of chlorine, the *K* absorption edge is at $\lambda \cong 4\cdot4$ A., and with copper radiation the principal effect would be expected from the *K*-electrons. Using a value of $\Delta f'' = 0\cdot83$ taken from James[4], satisfactory agreement with experiment is again obtained, as can be seen from Table 1. Thus it is clear that the initial feeling of surprise that one feels at such a wholesale failure of Friedel's law is not justified.

The significance of the above findings for direct structure determination by Fourier synthesis in the non-centrosymmetrical case is at once apparent. In the case of tyrosine hydrochloride and hydrobromide, a direct solution of the structure has been readily obtained using no structure hypotheses, but only the information contained in the measurements themselves. The results of this investigation will appear in due time.

The success of the method is clearly dependent on accurate intensity measurements, preferably those made with a Geiger counter; however, the most commonly available radiations can successfully be used.

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## Nuclear Spin and Hyperfine Structure of Radioactive Silver, $^{111}_{47}$Ag

AN atomic beam magnetic resonance apparatus[1] has been constructed, and the nuclear spin and hyperfine structure separation of the $^2S_{1/2}$ ground state of silver-111, of half-life 7·5 days, have been measured. Also a new value of $g_J$ for silver has been derived from the experimental results.

The nuclear spin is $\frac{1}{2}$ in units of $h/2\pi$, which confirms the value of McGinnis[2] and of Lemonick and Pipkin[3]. The transition ($F = 1 \longleftrightarrow 0, m_F = 0 \longleftrightarrow 0$), which is independent of the field to the first order, was observed at a magnetic field of 2·3 gauss, giving a value for the hyperfine structure separation of $|\Delta\nu| = 2,204\cdot54 \pm 0\cdot05$ Mc./sec. This agrees with the tentative value $2,180 \pm 100$ Mc./sec. given by Lemonick and Pipkin[3].

The transition ($F = 1, m_F = 1 \longleftrightarrow 0$) was observed at several fields up to 263 gauss, from which was calculated

$$g_J(\text{Ag}, {}^2S_{1/2}) = 2\cdot00242 \pm 0\cdot00011,$$

assuming $\mu_I$ ($^{111}$Ag) $< 0$. The choice of a positive sign for the nuclear magnetic moment of silver-111 leads to a value of $g_J$ (2·00258) outside the limits of error of the value $g_J(\text{Ag}, {}^2S_{1/2}) = 2·00224 \pm 0·00020$ given by Wessel and Lew[4]. On this evidence we conclude that the nuclear magnetic moment is negative.

With the values of the hyperfine structure of silver-107 and silver-109 given by Wessel and Lew[4], the ratios

$$\frac{\Delta\nu(^{111}\text{Ag})}{\Delta\nu(^{107}\text{Ag})} = +\ 1·287278 \pm 0·000059$$

$$\frac{\Delta\nu(^{111}\text{Ag})}{\Delta\nu(^{109}\text{Ag})} = +\ 1·115127 \pm 0·000048$$

are found. These are sufficiently accurate for a determination of the hyperfine structure anomaly (expected to be about 0·5 per cent), when the nuclear magnetic moment of silver-111 can be measured precisely at some future time. At present we can only give a value $\mu_I$ ($^{111}$Ag) = − 0·145 n.m. accurate to about 1 per cent.

The details of the experiment are to be published elsewhere.

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## Structure of Polyglycine

Nearly twenty years ago, Meyer and Go[1] described the X-ray diffraction powder photograph of some glycine peptides, and found that different photographs were obtained from polyglycine according to the method of preparation. When the polymer was made by decomposition of the N-carboxy glycine anhydride in the presence of pyridine, reflexions corresponding to 4·4 A. and 3·45 A. were observed; but the same polymer precipitated by water from aqueous lithium bromide solution gave a photograph in which a reflexion at 4·15 A. was predominant. Subsequent observations[2-4] have related to the first form, which may be produced by casting from solution in dichloracetic acid or in trifluoracetic acid. It will be convenient to refer to this form as polyglycine I, and to the form characterized by the 4·15-A. reflexion as polyglycine II.

It has recently been found[5] that the two forms have different infra-red spectra. Whereas polyglycine I is a typical β-polypeptide, with absorption bands at 1,630 cm.$^{-1}$ (C=O) and 1,530 cm.$^{-1}$, polyglycine II has bands at 1,648 cm.$^{-1}$ (C=O) and 1,558 cm.$^{-1}$. The C=O mode of the second form, therefore, does not fall within the range found for either α- or β-synthetic polypeptides[6]. Other bands enable polyglycine I and II to be distinguished; the most convenient are at, respectively, 1,015 cm.$^{-1}$ and 1,026 cm.$^{-1}$. Under suitable conditions of precipitation, which were found by examining the infra-red spectra, polyglycine II can be obtained in a pure form. The X-ray diffraction diagram of this pure form is shown in Fig. 1. It would appear that Meyer and Go's polyglycine (shown in Plate II of their paper) was a mixture of I and II.

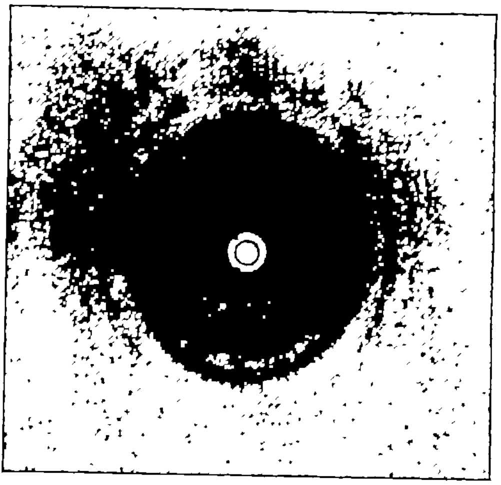

Fig. 1

The diffraction pattern of polyglycine I contains a reflexion at a spacing of 1·16 A. A reflexion occurring at this spacing in other β-polypeptides and silks is the 006 reflexion (c is the molecular chain axis), and if polyglycine consists of extended polypeptide chains, strong reflexion would be expected very near this spacing whether the chains were packed in a rectangular or a triclinic cell[4]. We have found no reflexion corresponding to a spacing in the neighbourhood of 1·16 A. in polyglycine II, showing that the two forms do not arise from different ways of packing extended (or nearly extended) chains; the chains in the two forms must have different configurations. This also follows from consideration of the relative intensities of the rings in the two powder photographs. The relative intensities of the equatorial reflexions from a given crystalline arrangement of extended (β) chains may be estimated from optical transforms of the c-axis projection. It is readily seen that the 3·45-A. reflexion should be somewhat stronger than the 4·4-A. reflexion if, following Astbury[6], these are indexed as 010 and 100 respectively; and in fact this is observed in polyglycine I, the β-form. However, to interpret polyglycine II in terms of a nearly extended chain would require us to take the very intense 4·15-A. reflexion as 100, with the next strongest (3·1 A.) as 010, in order to get a reasonable molecular packing. The predicted intensities for such an arrangement are quite different from those observed.

The very intense 4·15-A. reflexion appears to come from planes which are parallel or nearly parallel to the fibre axis (see below). The high intensity shows that the electron density has a very marked periodicity of 4·15 A., and it is reasonable to conclude that this is the separation of layers of polypeptide chains, possibly in hexagonal array. The α-helix (which would give hexagonal packing) can be excluded, since with such close approach of chains the density would be impossibly high (more than 3 gm./c.c.).

Of the various structures which have been proposed for polypeptide chains, only two appear to provide reasonable values for the density, and optical transforms of these, the 2·2$_7$ helix[7] and the unrotated parallel polar sheet[8], have been examined. Space-filling models of the polar sheet show that interplanar distances of about 4·15 A. and 3·6 A. occur; but the optical transform shows that these reflexions should appear with comparable intensities, whereas the X-ray photograph shows a very weak ring corresponding to 3·8 A. and an overwhelmingly strong 4·15-A. reflexion (see Fig. 1). It seems, therefore, unlikely that a polar sheet structure is present.

Transforms of the $2 \cdot 2_7$ helix based on a 10$\bar{1}$0 reflexion of 4·15 A. lead to a prediction of intensities in general agreement with those observed in the X-ray powder photograph; but the details are not in agreement. In particular, no reflexion corresponding to the residue repeat 2·75 A. is seen. In a triclinic cell, such a reflexion would not be expected, since there is no reciprocal lattice point corresponding to 2·75 A.; but clearly such a possibility cannot be examined profitably until a fibre photograph is obtained. The density predicted for such an arrangement of $2 \cdot 2_7$ helices is 1·67 gm./c.c., which is considerably higher than the measured density of polyglycine II (1·43 gm./c.c.).

The methods by which polyglycine II may be prepared suggest that it might be an intra-chain hydrogen-bonded structure. Casting from any solvent such as dichloracetic acid invariably produces a predominance of the β-form, and we have found that precipitation from solution is generally necessary in order to prepare form II. The only method we have found which produces coherent films of form II is to prepare films in the presence of a salt. The polymer is dissolved in a mixture of formic acid, and calcium chloride and the formic acid dried off. The calcium chloride may then be washed out with alcohol, leaving a spongy film. It appears likely that the effect of the salt is to reduce the probability of intermolecular hydrogen bonding. If films made in this way are rolled, a small amount of orientation of form II is obtained which indicates that the 4·15-A. reflexion is probably equatorial rather than meridional. In addition, if the films, which from infra-red and X-ray examination are found to contain no β-material, are rolled hot, a small amount of doubly oriented β-material is produced. The β-material is quite well oriented, the mean direction of the chain axis lying in the direction of rolling; a similar orientation is observed in the α → β transformation in other synthetic polypeptides.

These facts suggest very strongly that the molecules of form II are folded and that on rolling a number are pulled out into the β-form. It would appear that here we have strong evidence for a configuration of the polypeptide chain which is outside the range of structures hitherto accepted.

No evidence of the α-helical form of polyglycine has been found, except observation of parallel dichroism of the NH-band in a specimen which had been stretched in polystyrene[5]. Recent observations suggest that this may really be a 'cross β' structure, since the C=O band accompanying the dichroic NH band has the β- rather than the α-frequency.

The fact that the 1,015 cm.$^{-1}$ band of polyglycine disappears when the β-form is converted into form II shows that the absence of this band in the spectrum of polymers containing glycine is no proof that the structure is one in which there are no glycyl–glycyl bonds. Especially in the case of alanine–glycine copolymers, and in silks, the possibility that frequency changes are caused by change of molecular configuration must be considered. Since criteria for the recognition of α- and β-forms have now been known for some years[6], we consider that these possibilities should be considered before conclusions on the chemical constitution of silk are based on the appearance or absence of bands in the spectrum[9]. The work we have here reported shows that there exists, in polyglycine at least, a configuration of the polypeptide chain other than the α-helix and the normal β-forms.

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## Positive-Point D.C. Corona

With a point-to-plane gap geometry, a visible (corona) discharge can occur at much lower values of applied gap voltage than those necessary to cause spark breakdown. Such a positive-point d.c. corona discharge in room air has been studied by recording the light emitted with an 11-stage photomultiplier. The output from the photomultiplier was delayed, amplified by 'distributed' amplifiers[1], and displayed on a high-speed cathode ray oscilloscope. The time base of the oscilloscope was triggered by the output of light through a separate photomultiplier, distributed amplifier and thyratron trigger circuit.

The discharge in room air could occur in two distinct forms: (1) a filamentary form which showed discontinuities of current and light throughout a wide range of applied voltage (that is, 'burst pulses', 'pre-onset streamers' and 'pre-breakdown streamers'); (2) a diffuse glow discharge, in which the mean gap current, measured by a galvanometer, was less (~ 40 per cent) than in the filamentary discharge for the same gap geometry at a given value of applied voltage. The spark breakdown voltage was higher and the mean gap current immediately preceding breakdown was lower for the glow discharge than for the filamentary discharge for the gap geometries investigated. The glow discharge showed discontinuities of current and light only over a narrow range of applied voltage (~ 200 V.) near onset; these discontinuities were presumably associated with a 'Geiger' counting action in the gap.

The filamentary form of discharge was investigated. The discontinuities of current and light were observed to be pulses of short duration. The current pulses were similar to those observed by other workers[2,3]. A light pulse was associated with each current pulse. The light pulses occurred about $5 \times 10^{-8}$ sec. after the current pulses, as shown by their relative displacements from the initiation of the oscilloscope time-base. The instrumental part of this delay was

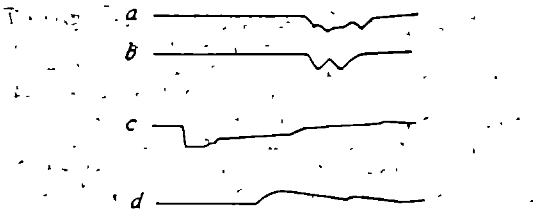

Fig. 1. Tracings of typical pulses observed with an applied gap voltage of 16 kV.
(a, b) High-amplitude initial portion of light pulse, sweep duration 0·56 µsec.; (c) low-amplitude portion of light pulse, sweep duration 2·3 µsec.; (d) electrical pulse, sweep duration 0·56 µsec.

about $2 \cdot 5 \times 10^{-8}$ sec. The light pulses (Fig. 1) showed an initial portion of high light intensity and short duration ($\sim 6$–$2 \times 10^{-8}$ sec.), followed by a portion of lower intensity ($\sim$ 1 per cent) and relatively long duration ($\sim 10^{-6}$ sec.). The initial portions of the light pulses usually showed several irregular peaks and were identifiable with the pulses recorded by English[4] and Amin[2]. The peaks were thought to be associated with branching of the discharge, such branching apparently taking place when the discharge was operated into a weak field region. If branching of the discharge was the explanation for the peaks, then the branches did not appear to be propagated simultaneously but in rapid succession. The low-intensity portion of the light pulses corresponded to the light pulses observed by Gaunt and Craggs[5].

The spatial distribution of the emitted light was investigated by projecting an enlarged real image of the axis of the gap in the plane of the photocathode of the recording photomultiplier. Light pulses were observed from all regions of the gap. By measuring the relative displacement of the pulses along the time-axis of the oscillograms, the spatial growth of the discharge could be determined. The results shown in Fig. 2 were obtained with an applied voltage of 16 kV., a tungsten point of radius of curvature 0·228 mm., a gap-length of 3 cm., an aluminium plane cathode of 15 cm. diameter and a resistance of 200,000 ohms in series with the point electrodes. The effective sampling area was 3 mm. in diameter.

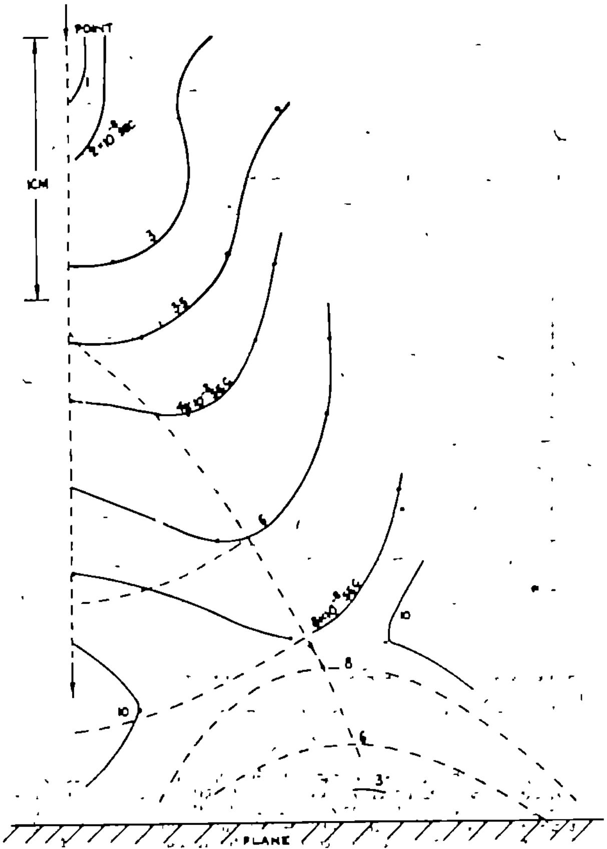

Fig. 2. Observed spatial growth of 'breakdown streamer'. Point radius 0·228 mm.; applied voltage 16 kV.

The discharge was propagated from the point steadily and with constant luminosity for a distance of about 1 cm., after which the luminosity decreased and branching of the discharge was thought to occur. About three, but up to five, branches were possibly associated with each discharge sequence, and about one in three branches was estimated to continue to be propagated along the axis. When branches were deflected from the axis, possibly by space charge in the gap, then a visible discharge was observed to grow from the plane cathode. Presumably the visible discharge from the cathode was caused by photo-electrons from the cathode causing excitation, even though moving in a very low field ($x/p \sim 1 \cdot 4$ volts/cm. per mm. mercury pressure).

The form and growth of the individual events in the filamentary discharge were very similar to the type of growth which contributed to the founding of the streamer theory, where the principal secondary mechanism in the discharge was considered to be photo-ionization in the gas. Most of the observations could be explained satisfactorily by the streamer theory[6]. It is hoped to publish elsewhere a full account of the results and their implications.

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## Ion-Exchange Chromatography in Alcohol

IN the technique of ion-exchange chromatography, the order in which compounds are eluted from a column depends basically upon differences in their ionization constants; but other factors modify and in many instances reverse the expected order[1]. This is illustrated in Fig. 1, where the elution peaks of a number of acids from a 'Dowex' resin are plotted against their $pK$ values. Although there is a definite correlation between acid strength and ease of elution, the points are very scattered, and in particular acids containing an aromatic group are eluted much later than would be expected on the basis of their ionization constants.

The suggestion has been made by Martin[2] that separations on all chromatograms consisting of a

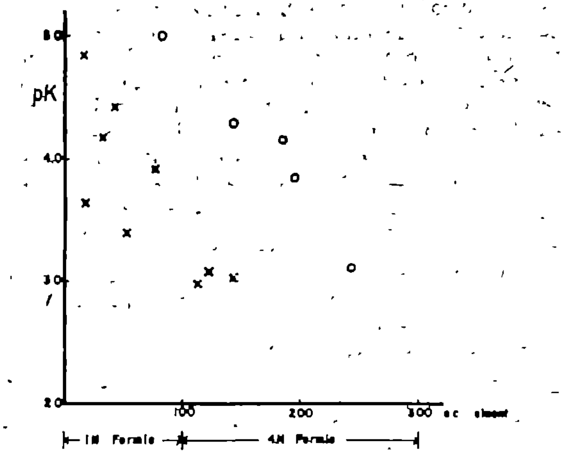

Fig. 1. Ion-exchange chromatography on 'Dowex 1-×8'. The resin was converted to the formate form as described by Busch, Hurlbert and Potter (ref. 10), and the chromatograms were run in a column 12 cm. × 1 cm., eluting with 1 $N$ and 4 $N$ aqueous solutions of formic acid. The $pK$ values of the acids were taken from the literature. Elution peaks of acids containing a benzene ring are indicated by ⊙

stationary gel phase and a moving liquid phase will be influenced by the relative solubility of the solutes in the two phases. Applied to ion exchange chromatography, this means that the rate of travel of compounds on a column should be affected by their partition coefficients, based on solubility, between the eluting solvent and the swollen ion-exchange resin. In our experiments, the eluting solvent is primarily an aqueous solution, while the gel phase, although it contains water and electrolyte, has in addition some of the characteristics of an organic solvent imparted to it by the polystyrene backbone, which makes up about half the weight of the hydrated gel[8]. Therefore, acids which are relatively water-soluble should favour the moving phase and their rate of travel should be accelerated relative to water-insoluble acids. This concept helps to explain the observed retardation of acids containing an aromatic group, which as a class have limited solubility in water.

Further evidence that partition coefficients take a role in ion-exchange chromatography has been obtained by replacing the water in the eluting solvent with absolute ethanol and repeating the chromatograms with the acids used in Fig. 1. Since alcohol is also an ionizing solvent, the resulting chromatographic pattern is still apparently based on an ion-exchange process, while the shifts in elution peaks of the various acids from their previous positions can be predicted from solubility considerations (Fig. 2). Acids with a greater solubility in alcohol than in water, such as those containing a benzene ring, were eluted much earlier in the alcoholic medium, whereas the more water-soluble acids were retarded to varying degrees. Similar results have been obtained by Stein and Moore[4], who found that adding 1 per cent of benzyl alcohol to the eluent tended to increase the rate of travel of the aromatic amino-acids relative to others, while inclusion of 25 per cent propyl alcohol preferentially accelerated those possessing longer non-polar side-chains.

The position of individual acids in our chromatograms was determined by running them in small groups and identifying them by melting points and by paper chromatography in a *sec*-butanol/water/formic acid (80 : 8 : 12) system similar to one used by Kowkabany and Cassidy[5]. This system gives $R_F$ values almost identical with those obtained with the $n$-butanol/water/formic acid system of Lugg and Overall[6], but has the advantage that *sec*-butanol esterifies less readily with the formic acid.

The $R_F$ values of compounds in such an alcohol – water system are related to their partition coefficients between the alcohol and water by the equation[7]

$$\alpha = \frac{\text{concentration in water phase}}{\text{concentration in alcohol phase}} = \frac{A_L}{A_S}\left(\frac{1}{R_F} - 1\right)$$

where $A_L/A_S$, the ratio of the volumes of alcohol and water phases in the chromatogram, is a constant for any given system. From this it can be seen that compounds with partition coefficients favouring the aqueous phase will have low $R_F$ values whereas those with coefficients favouring the alcohol phase will have high $R_F$ values.

It is therefore not surprising to find that acids with high $R_F$ values ($> 0{\cdot}80$) are all eluted more readily on the ion-exchange chromatograms when alcohol is substituted for water, while acids with lower $R_F$ values ($< 0{\cdot}80$) are all retarded by the use

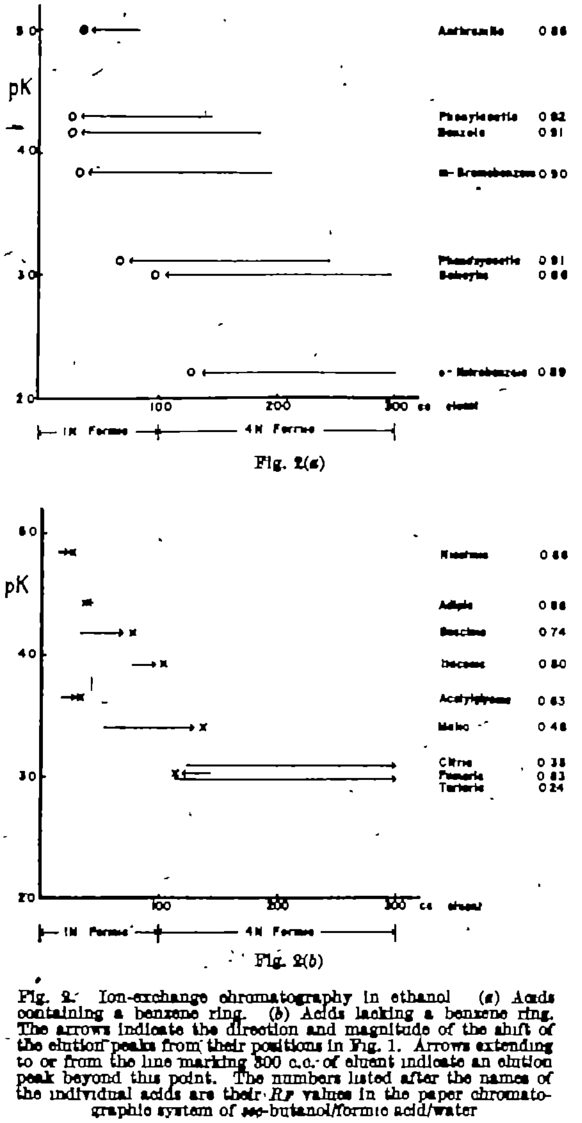

Fig. 2(a)

Fig. 2(b)

Fig. 2. Ion-exchange chromatography in ethanol (a) Acids containing a benzene ring. (b) Acids lacking a benzene ring. The arrows indicate the direction and magnitude of the shift of the elution peaks from their positions in Fig. 1. Arrows extending to or from the line marking 300 c.c. of eluent indicate an elution peak beyond this point. The numbers listed after the names of the individual acids are their $R_F$ values in the paper chromatographic system of *sec*-butanol/formic acid/water

of alcohol. This may perhaps be used as a rough method for predicting whether substances which are eluted together in an aqueous ion-exchange chromatogram could be separated by using alcohol. It should be recognized, however, that this relationship may not apply in all cases, especially since *sec*-butanol rather than ethanol was used in the paper chromatograms.

The demonstration that absolute ethanol can be used as a medium for ion-exchange chromatography promises to extend the usefulness of this technique to include many acids and bases with limited solubilities in water. The separation of long-chain fatty acids is at present being investigated in our laboratory, while Kornberg and Pricer have used chromatography in alcohol on a 'Dowex' resin for purifying a diacyl-phosphatidic acid[8], and Kennedy has used a similar method for separating phosphatides of mitochondria[9]. It appears that high recoveries can be obtained from alcohol columns, and in the experiments reported here all except one of the acids were recovered in better than 80 per cent yield although no special attempt was made to obtain quantitative recoveries (that is, the eluting solvent was removed by drying in an oven at 80° C. and some losses undoubtedly occurred due to volatility of the acids at this temperature). The use of ethanol, and of other ionizing solvents such as methanol, higher alcohols, ketones, etc., may also, by virtue of their differing solvent properties, permit separations which are not possible by other techniques at present available.

This work began during the tenure of an Agricultural Research Council Fellowship under the direction of Sir Alexander Todd at the University Chemical Laboratory, Cambridge; I wish also to acknowledge the financial assistance of the National Research Council of Canada.

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## Transformation of Pentose Phosphates by Enzymes of Animal Origin

In the hexosemonophosphate oxidative cycle, pentose phosphate isomerase is required for the interconversion of ribose-5-phosphate and ribulose-5-phosphate[1], a necessary stage for the subsequent enzymic re-synthesis of hexose from pentose[2]. The enzyme has been much purified from alfalfa leaves[3], but little is known of the animal system, although the facts that xylulose-1-phosphate may be a precursor of ribose in crude liver extracts[4], and that in spleen extracts[5,6] ketopentoses other than ribulose (xylulose and 3-ketopentose) may be formed from ribose-5-phosphate, suggest that pentose transformations may be complex.

For the preparation of suitable systems, acetone-dried powders from rabbit muscle and washed red blood cells of the horse were extracted twice with ten times their weight of 0·05 *M* 'tris' buffer (tris(hydroxymethyl)-aminomethane) of *p*H 7. The extracts were heated at 55–60° C. for 5 min., freed from the resulting coagulum, and the fraction precipitated between 0·3–0·5 saturation with ammonium sulphate was suspended in water and dialysed. After rejection of the insoluble globulins, the freeze-dried material contains most of the pentosephosphate isomerase of the original extract, and remains active for months when stored at – 20°.

For the preparation of the barium salt of the ketopentose phosphate, the muscle preparation (30 mgm.) was incubated at 37° with a solution of 1 gm. (2,500 μ-moles) barium ribose-5-phosphate in 25 ml. water at *p*H 7. The ketopentose formed was measured by the Dische reaction (method of Axelrod and Jang[7]), until no further increase occurred (90 min.) and it remained unchanged at 930 μ-moles (37 per cent) for a further 30 min. After deproteinizing with perchloric acid, careful neutralization, and removal of aldoses with bromine and barium carbonate, the phosphate esters were adsorbed on a 'Dowex-1 (formate)' column and eluted with 0·1 *M* formic acid in 0·1 *M* sodium formate. By careful neutralization with barium hydroxide and precipitation with 4 vol. of ethanol, the vacuum-dried barium salt (357 mgm.) was obtained with a purity of 93 per cent based on ketopentose and 85 per cent based on ester-phosphorus content (800 μ moles ketopentose phosphate, or 32 per cent of the total initial pentose). At least 90 per cent of the total ketopentose was alkali-labile, and the rate of hydrolysis in *N* acid at 100° ($k = 5\cdot2 \times 10^{-3}$) also indicated a 5-position for the phosphate. The ratio of intensities in the orcinol reaction at 540/670 mμ we found to be 0·90–1·00 for chromatographically purified synthetic ribulose and 0·45–0·50 for xylulose. The free ketopentoses liberated by purified acid phosphatase from the above barium salt gave an intermediate value (0·55–0·60). The dephosphorylated de-ionized sugars separated sharply with 88 per cent recovery on a 'Dowex-1 (borate)' column into two peaks, of which the first (51 per cent of total ketopentose in eluate) corresponded exactly in colour reactions and position on elution with pure xylulose and the second (49 per cent) with pure ribulose. No interconversion of the pure sugars similarly processed was detectable.

The enzyme prepared from red cells gave a similar proportion (43 per cent) of total ketopentose to pentose at 'equilibrium'. But the barium salt, prepared and treated as above, had orcinol ratio 0·78, and separation on the column showed that it was substantially the ribulose ester (peak I = 10 per cent, peak II = 90 per cent of total ketopentose; orcinol ratios 0·50 and 0·90 respectively). This barium salt, when incubated with the muscle preparation, lost 59 per cent of its total ketopentose (by conversion to ribose phosphate), while the remaining ketopentose was largely the xylulose ester (peak I, 71 per cent; peak II, 29 per cent of total bromine-resistant pentoses; orcinol ratios 0·50 and 0·98 respectively).

At least one enzyme in addition to the pentose phosphate isomerase is therefore active in the muscle preparation, and converts ribulose-5-phosphate to the xylulose ester. Since no 3-ketopentose[6] formation was detected, the enzyme is presumably a type of 'waldenase', causing inversion at $C_{(3)}$ of the pentose, and resembling that recently suggested as active in *Pseudomonas hydrophila*[8].

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## Modification of Response to Adrenocorticotrophic Hormone by the Simultaneous Administration of Gonadotrophic Hormones

MANY facts suggest that the adrenal–gonad relationship is an intimate one[1]. Our previous work[2] has indicated that the mouse ovary, provided it is in the luteal phase, has an effect similar to that of the adrenal cortex. While appreciating that major species differences may occur, this finding led us to commence experiments on the adrenal–gonad relationship in the guinea pig, since the urinary steroids in this species are excreted in sufficiently large amounts to be determined by routine chemical methods. It has now been shown that the response to adrenocorticotrophic hormone (ACTH) is modified by the simultaneous administration of gonadotrophins.

Ten similar experiments, each using four mature female guinea pigs, were planned as follows:

| Day of experiment | 'ACTH-only' group. Guinea pigs *A* and *B* | 'ACTH + Gonadotrophin' group. Guinea pigs *C* and *D* |
|---|---|---|
| 1 | No treatment | No treatment |
| 2, 3 | ACTH | ACTH |
| 4 to 15 | No treatment | C.G. + P.M.S. |
| 16, 17 | ACTH | ACTH + C.G. + P.M.S. |

Subcutaneous injections of 10 I.U. ACTH gel (Armour Laboratories or Wilson Laboratories) twice daily, 50 I.U. pregnant mares' serum gonadotrophin (P.M.S.; Boots Pure Drug Co., Ltd.) in distilled water once daily, and 50 I.U. chorionic gonadotrophin (C.G.; Organon Laboratories, Ltd.) in distilled water once daily, were given into separate sites. Animals were maintained on a standard diet supplemented by 15 gm. cabbage daily. Gonadotrophin treatment led to extensive ovarian luteinization. 17-Ketosteroids and 17-ketogenic steroids were determined on 24-hr. collections of urine from pairs of animals by the method of Norymberski and others[3]. Urine was collected into flasks containing a few drops of chloroform, and standing in vacuum flasks containing solid carbon dioxide. Burstein, Dorfman and Nadel[4] have shown that the main corticosteroids in normal guinea pig urine are cortisol and 6β-hydroxycortisol.

Results, expressed as the mean excretion of steroid in mgm. ± S.D./guinea pig/24 hr., are summarized as follows:

| Days of experiment | 2, 3 | 16, 17 |
|---|---|---|
| 'ACTH-only' group | | |
| 17-ketosteroids | 1·00 ± 0·43 | 0·99 ± 0·33 |
| 17-ketogenic steroids | 0·60 ± 0·27 | 0·59 ± 0·28 |
| 'ACTH + gonadotrophin' group | | |
| 17-ketosteroids | 1·00 ± 0·37 | 0·99 ± 0·37 |
| 17-ketogenic steroids | 0·62 ± 0·22 | 0·36 ± 0·16 |

The mean difference in 17-ketosteroid excretion between the first and second periods of ACTH administration was − 0·01 ± 0·22 mgm. for the 'ACTH-only' group, and − 0·01 ± 0·29 mgm. for the 'ACTH + gonadotrophin' group. These results are not significantly different ($P = 0·75$). The mean difference in 17-ketogenic steroid excretion between the first and second periods of administration of adrenocorticotrophic hormone was − 0·01 ± 0·10 mgm. for the 'ACTH-only' group and − 0·26 ± 0·15 mgm. for the 'ACTH + gonadotrophin' group. These results are significantly different ($P = 0·007$).

The urinary excretion of 17-ketogenic steroids in response to administered adrenocorticotrophic hormone has therefore been modified by treating the animals with gonadotrophic hormones, and experiments are in progress to try to elucidate this effect. Gonadotrophin treatment did not alter the urinary 17-ketosteroid response to adrenocorticotrophic hormone.

We are indebted to the Medical Research Council for a gift of adrenocorticotrophic hormone.

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## Separation of Ehrlich Ascites Tumour Cells from Other Cellular Elements

THE experimental production of ascites tumours has offered an ideal material for biological, physiological and biochemical research on neoplastic cells[1]. For many problems, however, the variable admixture of leucocytes and other contaminating host cells in the ascites tumours (cf. ref. 1) implies a source of error which in certain cases may be of great importance. We have therefore investigated the possibility of reducing the concentration of such cells with the aid of a counter-streaming centrifuge, the principle of which has already been described by one of us (P. E. L.)[2]. In this centrifuge, constructed mainly for the separation of differently sized particles of the same specific density, liquid containing the particles to be separated is forced to stream through a conical centrifuge tube against the centrifugal force. Here the bigger particles down to a required size are concentrated (fraction *M*), whereas the smaller ones are carried off by the continuous stream of liquid to a second tube of a different shape where they are made to sediment (fraction *G*).

The tetraploid line of the Ehrlich ascites tumour[1] was used for the experiments. Cell samples were withdrawn from the peritoneal cavity at various intervals after inoculation. They were diluted with Krebs's phosphate Ringer solution, containing 1 per cent glucose and 1 per cent gelatine. The same solution was used as the flowing suspension medium in the centrifuge. The separation was carried on for 60 min. at 300 r.p.m. and a streaming velocity of about 0·25 ml. sec.$^{-1}$. The greatest diameter of the conical tube was 2·40 cm., and the distance between this and the theoretical point of the cone 18·0 cm., the latter being 24·0 cm. from the centre of rotation. In most experiments the cells are quite undamaged after the separation. Tumour cells and non-tumorous exudate cells were counted differentially on Papanicolaou smears as described elsewhere[3]. Some experimental figures are collected in Table 1.

Table 1. PERCENTAGE OF NON-TUMOROUS EXUDATE CELLS IN VARIOUS SAMPLES BEFORE AND AFTER CENTRIFUGATION

| Exp No. | Original suspension | Fraction | |
|---|---|---|---|
| | | *M* | *G* |
| 1 | 13·0 | 3·8 | 3·6 |
| 2 | 17·3 | 9·0 | 2·8 |
| 3 | 40·7 | 12·6 | 15·8 |
| 4 | 20·5 | 11·2 | 5·2 |

In three of the four experiments, the percentage of small cells has been reduced to about one-fourth of the original value (in one experiment to one-sixth). All cells having the same specific density, one would expect to find most of the small cells in fraction *G*; it is seen from Table 1, however, that the percentage of contaminating cells is often smaller in fraction *G* than in fraction *M*. The contaminating cells thus appear to have a higher specific density than the tumour cells.

A detailed description of the centrifuge will appear shortly in I.V.A.'s *Tidskrift för Tekniskt-vetenskaplig Forskning* (Stockholm). We are indebted to Eli Lilly and Co. for financial support.

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## Comparison of Rectal and Deep Body Temperature in the Calf

IN the bovine animal as with other domestic mammals including man, the rectal temperature is generally accepted as a measure of deep body temperature, and it is widely used both in field and laboratory studies for indicating the state of thermal balance of cattle when subjected to climatic stress. Despite the possibility of thermal gradients within the rectum, as has been found in man[1], there is no obvious reason for doubting the validity of this assumption, at least as an approximation, when body temperatures are steady. However, under conditions of thermal stress, when body temperatures are rising, a constant and close relationship between rectal and deep-body temperature cannot be assumed, as there is almost certainly a delay before the temperature of the fæcal mass reaches equilibrium with that of the rectal wall. Consequently, an investigation has been made to study the validity of using rectal temperature as a measure of deep body temperature in Ayrshire bull calves, four to six months old. Cattle of this age and breed have already been used in studies of environmental physiology in a climatic chamber in this Institute[2].

A reasonable measure of average deep body temperature would seem to be that of the pooled and well-mixed venous return to the heart. Eichna and others[3] and Mather, Nahas and Hemingway[4] failed to find any temperature difference across the lungs in man and dog, and assuming this to be true also of the bovine, the temperature of the blood leaving the left side of the heart should be a valid measure of both deep body temperature and of the blood supplying the temperature-regulating centre in the brain. For this reason, and because the temperature of the well-mixed venous blood in the pulmonary artery is difficult to measure without extensive surgery, the temperature of the free-flowing arterial blood in the bicarotid trunk was compared with rectal temperature.

A fine copper-constantan thermocouple, threaded into a narrow polyvinyl chloride plastic tube, sealed at the couple end, was introduced into the right carotid artery by means of aseptic surgery. The tube was passed down the inside of the artery until the thermocouple junction was estimated to lie in the bicarotid trunk. Five animals were used, and although on examination several days later an embolism was invariably found at the point of entry of the thermocouple wires into the artery, the junction was found to be lying in free-flowing blood passing up the left carotid artery. The leads were brought out through a stab wound in the skin lateral to the main incision, and terminated on a 'Perspex' button sewn on to the skin over the stab wound. A protective cap was then fitted over the button, and this allowed the animal free movement in the byre. Recovery was complete in three to four days, when the animal appeared to be normal. The calf was then placed in the climatic chamber for periods of up to 6 hr. at 20°, 30° and 40° C. at a constant low humidity (17 mgm./l. absolute humidity), and at 35° and 40° C. at a constant high humidity (7 mgm./l. saturation deficit). During the experiment, the protective cap was replaced with a cap containing copper and constantan contacts from which leads were attached to the temperature-measuring system which has already been described[2,5]. Rectal temperature was expressed as the average of almost simultaneous readings from four thermocouples each 2·5 cm. apart, the deepest being 15 cm. from the external anal sphincter. Only slight and random variations occurred between the temperatures measured by the rectal thermocouples at different depths of insertion. Measurements of rectal and carotid temperatures were taken every 5 min.

In all five animals, the carotid blood temperature was 0·1–0·3 deg. C. below that of the rectum at every low-humidity exposure. This difference remained fairly constant for any one animal at any one environmental temperature, whether body temperatures were relatively steady or were slowly climbing (Fig. 1). At the environmental conditions of 35° C. and high humidity, when body temperatures were rising, a difference between carotid and rectal temperatures remained, though in some instances the difference was less than that noted before the humidity was raised (Fig. 2A). At 40° C. and high humidity,

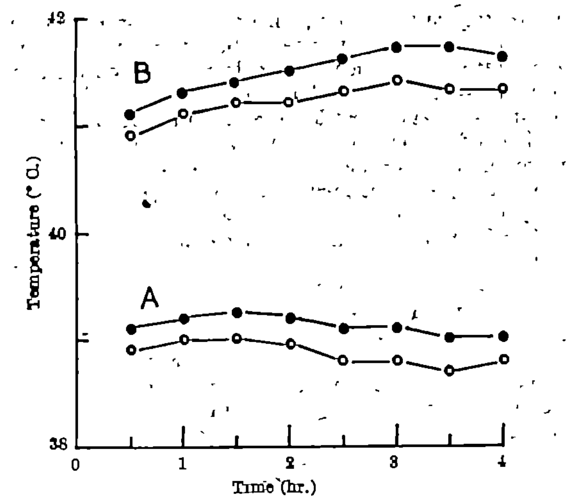

Fig. 1. Rectal (—●—) and carotid blood (—○—) temperatures of a calf while it was subjected to environmental temperatures of (*A*) 20° and (*B*) 40° C. Humidity was maintained at 17 mgm. water/l. in each experiment. Readings were taken at 5 min. intervals and plotted as half-hourly averages

when virtually all channels of heat loss were denied the animal and body temperature rose steeply at a rate determined by its heat production, the temperature difference disappeared and rectal and carotid temperatures became identical (Fig. 2*B*). Sometimes the carotid blood temperature was even slightly higher than that of the rectum.

The change in relationship between rectal and arterial blood temperatures when the humidity is raised at 40° C. is at least partly due to the delay in temperature changes of the fæcal mass. However, these are more extreme conditions of thermal stress than are normally encountered under field conditions, and it is concluded from these experiments that although rectal temperature is slightly above the temperature of the blood leaving the left side of the heart under any but the most adverse conditions of climatic stress, for all practical purposes pertaining to environmental studies with the bovine animal upward changes in rectal temperature in response to external heat stress indicate changes of a similar magnitude in 'deep body temperature'.

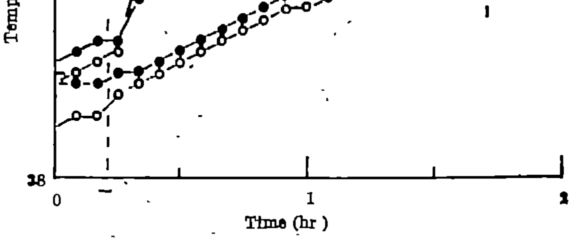

Fig. 2. Rectal (—●—) and carotid blood (—○—) temperatures of a calf while it was subjected to environmental temperatures of (*A*) 35° and (*B*) 40° C. In each experiment high humidity conditions (7 mgm./l. saturation deficit) were maintained in the room during the period within the vertical interrupted lines. The humidity was low at the beginning and end of each experiment

The 'Perspex' button and caps were designed and made by Mr. W. Nisbet of this Institute.

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## Modification of the After-Potential of Single Muscle Fibres by 2:4-Dinitrophenol

INTRACELLULAR recording of electrical activity in the excised sartorius muscle of *Hyla coerulea* shows a negative after-potential of 20–25 mV. with a half-time of decay ($t_{1/2}$) of 8–12 m.sec. at 25° C. The time of recovery to resting potential level is increased to $t_{1/2}$ of 18–25 m.sec. when K+ is absent from the glucose–phosphate–Ringer medium. Successive increases of K+ concentration up to 15 *N*/1,000 cause successive shortenings of repolarization time to $t_{1/2}$ 6 m.sec.[1]. These processes are faster by one-third in *Rana catesbiana*. The after-potential of *Hyla* muscle is prolonged, also, by reduction of Na+ in the medium to 20 *M* ($t_{1/2}$ 15–20 m.sec.) or by increase of H+ to *p*H 6·5, which gives $t_{1/2}$ of 28 m.sec.

The possibility that the effect of ions upon repolarization is linked with energy supplies is suggested by Lorente[2], who used hypoxia for changing the positive after-potential of nerve. To test whether phosphate were the energy source of muscle after-potential ionic movements, 2 : 4-dinitrophenol (DNP) was added to the Ringer solution. In 20 min. 2 m*M* DNP abolished all the negative after-potential (Fig. 1,*b*). After another 10 min. it slightly reduced the resting potential to 60–65 mV. The endplate potential was not significantly altered, though the overshoot was reduced by 8–10 mV. (Fig. 1,*c*). Soaking in normal Ringer solution restored the after-potential to its previous voltage and duration. Addition of 2 m*M* DNP to a medium from which K+ was omitted prevented the normal rise of resting potential to 105 mV.; but it abolished the after-potential. In an atmosphere of nitrogen the sartorius muscle fibres were found to lose the greater part of the after-potential, and recovery followed the readmission of oxygen. Similarly, cooling the muscle to 6° C. eliminated nearly all the after-potential. The duration of the spike increased.

These findings may be interpreted as the consequences of reduction in available phosphate by the decoupling of oxidative phosphorylation, probably in the mitochondria[3,4]. Lack of oxygen would reduce phosphorylation. Active ion transfer then would be reduced. The negative after-potential would thus be the result of sodium extrusion (or possibly chloride intrusion) aided by phosphate energy, derived from oxidative sources. The effects of K+ may follow competition for transfer between K+ and the more actively transported ion.

*Heart muscle.* The intracellular record of action potentials of frog cardiac muscle cells shows pro-

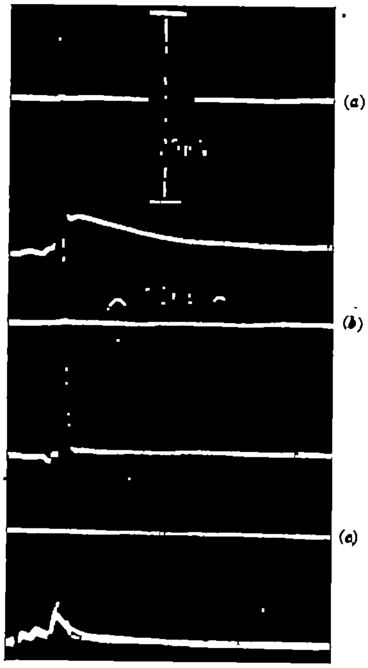

Fig. 1 (a) Intracellular muscle fibre action potential in normal glucose–phosphate–Ringer solution at 25° C. Resting potential, 85 mV ; overshoot, 46 mV.; (b) same muscle and conditions as (a) with addition of 2 m*M* 2 : 4-DNP, after 20 min. soaking The after-potential is eliminated; (c) another muscle after 30 min. in 2 m*M* DNP, at the nerve-muscle endplate, showing summation of two endplate potentials. A second sweep with action potential is superimposed. Resting potential, 60 mV.; overshoot, 38 mV.

longed depolarization when the K+ in the medium is reduced and some shortening of the depolarization time follows increase of K+ concentration up to 15 *N*/1,000. Clinically in man, this effect of K+ is detected as longer or shorter S—T intervals of the electrocardiogram in hypo- and hyperkalæmia respectively[5,6]. Reduced oxygen supply also shortens repolarization time. It seemed likely that the prolonged depolarization of the heart cell might, in part at least, be equivalent to the negative after-potential of skeletal muscle. Frog ventricular intracellular potentials were examined in the presence of 2 : 4 DNP at 25° C. The duration of the action potential was reduced from 660–700 m.sec. to 200 m.sec. without reduction in resting potential or overshoot. Longer time of action of DNP abolished the overshoot and left the ventricular action potential as a short event, occupying 90–110 m.sec. This is less than one-sixth the duration of the normal repolarization time at 25° C. and it took place without change of heart-rate. Neutral red 0·2 m*M*, when it has stained the muscle, also shortens the time-course of the action potential to one-third. It is a weak decoupling agent. The increased K+ loss from DNP-treated heart muscle[7] is probably linked with decreased sodium extrusion during repolarization. The refractory period of cardiac muscle may thus be regarded as an energy-linked ion transfer which maintains the potential near zero until half a second has passed. Five-sixths of this time of depolarization can be abolished by DNP, probably by the decoupling of phosphorylation and exhaustion of phosphate stores.

The negative after-potential of skeletal muscle appears from this evidence to be an event homologous with the greater part of the long depolarization of cardiac muscle. The two slow potentials behave in a similar fashion to K+ concentration changes and to 2 : 4-DNP. These slow potentials appear to be dependent upon phosphate energy and oxygen for the active process of ion transfer.

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## Occurrence of Vertebrates in the Triassic of Israel

VERTEBRATE bones from the Triassic in southern Israel were noted by Shaw so early as 1947[1]. Further W. E. Swinton described a single nothosaurian vertebra from the same locality in 1952[2]. During my first visit in 1953, it was possible to state that more or less well preserved vertebrate bones occur abundantly in the Triassic of Wadi Raman, and a more complete fossil was found and prepared at the Swedish Geological Survey at Stockholm. After preparation, this fossil could be identified as half of the dorsal armour of the turtle-like placodont *Psephosaurus*. Hitherto, only fragments of the dorsal armour of this reptile were known, found in the lowermost part of the Upper Triassic in Germany.

The new fossil shows not only the central parts of the dorsal armour but also the incisions for the neck and the fore and hind legs, the marginal part and parts of the ventral armour.

During 1954, the number of finds of vertebrate fossils increased and hundreds of fragments were collected. Among this material there are vertebræ, teeth and bones from the extremities of numerous nothosaurian and other reptiles, five imperfect skulls, of which one belongs to *Psephosaurus* and one to a large placodont, the middle part of a nothosaurian skull and others which have not yet been thoroughly studied.

The skull of *Psephosaurus* is the most complete one. The entire occipital region, parts of the vomera area with two large teeth, the posterior part of the dorsal side of the skull, and one of the very typical jugales are well preserved. The relationship to the Placodontia is given by the teeth, and other parts of the skull also show this relationship. On the other hand, the skull of *Psephosaurus* from Israel has special characters, which show that the group of turtle-like placodonts was already distinctly separated from the other placodonts in the lower Meso-Trias.

In addition to the skull fragment, an almost complete dorsal armour of *Psephosaurus* was discovered.

The fossil-bearing layers begin with beds characterized by the ammonoid *Beneckeia*. I divide the uppermost part of the section with bones into five zones containing different types of *Paraceratites* and *Siniaceratites*[3]. The layers between the Ceratite and *Beneckeia* beds are of terrestrial origin, containing vertebrates and plant remains. The stratigraphical range of the new locality with its large vertebrate fauna begins in the deepest Lower Meso-Trias and aches the Upper Meso-Trias according to the lassification by Spath[4]. The *Psephosaurus* from Vadi Raman is therefore the oldest known of the rmoured branch of the Placodontia.

F. BROTZEN

Swedish Geological Survey,
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Southern Palestine, Geological Map, 1/250,000, with explanatory notes (Government of Palestine).

*Ann. Mag. Nat. Hist.* (12), 5.

See G. al Din Hafez Awad, *Bull. Inst. d'Egypte* (1946).

Catalogue of Fossil Cephalopods in the British Museum, Part IV (1934).

## Age of Uraninites from Dimensions of their Unit Cells

THREE years ago Dr. Wasserstein suggested in a ommunication in *Nature*[1] that "the generation by adioactive decay of smaller atoms of tetravalent ead within the crystal lattice of uraninites caused a hrinkage in the unit cell proportionate with time", nd that this could be used for estimating their ges. In a more recent communication[2] he discussed is method in the light of a classification of uraninites nto three types, namely, the equivalents of artificial O$_2$, and materials having uranium – oxygen ratios f 1 : 2·33 (possibly $U_3O_7$) and 1 : 1·75 (possibly $_4O_7$), respectively, and thinks that they are all haracterized by a fluorite structure with different arameters' in the three cases.

Hoekstra and Katz[3] pointed out that the existence f these oxides in Nature is doubtful. In his answer Vasserstein mentions the occurrence of thorium, tanium and zirconium in some uraninites, and states at "these replacements of uranium are in accordnce with the principle that lower valence of an ement is indicative of larger ionic size, and conersely. The different 'valencies' envisaged in my assification must have influenced the nature of the placements at the time of formation of the minerals".

A number of points made by Dr. Wasserstein in ese communications call for comment.

(1) There is no ground for the supposition that diogenic lead is produced as tetravalent ions. The neration of radium G from radium F actually rings about a superabundance of electrons for tisfying the amount needed in the electronic chitecture of the lead atom.

(2) That the succeeding members of the uranium sintegration series can remain in position in the ystal lattice after the radon stage is reached is tenable, for the following reasons:

(*a*) The radius of the radon atom is 247 per nt that of tetravalent uranium. It is not possible r ions which differ more than 15 per cent in size replace each other.

(*b*) The reaction caused by the emission of the latively heavy α-particle at high speed is certainly g enough to cause a recoil of the parent element rough such a distance that it cannot return to its iginal position.

(*c*) Radon is even larger than the oxygen ion. It nnot diffuse through the uraninite lattice. That actually causes submicroscopic fractures is therere proved by the fact that it is able to leak out of e crystal, as shown by Kulp, Bate and Broecker[4]. It must be pointed out that the lead which is ally generated within these submicroscopic fracres will not be detected by a powder X-ray fraction investigation—it is present as isolated particles, not as a separate crystal, and not in the uraninite lattice.

(3) Even if the generation of lead within the crystal lattice were possible, the resultant shrinkage could not have been proportionate to time, but only to the amount of lead generated within the crystal lattice.

(4) It was not shown how $U_3O_7$ and $U_4O_7$ can exist in the form of a fluorite ($AX_2$) type of structure. How can these small unit cells which Wasserstein proposes contain the number of ions demanded by the formulæ, and Pauling's electrostatic valency principle be satisfied at the same time?

(5) Dr. Wasserstein quotes differential thermal data from a paper by Heystek and Schmidt[5] in support of a γ-type, represented by a sample from Gordonia. This curve actually shows three distinct thermal reactions, and proves that during heating a more complicated process than oxidation of $UO_{1\cdot75}$ to $UO_2$ occurs.

(6) The "principle that lower valence of an element is indicative of larger ionic size, and conversely" does not exist. The following table illustrates examples where the opposite is true.

| Ion | $Sn^{2+}$ | $Sn^{4-}$ | $Pb^{2+}$ | $Pb^{4-}$ | O | $O^{2-}$ | S | $S^{2-}$ |
|---|---|---|---|---|---|---|---|---|
| Valence | 2 | 4 | 2 | 4 | 0 | 2 | 0 | 2 |
| Ionic radius | 0·93 | 2·15 | 1 20 | 2·15 | 0·60 | 1·40 | 1 04 | 1 85 |

Both the magnitude and the sign of the electrostatic charge must be taken into account to correct this statement.

(7) Dr. Wasserstein was able to arrange some of his results in such a way that older samples show smaller unit cell dimensions. This is not surprising, when the following is borne in mind: (*a*) he states that unsuitable material is neglected by means of "sample selection"[3]; (*b*) corrections are applied for the presence of thorium[1]; but the validity of the method by means of which the amount of correction is arrived at was not proved; (*c*) by means of heat treatment in different atmospheres, the unit cell dimensions of unsuitable samples are increased or decreased, and classified into three different groups[3].

(8) He tested his method once for material of unknown age, and found 850 million years for the Witwatersrand uraninite[1]; later isotopic analysis gave an age which differed from this by more than 100 per cent.

S. A. HIEMSTRA

Geological Survey,
P.O. Box 401, Pretoria,
South Africa.

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[1] Wasserstein, B., *Nature*, 168, 380 (1951).

[2] Wasserstein, B., *Nature*, 174, 1004 (1954).

[3] Hoekstra, H. R., and Katz, J. J.; Wasserstein, B., *Nature*, 175, 605 (1955).

[4] Kulp, J. L., Bate, G. L., and Broecker, W. S., *Amer. J. Sci.*, 252, 352 (1954).

[5] Heystek, H., and Schmidt, E. R., *Trans. Geol. Soc. S. Afr.*, 56, 165 (1953).

MR. S. A. HIEMSTRA's criticisms can be answered as follows, using his reference numbers.

(1) and (2) The direct evidence that would satisfy him may never be forthcoming; my experimental findings are the available evidence. About four hundred unit cells were measured, and several hundred other X-ray patterns furnished evidence.

The fact that lead demonstrably lowers the parameter of uraninites is evidence that tetravalent lead satisfies the requirements within the lattice in all respects—no other alternative explanation can explain the data as satisfactorily. The ideal mineralogical material from the Belgian Congo provides evidence. Fresh crystals mined at depth are practically free from impurities. Heating in the absence of oxygen does not affect the parameter, clearly indicating that there are no effects due to weathering or radiation damage. The X-ray pattern is that of $UO_2$; but the parameter is less. Only its radiogenic lead-content (about 7 per cent) can be the cause for this reduction in the circumstances. (The reduction in the parameter equals the rate of 0·0035 A. per 100 million years—as has been found for other samples of different ages.)

Mr. Hiemstra suggests here and under (2c) that radiogenic lead occurs outside the lattice. My heating experiments were aimed at detecting such lead or its compounds, as increase of particle size and removal of strain would materially assist in detection by powder X-ray methods. It is very unlikely that such large amounts as 15 per cent—as are found in ancient uraninites—could have escaped detection not only by myself but also by so many chemists.

Radon does not enter the crystal lattice, nor does neutral lead (cf. RaG); but this does not mean that $Pb^{4+}$ is therefore excluded.

I am aware of the (Wigner) recoil effect. X-ray powder diffraction by its very nature records a statistical picture: it seems reasonable to assume that lead ions will drop into vacant U-positions—a process no doubt facilitated by the order effect of heating.

(3) The measured rate of shrinkage seems sufficient comment.

(4) I have previously dealt with $U_4O_7$ or $UO_{1·75}$ [1], and according to Zachariasen this compound has the fluorite structure. I suggested[1] that, as I am in the hands of the chemists for precision of the U : O ratios, this oxide could be written $UO_{2-x}$. In a further communication in *Nature*, July 23, p. 159, I write the chemistry of uraninites as $UO_{2\pm x}$ and such a concept may clear the matter in respect of the smallness of the unit cell.

The following extracts from a letter from Anderson (compare ref. 2) deals with the β-phase, which was proved to have a fluorite structure with a parameter of 5·440 A.; he writes: "A good deal of work was carried out at Harwell after . . . 1949 . . . for various reasons it has not been published . . . the oxidation of $UO_2$ has been proved to take place . . . there are at least three intermediate oxide phases . . . (i) the contracted cubic oxide (called by us β-phase), exactly $UO_{2·25}$ ($U_4O_8$, with 1 additional O atom per unit cell), $a$ = 5·430 kX . . .". This may may be Jolibois's[3] $UO_{2·33}$ or $U_3O_7$; there can be no doubt now that there is a higher oxide of the type $UO_{2+x}$ with a fluorite structure—which is my prototype for the pitchblendes.

(5) Differential thermal analysis requires relatively large samples, and the inclusion of weathered material cannot be avoided; this affected the curve, which nevertheless indicated the essential oxidation—an unpublished curve shows this effect better.

(6) Mr. Hiemstra is guilty of some basic misconceptions in interpreting an elementary principle of crystal chemistry. In dealing with the accepted relationship between valencies and ionic radii, I was, of course, dealing with those of lead and uranium in their role as cations. He has introduced neutral and negative charges; by giving the data incompletely he is highly misleading. If he gives the data on lead more fully, we have:

| | |
|---|---|
| $Pb^{4+}$ | 0·84 A. |
| $Pb^{2+}$ | 1·20 |
| Pb | 1·75 |
| $Pb^{4-}$ | 2·15 |

Basically he believes that "– 4" is bigger th "+ 2"; I stand by my original statement, ". . lower valence of an element is indicative of larg ionic size, and conversely"[1].

(7a) "Sample selection" here means that I selecte the freshest portion in a specimen—there is nothin unusual in doing this. Coupling selection with th minuteness of the sample required for X-ray diffra tion work, I seem to have avoided major effects radon loss—if this is indeed a factor here (cf. Hiemstr 2c)—which is more likely to be linked with weathere material.

(7b) The proof lies in the fact that thorianites hav much higher cube-edges than uraninites, and also the synthesis of the complete series $UO_2$—ThO which has shown that Vegard's law applies. Su data support the validity of my method of correcti for thoria, at least to a first approximation. T corrections used were sometimes small and negligibl

(7c) This is partly answered under (1). In practi all samples are subjected to the same heat trea ments; but owing to their different chemistry, envisaged in my classification, they react differentl If all samples are fresh, then heating in air oxidi the γ-types to give the requisite parameter; tho that could not withstand this treatment are heat in hydrogen instead to give the required paramete Only weathered γ-uraninite enforces a slight mo fication. Types can also be recognized by th origin: γ-uraninite, always with thoria, is typical high-temperature pegmatites; α-uraninite may occ in pegmatites or high-temperature veins, and t pitchblendes occur only in hydrothermal deposi This indicates the heating pattern.

(8) My preliminary result on the Witwatersra uraninites obtained five years ago was at a tim when I did not recognize the true nature of that ty of material. In 1951 I corrected that value in private report which I circulated to many co-worke in which I gave a minimum value of 1,600 milli years—and which, when corrected for thoria, giv more than 1,700 million years: this was a credita effort at a time when no isotope data were availab and my own efforts were of a preliminary nature. was this result that encouraged me to continue work.

One may theorize a great deal about the mecha isms involved (for example, vacant U-positions but I aim mainly at demonstrating that the pa meters of uraninites are affected by both age a the chemistry of the mineral, that is, that there nothing haphazard about the X-ray data; here is neglected but powerful approach to a first-cl riddle.

Since writing the above reply, I have seen a pr print of a chapter by H. R. Hoekstra and J. Ka in a new book[3]; they now accept the presence "a $\beta UO_2$ ($UO_{2·25}$)", and quote confirmatory eviden for Zachariasen's $UO_{1·75}$. Further, Giletti and Ku report radon losses from uraninites to be less th 0·80 per cent.

B. WASSERSTEIN

P.O. Box 401, Pretoria.

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[1] Wasserstein, B., *Nature*, 175, 605 (1955).

[2] Wasserstein, B., *Nature*, 174, 1004 (1954).

[3] "The Chemistry of Uranium", National Nuclear Energy Ser Chap. 6. (Title as yet unknown.)

Giletti and Kulp, *Amer. Min.*, 40, 481 (1955).

# FORTHCOMING EVENTS

## Monday, August 29—Friday, September 2

British Pharmaceutical Conference, 1955 (at Aberdeen).

## Wednesday, August 31—Wednesday, September 7

British Association for the Advancement of Science (at istol).—Annual Meeting.

**ednesday, August 31**

At 8.15 p.m.—Sir Robert Robinson, O.M., F.R.S.: "Science and e Scientist" (Presidential Address).

**ursday, September 1**

At 10 a.m.—Sir Alexander Todd, F.R.S.: "Nucleic Acid Structure d Function" (Presidential Address, Section B).
At 10 a.m.—Prof. F. W. Rogers Brambell, F.R.S.: "Immunity d Development" (Presidential Address, Section D).
At 10 a.m.—Dr. S. F. Dorey, F.R.S.: "The Influence of the gineer on Sea Transport and Trade" (Presidential Address, Section ).
At 10 a.m.—Dr. D. B. Harden: "Anthropology: a Scientific ity?" (Presidential Address, Section H).
At 10 a.m.—Prof. K. Mather, F.R.S.: "Biological Organization" residential Address, Section K, K*).
At 11.45 a.m.—Mr. Alec Rodger: "The Effective Use of Man-wer" (Presidential Address, Section J).
At 2.30 p.m.—Mr. P. Ritchie Calder: "The Fragmentation of ience" (Presidential Address, Section X).

**day, September 2**

At 10 a.m.—Prof. N. F. Mott, F.R.S.: "Physics of the Solid State" residential Address, Section A).
At 10 a.m.—Prof. J. R. Hicks: "The Economic Foundation of age Policy" (Presidential Address, Section F).
At 10 a.m.—Prof. E. C. Mobbs: "Afforestation and the Community" hairman's Address, Section K*).
At 10 a.m.—Mr. J. F. Wolfenden: "The Educated Man in 1955" residential Address, Section L).
At 10 a.m.—Mr. W. B. Mercer: "The Impact of Education on arming" (Presidential Address, Section M).
At 11.30 a.m.—Mr. J. N. L. Baker: "Geography and its History" residential Address, Section E).
At 2.30 p.m.—Mr. R. A. Hamilton: "The Scientific Work of the itish North Greenland Expedition" (Special Lecture for Young ople).
At 8 p.m.—Prof. C. F. Powell, F.R.S.: "Experiments at Great ights with Free Balloons".

**urday, September 3**

At 8 p.m.—Prof. David Douglas: "The Living Past".

**nday, September 4**

At 11 a.m.—(In Bristol Cathedral)—Religious Service. Preacher: Rt. Rev. the Lord Bishop of Bristol.
At 8 p.m.—Prof. H. D. F. Kitto: "Scientific and Dramatic Modes Thought".

**nday, September 5**

At 10 a.m.—Mr. W. N. Edwards: "Geographical Distribution of st Floras" (Presidential Address, Section C).
At 10 a.m.—Dr. R. S. Creed: "The Sensory Pathway" (Presidential dress, Section I).
At 8 p.m.—Mr. R. J. C. Atkinson: "Stonehenge in the Light of cent Research".

**esday, September 6**

At 2.30 p.m.—Mr. B. J. Mason: "Man's Influence on the Weather: cent Progress and Future Possibilities" (Special Lecture for Young ople).

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or ure the dates mentioned:

Assistant in the Department of Zoology at St. Salvator's College, Andrews—Joint Clerk to the University Court, College Gate, Andrews (August 31).

Assistant Statistician (with a first- or second-class degree in tistics, or in economics combined with statistics), to act as mathe- tical specialist in the Statistics Section—The Secretary, North stern Gas Board, 60 Whitworth Street, Manchester 1 (September 1).

hief Analyst (with a good degree or equivalent qualifications in mistry, and a thorough knowledge of the methods of sampling analysis of coal and mine airs) in the Divisional Scientific partment—The Divisional Chief Scientist, National Coal Board, rthern (N. and C.) Division, The Grange, Grange Avenue, Long- ton, Newcastle-upon-Tyne 1 (September 1).

alytical Chemist (with a degree in chemistry or at least the her national certificate in chemistry) to work mainly on plant terial—The Secretary, National Vegetable Research Station, llesbourne, Warwick (September 3).

ochemist, Basic grade (with a university degree in chemistry biochemistry, or an equivalent qualification)—Prof. C. H. Gray, partment of Chemical Pathology, King's College Hospital, Denmark l, London, S.E.5 (September 3).

Experimental Officer or Assistant Experimental Officer (with a good knowledge of at least two European languages, and preferably with a degree in a scientific subject, or at least a general certificate of education in five subjects, with two scientific subjects at advanced level) in the Colonial Products Laboratory, London, S.W.7, for technical indexing from scientific publications—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.591/5A (September 3)

Demonstrator in the Department of Chemistry—The Registrar, King's College, Newcastle-upon-Tyne (September 5).

Assistant Lecturer or Lecturer in Animal Husbandry, in the Faculty of Veterinary Science—The Registrar, The University, Liverpool (September 10).

Physicist (basic grade) for duty in the X-Ray Diagnostic Department—The Administrator and Secretary, University College Hospital, Gower Street, London, W.C.1 (September 10).

Scientific Assistant (university graduate in science or agriculture and preferably with special training in nutrition and/or knowledge of foreign languages), for duties which include abstracting, indexing and proof reading—The Director, Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire (September 10).

Lecturer in Philosophy, and a Lecturer in the Department of Civil and Mechanical Engineering—Joint Clerk to the University Court, Queen's College, Dundee (September 15).

Metallurgist to work in the Bio-mechanical Research Unit in the Faculty of Engineering on the metallurgical problems presented by the use of implants in surgery—The Registrar, University of London, King's College, Strand, London, W.C.2 (September 16).

Lecturer or Assistant Lecturer in Physics—The Registrar, The University, Sheffield (September 17).

Research Officer or Senior Research Officer (with a university honours, or higher degree in science, with research experience in physical chemistry or biochemistry, and experience of the development of new chromatographic methods) in the Division of Plant Industry of the Commonwealth Scientific and Industrial Research Organization, to study the properties of plant proteins with particular reference to their chromatographic separations, to collaborate in the studies of plant protein biosynthesis, and to assist with the development of chromatographic facilities and techniques in the Division—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (September 17).

Scientific Officer (with a good honours degree in botany or agricultural botany, and preferably with an interest in fruit culture) in the Department of Pomology, for work on the growth, development and cultivation of the raspberry—The Secretary, Scottish Horticultural Research Institute, Mylnefield, Invergowrie, Dundee (September 17).

Research Worker (with an honours degre in biochemistry or equivalent qualification) to assist in work on the metabolism of the autotrophic nitrifying bacteria—Prof. W. O. Kermack, Department of Biological Chemistry, Marischal College, Aberdeen (September 19).

Lecturer (with a good honours degree in chemical engineering or in physical chemistry) in Mineral Dressing in the Department of Mining—The Registrar, The University, Leeds (September 23).

Research Assistants (2) (with a good honours degree in physics or physical chemistry) in the Department of Mining—The Registrar, The University, Leeds 2 (September 23).

Assistant Lecturer in Dairy Bacteriology—The Registrar, University College of Wales, Aberystwyth (September 30).

Lecturer in Psychology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 30).

May and Baker Research Fellow (graduate in chemistry) to undertake research work on plant growth-regulating substances under the direction of Prof. R. L. Wain—The Registrar, Wye College (University of London), Wye, Kent (September 30).

Senior Lecturer in Anthropology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 30).

Senior Lecturer or Lecturer in Physical Chemistry or Inorganic Chemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 7)

Senior Lecturer and a Junior Lecturer in the Department of Pharmacology and Therapeutics at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, October 10).

Chair of Botany at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, October 15).

Research Fellow (with experience in one of the following subjects: igneous metamorphic or structural petrology; crystallography or crystal physics; physics of high pressure; general geophysics including seismology or rock magnetism) in the Department of Geophysics, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

Senior Lecturer (with an honours degree and a research degree in zoology, and teaching experience at university level) in Zoology at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, October 31).

Engineer for the design of apparatus producing very strong magnetic fields to be used in low temperature and nuclear research—"Engineer", Clarendon Laboratory, Oxford.

Lecturer (with an honours degree of a British university, and preferably some industrial and/or research experience) in the Physics Department—The Principal, Paisley Technical College, Paisley.

Nuclear Physicist (with at least a good second-class honours degree in physics, and a comprehensive knowledge of high energy physics) in the General Physics Division to lead the work of a research team using a 175 MeV. synchrocyclotron for fundamental studies in the field of high energy physics—The Establishment Officer, United

Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/363.

Senior Experimental Officer or Experimental Officer (preferably with a degree or equivalent in either physics or chemistry, with experience in the field of emission spectroscopy), for analytical and applied research work on radioactive and non-radioactive materials—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. A.608/34.

Senior Geneticist, Senior Principal Scientific Officer grade (with at least a second-class honours degree in botany or other natural science, with some years experience of plant breeding and genetics), as Head of the Plant Breeding Division, West African Institute for Oil Palm Research, to plan and execute the research programme of the division, which is directed towards improving the oil-palm by selection and breeding and includes investigation of the genetics and cytology of the crop—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/199/03.

Senior Reader or Lecturer (preferably with experience in nutrition and food analysis) in Biochemistry—Dean Ernest Said, Queen Aliyah College, Baghdad, Iraq.

Systematic Botanist (with a degree in botany or agricultural botany or equivalent qualification, and preferably with experience of systematic botany or the classification of crop varieties), for work on the classification and identification of varieties of agricultural crops; a Technical Officer (with a degree in agriculture or botany or equivalent qualifications, and preferably with field experience) for Potato Trials; and a Technical Officer (with a degree in botany or equivalent qualifications, and preferably with practical experience of seed production) for Herbage Seed Production—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

University of Reading. National Institute for Research in Dairying. Report, 1954. Pp. 140+8 plates. (Shinfield: National Institute for Research in Dairying, 1955.) 4*s*. [206

National Museum of Wales. Welsh Folk Museum, St. Fagans—Handbook. Pp. 29 (10 plates). (Cardiff: National Museum of Wales, 1955.) 1*s*. [206

Institution of Gas Engineers. Publication No. 460: 92nd Annual Report and Accounts. Pp. 41. Publication No. 461: Presidential Address by W. K. Tate, given at the 92nd Annual General Meeting, Portsmouth and Southsea, 24th to 27th May, 1955. Pp. 16. Publication No. 462: The Architect and Industry. By H. D. Jefferies Mathews. Pp. 28 (15 plates). Publication No. 463: Accelerated Continuous Carbonization: Full-scale Development and the Utilization of Low-swelling Coals. By W. Hodkinson, T. Nicklin and M. Redman. Pp. 46. Publication No. 464: Static Vertical Retorts at Southampton. By H. G. Burgess and G. Neil. Pp. 40. Publication No. 465: The "Backbone" Main in the East Midlands Area. By H. W. Pickering and J. B. Walsh. Pp. 43 Publication No. 466: Pumping of Liquids on Gas Works. By L. J. Clark. Pp. 41. Publication No. 467. Some Trends and Influences on the Domestic Load. By A. V. Horsfall. Pp. 23 Publication No. 468: A Practical Approach to the Problems of Gas Water Heating. By W. R. H. Lorimer. Pp. 11. Publication No. 469: Town Gas and the Changing Needs of Industry. By R. F. Hayman and H. A. K. Patrick. Pp. 30. Publication No. 470: Official Programme—92nd Annual General Meeting, Portsmouth and Southsea, 24th to 27th May, 1955. Pp. 11. (London: Institution of Gas Engineers, 1955.) [216

Coal-Tar Research Association. Review of Coal-Tar Technology, July–December, 1954. (Vol. 6, Part 2.) Pp. ii+95–172+xiii. (Gomersal, Nr. Leeds: Coal-Tar Research Association, 1955.) [216

Atoms for Peace Digest. Vol. 1, No. 1 (June 18, 1955). Pp. 9. (London: United States Information Service, 1955.) [216

Scottish Home Department. Freshwater and Salmon Fisheries Research Series No. 8: The Movements of Salmon Tagged in the Sea, Montrose, 1948, 1950, 1951. By K. A. Pyefinch and W. B. Woodward. Pp. 15. (Edinburgh: H.M. Stationery Office, 1955.) 3*s*. net. [226

Department of Scientific and Industrial Research. Report of the Mechanical Engineering Research Board, with the Report of the Director of Mechanical Engineering Research for the year 1954. Pp. iv+64+4 plates. (London: H.M. Stationery Office, 1955.) 3*s*. net [236

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1954. Northern Division. By W. Brown. Pp ii+30+7 plates. (London: H.M. Stationery Office, 1955) 2*s*. net. [236

Department of Scientific and Industrial Research. Food Investigation Special Report No. 61: Scientific and Technological Problems Involved in Using Ionizing Radiations for the Preservation of Food. By Dr. R. S. Hannan. Pp viii+192. (London: H.M. Stationery Office, 1955.) 7*s*. 6*d*. net. [236

Lister Institute of Preventive Medicine. Report of the Governing Body, 1955. Pp. 15. (London. Lister Institute of Preventive Medicine, 1955.) [236

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 940, Vol. 248 (23 June 1955): On the Product of Three Homogeneous Linear Forms and Indefinite Ternary Quadratic Forms. By J. W. S. Cassels and H. P. F. Swinnerton-Dyer. Pp. 73–96. 7*s*. 6*d*. No. 941, Vol. 248 (23 June 1955): Trapped Flux in Superconductors. By A. B. Pippard. Pp. 97–129. 10*s*. 6d. (London: Royal Society, 1955.) [236

Wye College (University of London). Department of Hop Research Annual Report, 1954. Pp. 129. (Ashford, Kent: Wye College, 1955.) 5*s*. [276

Department of Scientific and Industrial Research. Report of
Forest Products Research Board, with the Report of the Directo
Forest Products Research for the year 1954. Pp. vi+60+8 pla
(London: H.M. Stationery Office, 1955.) 3*s*. 6*d*. net.

Ministry of Agriculture, Fisheries and Food. Toxic Chemical
Agriculture: Risks to Wild Life. (Report to the Minister of A
culture, Fisheries and Food, and to the Secretary of State for Scotla
of the Working Party on Precautionary Measures against To
Chemicals used in Agriculture.) Pp. iv+31. (London: H.M. Statio
Office, 1955.) 1*s*. 6*d*. net.

## Other Countries

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# THE INTRINSIC VALUE OF SCIENCE

HE title of Sir Robert Robinson's presidential address to the British Association, which is nted in full beginning on p. 433, recalls the ex- ition of the cultural and human value of science ich a former president, Sir Edward Appleton, gave the Association in Liverpool two years ago. The ilarity indeed goes further. Both addresses provoke invite discussion on such topics as the teaching and ining of scientists and the place of science in, and use as, a vehicle of liberal education. But though Robert displays to the full, as did Sir Edward pleton, the place of imagination as well as of alysis and order in the advance of science, his in concern is with the scientist. As Sir Edward tified to the cultural and human value of science, Sir Robert presents the scientist as a human son and displays the conditions under which he s to work, his dignity and his problems, stripped the mystery or magic with which popular opinion ll too prone to invest him, and which in this age of hnology can be so fraught with danger to mankind. Sir Robert expressly excludes scientific method elf from his observations; but there are two ints in connexion with the definition of science th which he starts that are worth emphasizing view of this tendency to attribute mystical magical powers to the scientist. Science, he ists, is simply the record of the system of know- ge and of the conceptions correlating parts of that tem. That record, he points out, may be imperfect d the conceptions erroneous. Accordingly, science potentially fallible, and accordingly also it cannot based on dogma or authority of any kind.

While Sir Robert adds that there are degrees of certainty and that even the apparent revolution in ysics which has occurred in the twentieth century s not so much superseded the older teaching as plemented and extended it by wider generaliza- n, this first point as to the limitations of science of fundamental importance in regard to the ition of the man of science in society. Later in address, in referring to nuclear explosions and confident claim of the physicists that there is no k of unpredictable reactions in the lighter elements uclear tests are taken to further stages, Sir Robert nders whether we really know enough about clear reactions to be sure that there is no loop- e, and whether every conceivable case has been sidered. Cromwell's plea to the General Assembly the Church of Scotland, "I beseech you, by the wels of Christ think it possible you may be mis- ten", might well be emblazoned on the walls of ry research laboratory; and it is the realization ong scientists themselves of the limits of our owledge that has found expression recently in ir misgivings as to the continuance of nuclear test losions and the biological hazards of radiation.

he second point is also well brought out by Sir bert at a later stage in his address. After remarking the improvement of knowledge by successive approximations, he proceeds to illustrate his point by selecting examples from the history of science with the imaginative skill which is the mark of the artist no less than of the creative scientist. It is not, however, so much the way that scientific theory is justified by the success of predictions and by the unanticipated convergence of more than one line of approach that are impressive. Far more important than the fact that the degree of coincidence may become so great as to carry conviction that we have been vouchsafed, if not the whole truth, at least something very closely related to it, is the fact that this whole process depends on freedom of communication. "Who ever", cried Milton in the Areopagitica, "knew Truth to be put to the worse, in a free and open encounter". The principle of free discussion is implicit in the conception of science, and it is the birthright of the scientist.

Probably the most important feature of the Geneva Conference on the Peaceful Uses of Atomic Energy is the demonstration it gave of just that relaxation of secrecy on the scientific aspects of the development of nuclear energy to which Sir Robert refers. The five hundred technical papers read at that Conference discussed details which were close secrets only a short time ago. Now the fruits of some fifteen years of intensive, laborious and costly research are becoming largely international property, with benefits to further advances and advantages in economy of scientific and technical man-power and resources that can scarcely be over-stressed.

Sir Robert Robinson also suggests some form of international consultation before novel and greatly increased releases of energy are attempted. This lay outside the strictly technical orbit of the Geneva Conference; but the very success of the Geneva Conference in discussing matters previously so largely secret led its members to realize that it might soon be necessary for some body—and not a scientific body—to make proper arrangements for administering the solutions to the problems of the nuclear age to which technical advance might point. That in itself is a factor indicating the need for clearer understanding of the scientist and technologist as men, and of the significance of the technical and scientific elements in a political, social or economic problem, on the part of the administrator, whether the latter be Minister or Civil servant.

Meanwhile, however, it is all to the good that the importance of this relaxation of secrecy should be stressed so authoritatively; and scientists generally can show their appreciation of Sir Robert Robinson's address in no more fitting way than by emphasizing at every appropriate opportunity the vital connexion between scientific advance and the free communication and discussion of results and ideas. That this has been so admirably stated on repeated occasions in the past decade—by Sir Henry Dale and by the Commission on Higher Education in the United States, for example—does not minimize the need for continuing this process of educating the public understanding of the prime importance to a free society of academic freedom and untrammelled avenues of communication and discussion. The larger the place science and technology come to occupy in society, the greater the importance to society itself that the scientist should be able to move with freedom toward the truth wherever the path may lead, stayed by no authority or tradition, and hindered by no dogma, prejudice or vested interest from thoroughly exploring every promising avenue he sees. The whole atmosphere of the Geneva Conference warrants the hope that the climate of opinion is changing, and that statesmen and the public generally are disposed to accept an argument that for ten years or more has largely been rejected. To seize that opportunity is not solely a matter for the man of science. Rightly and firmly, Sir Robert includes all branches of knowledge in his definition of science, provided their record has been made without appeal to authority, nor does he believe that any philosophical line of demarcation separates one branch of learning from another.

Here he is at one with J. B. Atkins, who in "Incidents and Reflections" pleaded for the universal recognition that physical science belongs in essence to the humanities, and is a part, and may become the most important part, of that body of teaching, which though once narrowly confined was always destined to expand and in unity embrace the obligations of the good life. Emphatically, too, Sir Robert rejects the assertion that culture is the preserve of students of some particular branches of knowledge and is denied to others. Moreover, while the illustrations he chose to exemplify his thesis show he concurs with Sir Howard Florey's remark, in his Lister Memorial Lecture, that real and continuous progress and understanding in such a field as that of antibiotics research can be obtained only by the collaboration of people with various outlooks and experimental accomplishments, it is clear that Sir Robert recognizes that contributions to scientific advance can come from people whose primary occupation is not usually regarded as scientific.

Sir Robert's skilful exposition of the nature and drama of the scientific discipline may well induce the passing reflexion that a wider and wiser use of the historical method in teaching science might contribute not merely to give the scientist a clearer perspective in his work but also, and perhaps more important still, to give the non-scientist an understanding of the mind and method of the scientist and the conditions necessary for effective scientific work, as well as the limitations of that work. So too in his reference to the universality and the fully international character of science, Sir Robert indicates both the reality of the brotherhood of scientists—which of course is by no means unique—and the real basis for the state of mind which has found expression in Lord Russell's statement and others on the problems of the release of atomic energy. He sees in the world-wide co-operation which the development of science requires, one of the bulwarks of peace.

There are passages in Sir Robert's address whic testify to the intrinsic value of science as fully as d Sir Edward Appleton in his presidential address Liverpool. They recall the view of science whic Eddington advanced in a Gifford Lecture as springi from "a striving which the mind is impelled to follo a questioning that will not be suppressed". But and large, it is in what he reveals of himself in th address, more than in what he said, that Sir Robe displays the human qualities of the man of scien to the world, and the rich contribution he can bri not merely to its material life and technology b also to its thought and experience. The flashi asides, which uncover fresh angles of discussion varied topics, such as the need for a technologic grants committee to administer technological educ tion, the control of nuclear energy developments, the training of scientists, do not distract us from t consciousness that in himself the President exem plifies the judgment, the sense of values and t skilful selection that are the mark of a man of t highest culture. If by culture we mean the abili to think clearly and to express those thoughts language both dignified and lucid, we need look further for evidence that those trained in the physic or biological sciences possess those qualities as ful as any of their fellows, within or without the walls a university.

# CHRISTIAN FAITH IN THE WORLD OF SCIENCE

## Science and Christian Belief

By Prof. C. A. Coulson. (The John Calvin McNe Lectures, 1954.) Pp. x+127. (London: Oxfo University Press, 1955.) 8s. 6d. net.

In these lectures, delivered at the University Chapel Hill, North Carolina, Prof. C. A. Couls has followed up the line of thought set out in h Riddell Lectures in Durham and his address to t British Association at Oxford. He has been singula successful in interpreting the relationship betw the scientific discipline and outlook and that religion and of the Christian faith. In defini religion as "the total response of man to all environment" (p. 83) and by insisting that t scientist is no mere gadget-monger but a ful developed man using not only his curiosity and lo but also his imagination, his reflexion and his pow of commitment, he can present his case that scien represents, as it were, an architect's plan of t building, a plan which gives a true picture of o aspect of the whole but must not claim to be m than this—a plan to be supplemented by ot interpretations and harmonized with them ( 66–68).

Prof. Coulson begins with a searching criticism most of the traditional attempts to relate science religion. His examination of the supposed an thesis, of the attempts to define the intrusions of t one world into the other, of the well-meant desire find room for God in the gaps left by the inco pleteness of the scientific picture, should be studi by every theologian. It is illustrated by a la number of actual examples which show how v ny of the apologists for religion contradict their n professed belief in the omnipresence of God, and at the physical world as external to Him.

In his second lecture he disposes of the idea that ience is merely technology—a particular and ictly limited exercise of the logical intellect. Here ain he brings together a great mass of quotations prove that science, like religion, is a proper activity the whole man, an adventure demanding full use all the faculties and inspired by a belief in the ity and coherence of all reality.

In the third lecture he contends that not only is e whole man involved in the scientific quest but o that this quest is ultimately religious in character d linked with other modes of human response to e universe. It is an essential contribution, not ly to man's understanding of his environment or his control of it, but also to his whole reaction it and experience of it.

Finally, he concludes that this environment is sentially personal or superpersonal in character and at it can therefore be appropriately expressed for manity "in one person, a representative person, an chetype" (p. 112), and that this person is for the ristian the Christ. The scope and significance of is conviction he states briefly, clearly and with levant evidence.

It is difficult for one whose general position is very se to that of this book to express anything but miration for it. If there is to be criticism, it will that the wealth of quotations, though impressive d well chosen, leaves too little room for Prof. ulson's own admirably lucid and effective exposi- ons. It is to be hoped that he will before long give a fuller account of the position here outlined as sees it in regard not only to the present findings science but also to the great issues which to-day nfront mankind.

CHARLES E. RAVEN

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# REDBRICK'S DESTINY

## vic University

pects of a British Tradition. By W. H. G. Armytage. . 328+8 plates. (London: Ernest Benn, Ltd., 55.) 30s. net.

THE sub-title of Prof. Armytage's book is "Aspects of a British Tradition", and those rds provide the clue to his design and its fulfil- ent. He begins right back with the earliest impacts Christianity on Britain. In separate chapters he rks through the foundation of universities at ford and Cambridge, the laicization of the pro- sions, the emergence of a scientific spirit, the ntribution of Francis Bacon, the influence of the yal Society, the rise of corporate patronage, and e nineteenth-century "new clerisy". Then, through e conflict of ideas occasioned by the Great Exhibi- n of 1851, we arrive at the efflorescence of civic iversity colleges in England. In the eleventh of e book's fourteen chapters we enter the twentieth ntury, and the last fifty pages give a clear picture the problems which confront the universities of e British Isles to-day.

The main body of the book, then, is historical, not gumentative or theoretical. Each chapter is both essay in itself and a contribution to the developing ry; and each stage in the development of the dition is documented with a wealth of detail. deed, in places the detail becomes so rich that the ordinary reader may be overwhelmed by it, for the accumulation of proper names sometimes clogs the march of the narrative.

Prof. Armytage's general thesis is that the transmission of knowledge demands, in each separate historical context, its own appropriate institutions: that the pushing forward of the frontiers of knowledge is not always best done by institutions suitable for its preservation and transmission; and that the demands of science, pure and applied, require for their satisfaction instruments quite different from the universities of tradition. He sees the modern civic universities, in close alliance with technical and technological colleges and with other research-organizing bodies, as the agents of these vital developments; and his tracing of the historical story is designed to show that this is their destiny.

The fascinating narrative which he unfolds inevitably gives rise to questions. The first is the ancient one, of the nature and definition of 'university' itself. It is not to be expected that the opinions of Walter de Merton, Richard Mulcaster, Cardinal Newman, Abraham Flexner and Bruce Truscot should coincide. But more than once a doubt arises whether Prof. Armytage is not too hospitable to quotations from writers who mean by it simply an institution for higher education whether general, specialized, vocational, scientific or commercial; and this multiplicity of meanings darkens counsel.

A second is whether there really is any genuine historical connexion between scientific and technological studies, on one hand, and, on the other, the kind of institution which we know as 'Redbrick University'. There is no doubt that during their slothful centuries Oxford and Cambridge failed to realize their duties and their opportunities in relation to the new knowledge; and there is no doubt either that within the past hundred years needs which Prof. Armytage cannot avoid calling "banausic" have led to the deliberate inclusion within the modern universities of studies which the more ancient ones found indigestible. But it is difficult to believe that there is a necessary connexion. The older universities are by now scarcely less interested in technology than their younger sisters; and of the population of these latter nearly one half are engaged on arts courses.

A third question concerns the extent to which the newer universities ought to become, or remain, provincial, regional or civic. 'Civic' suggests a relationship with the local civic authorities much more intimate than is customary. 'Regional' suggests a connexion with a particular geographical area, and while this may properly give to a university certain special interests it ought not to determine that university's development. Especially, this local connexion ought not to determine the area of recruitment of its students—'provincial' in that sense is an undesirable adjective. More and more the value of life in a hall of residence is recognized, and although there may be something to be said for concentrating various technological studies in the geographically appropriate places, there is much more to be said for collecting the students from as far afield as may be.

There remain the three most urgent major problems of university policy: the possibility of some genuine marriage inside the university course between the new scientific studies and the wider humanities of tradition; the extent to which the clamant national need for educated technologists is for the universities to supply; and the assessment of the right proportion of university places to the population of the British Isles. Each of these is a matter of daily debate, and to each of them so far the attitude has been empirical, both in the universities and in the nation at large. The growth of the universities during the past fifteen years has been astonishing, not only in the sheer numbers of students and staff, but also in the variety and complexity of the fields of study and investigation. It is natural enough that among its results there should be a certain confusion about aims and untidiness about means. To what extent should the spontaneous and organic development of the individual universities be controlled by some central plan? If at all, how far can central planning avoid infringement of that autonomy which universities have traditionally claimed? Fundamentally, are universities properly regarded as 'community service stations'? These problems Prof. Armytage sets out with clarity and vigour in his concluding chapters.

In fact, this is several books. It is a valuable narrative of the development of many kinds of institution for higher education, including the Inns of Court, the hospitals and the nonconformist academies. It is a series of historical vignettes of particularly fruitful moments in the story of British education. It is a reasoned and well-documented appreciation of the present needs both of the universities and of the society which supports them. Prof. Armytage would not claim that he can prescribe a remedy for our present headaches; but he has certainly given us the material for seeing ourselves in the perspective of a majestically unfolding story.

J. F. WOLFENDEN

## A BIBLIOGRAPHY OF THE WORKS OF LAVOISIER

### A Bibliography of the Works of Antoine Laurent Lavoisier, 1743–1794

By Denis I. Duveen and Herbert S. Klickstein. Pp. xxiii + 493 + 42 plates. (London: Wm. Dawson and Sons, Ltd., and E. Weil, 1954.) £10 10s.

STUDENTS of Lavoisier have hitherto been badly handicapped by the lack of any adequate bibliography of his writings, which cover so many fields in addition to chemistry. Their difficulties were increased since Lavoisier not infrequently did not publish the papers which he had read to the Academy of Sciences in Paris, while the editors of the six volumes of his collected works, the "Œuvres de Lavoisier", had access to his manuscripts and printed them without any indication of whether they had been previously published or not. So there are many traps for the unwary. For example, the account of Lavoisier's earliest scientific investigation, describing his observations of an aurora, was written in 1763 but was not published until 1863.

Mr. Denis Duveen has been an assiduous and discerning collector of everything relating to Lavoisier, and now, with the aid of his unique collection, he and Dr. H. S. Klickstein have given us this comprehensive volume of bibliographical studies, which is the result of years of research and scholarship. Following the modern tradition of 'personalized bibliographies', it contains not only the bibliographical details of all Lavoisier's books and papers and their translations but also a short analysis and appraisal of their contents which will be of th greatest help to students in the future. With th exception of one or two foreign works, copies of a the 705 printed documents catalogued in the bibli graphy are in Mr. Duveen's private collection, pa of which was shown at an exhibition at the Groli Club of New York in 1952.

The bibliography contains six sections dealin respectively, with (1) Lavoisier's papers published i scientific periodicals, (2) his four major works c chemistry, (3) his minor writings which were pul lished separately, (4) his minor contributions to oth works, (5) the reports of the committees of th Academy which were written by him, and ( the various collected editions of his papers ar books.

Lavoisier contributed more than a hundred pape to scientific periodicals, and many of those dealir with his more important chemical discover appeared in the Memoires de l'Academie Royale d Sciences, the volumes of which were usually pul lished several years in arrears. This has cause historians no little difficulty. Papers published b the Academy are listed in the bibliography, not und the years in which the volume containing them w actually published, but under the years which th particular volume covers. This corresponds in mo cases, but not in all, with the date of the reading the paper. A short summary of each paper is giv and a reference to its inclusion in the "Œuvres Lavoisier" which is most useful.

The second section, dealing with his four maj works, the "Opuscules", the "Nomenclature" ar the classic "Traité Elémentaire", contains an inte esting account of the little-known "Memoires Chimie", the fragments of the complete edition his memoirs which Lavoisier had just begun befo he was guillotined. These were never put on sa but distributed privately by Madame Lavoisier 1805.

Sections (3) and (4) contain most of Lavoisier papers on agriculture, political economy and educa tion. Section (5) deals with the reports written b Lavoisier for committees of the Academy appoint to review books submitted for publication with th approval of that august body; and Section (6) wi the various collected editions of his writings, includi most useful details of the contents of the six volum of the "Œuvres" with cross-references to pape already listed in the bibliography and an analysis those which only appeared in the "Œuvres".

It is impossible in a short review to do justice the accuracy of detail and the fine scholarship of th bibliography. Those who have had experience of th difficulty of tracing the exact course of Lavoisie ideas will appreciate the immense amount of stu it has involved, and future historians of chemist will often feel grateful to the authors.

There is one serious omission—a general index, b means of which it would be possible to find imme ately any individual paper or to trace groups papers on particular subjects. There are indexes names, publishers, printers and artists; but the la of a general index does diminish seriously the ava ability of the results of this unique study Lavoisier's writings. It would be quite easy remedy this defect in a short supplementary volum when the opportunity might be taken to include list of the biographies of Lavoisier and the maj papers devoted to the study of his work on the lin of Dr. Holmberg's excellent bibliography of Berzeli

Looking through this book, with its interesting acsimiles of title-pages, one is struck once again with he amazing range of Lavoisier's accomplishment in is short life of fifty years. In chemistry, in physics, 1 physiology, in agriculture, in geology, in education, 1 statistics and in finance he was a pioneer, and in ach his contribution had the modern touch both in hought and phrase. With the publication of his etters in the near future and of his note-books, istorians will have much fresh material, and Mr. uveen and Dr. Klickstein's bibliography will be of nmense value to them in their studies.

HAROLD HARTLEY

# VICTOR VAN STRAELEN

olume Jubilaire—Victor Van Straelen

irecteur de l'Institut royal des Sciences naturelles e Belgique, 1925–1954. Tome 1: Pp. viii+640 (40 lates). Tome 2: Pp. vi+641–1216 (8 plates). Bruxelles: l'Institut royal des Sciences naturelles e Belgique, 1954.) n.p.

PROF. VAN STRAELEN, who was born at Antwerp in 1889, retired in June 1954 from his post s director of the Institut royal des Sciences naturelles e Belgique which he had occupied for twenty-eight ears; at a ceremony of "Manifestation d'Hommage" eld in his honour shortly afterwards he was presented ith two "Volumes Jubilaires" containing contriutions from all his scientific staff.

Prof. Van Straelen has had a most distinguished areer, in the course of which, following the path of s illustrious predecessors, he has guided the study the biological sciences in Belgium and the development of the Institut to a position of world-wide teem and reputation. After a brilliant university areer, followed by service in the Belgian forces uring the First World War, he occupied various ademic posts until at the early age of thirty-five he as appointed director of the Musée royal d'Histoire aturelle de Belgique, which has since become the stitut royal des Sciences naturelles de Belgique.

Van Straelen is primarily a palæontologist, and as particularly distinguished for his researches on e fossil Mollusca and Crustacea; but after this ppointment he devoted his great energies and lministrative abilities to developing the museum d widening its activities, and to encouraging the udy of biology in Belgium. The results of his life's ork are manifest in the Institut. Large though the useum was when he went to it in 1925, it is now eatly increased in size by a range of new and posing buildings which are, however, but a part of e plan that he devised for making the housing of e Institut one of the finest buildings in Europe. is much to be hoped that the plan will be completed before many years have passed. His scientific aff has grown in numbers from five to twenty-seven, d the important collections of the museum have en enormously enriched during his tenure of office. e publications of the Institut have been greatly ultiplied. The well-known *Annales* and the *émoires* have been increased in frequency of pearance and augmented by the addition of a ond series and the publication of many volumes *rs série*; in addition, the publication of the *lletin* was renewed after a lapse of forty-two years. ese are only a few of the many changes wrought by Prof. Van Straelen, who has also been very active in furthering the cause of education in the biological sciences in Belgium.

Prof. Van Straelen is a man of great strength of character who steadfastly refused any form of collaboration during the occupation of his country, and whose eminence has been recognized by the conferment of scientific honours throughout the world. He is a foreign fellow of the Linnean, Zoological and Geological Societies of London, foreign or honorary member of a great number of scientific societies in many other countries, and president of the International Association for the Protection of Nature. In Belgium, among many other scientific activities, he is president of the Institut des Parcs nationaux du Congo Belge, president of the Classe des Sciences of the Académie royale des Sciences, des Lettres et des Beaux-Arts de Belgique, and president of the Association pour l'Étude de la Paléontologie et de la Stratigraphie houillères; he has been responsible for the organization of numerous exploring expeditions to the Belgian territories in Africa.

The articles published in the Victor Van Straelen "Volumes Jubilaires" have been contributed by members of the scientific staff of the Institut royal des Sciences naturelles de Belgique, the Association pour l'Étude de la Paléontologie et de la Stratigraphie houillères, and the Institut des Parcs nationaux du Congo Belge. They represent some of the numerous lines of research that he has encouraged or developed in the course of his career. The volumes are beautifully produced and lavishly illustrated, thanks to the generosity of an anonymous benefactor.

Vol. 1 contains papers on mineralogy, palæobotany and palæozoology. They deal largely with the coal-measures of Belgium and include studies on their flora and fauna. In the section on mineralogy, J. Scheere gives a lengthy lithological study of the rocks of the Upper Westphalian *A* series overlying the coal-measures of the Campine, and R. Van Tassel details the occurrence and characters of the arsenopyrite mineral mispickel in Brabant. In the section on palæobotany, F. Stockmans and Y. Willière summarize their previous studies on the Namurian flora of Belgium, and R. Vanhoorne contributes a short paper on the dating of certain peat deposits by a study of the seeds and pollen recovered from them. In the section on palæozoology, M. Lecompte describes the 'reefs' of pink marble found in the Devonian of the Ardennes and discusses their probable formation by stromatoporids in superficial zones of turbulence and by corals at greater depths; and P. Sartenaer discusses the occurrence of two species of brachiopods from Senzeille and describes one of them as new. A short paper by F. Demanet follows, reporting a re-examination of the schistes of the Anhée coalfield; and in the next paper H. Chaudoir tabulates in detail the stratigraphical distribution of the flora and fauna of the eastern part of the Liège coalfield syncline. A. Pastiels contributes a biometric study of some of the lamellibranchs of the Liège basin, in which a number of species are shown to be divisible into two groups which show little overlap in their dimensions. A long paper by M. Glibert and J. de Heinzelin de Braucourt gives a review of the lower oligocene fauna and flora of Belgium, with illustrations of numerous species of mollusca. The next paper goes farther afield with a study of the lignite-bearing miocene strata and the marine pleistocene beds of eastern Tunisia by W. Van Leckwijck. The volume concludes with papers on the growth of brachiopods of the family Spiriferidae by A. Vandercammen, on some adult fossil Ephemeroptera by G. Demoulin, and an essay on the palaeobiogeography of the Euselachii by E. Casier.

Vol. 2 is devoted to zoology, and more than half of it deals with invertebrates. The first paper is a long essay by E. Leloup on the structure and phylogeny of the siphonophores, in which he concludes that these organisms are derived from littoral gymnoblastic hydrozoa, allied to the Tubulariidae, which have been freed from a sessile benthonic stage through the direct development of the actinula larva. The second is a short contribution by S. Lefevere on the occurrence and significance of esterolytic enzymes in the intestine, and of alkaline phosphatase in the nephridia, of *Nereis diversicolor*. The next two papers are devoted to invertebrates of tropical Africa—the first a study of the Vertiginidae and Valloniidae of Central Africa by W. Adam, and the second a review by A. Capart of the types of the species of fresh-water crabs of the family Potamonidae.

A paper by J. Cooreman gives the results of a two-year ecological study on the hydracarine fauna of a stream in a peat bog in the Hautes Faynes, Belgium; H. Synave discusses African Hemiptera Homoptera and describes a new species of the genus *Cordia*; and A. Collart describes two new species of *Microsania* (Diptera: Platypezidae) from Belgium. G. Fagel makes his twenty-seventh contribution to the study of the staphylinid beetles and describes numerous new species of the genus *Paederus* from the Belgian Congo; and A. Janssens gives his seventeenth contribution to the study of lamellicorn beetles with a description of a new species of *Onthophagus* from the Upemba National Park, to which is added a discussion on the evolution and convergence of certain scarabid beetles.

The first paper on the vertebrates is a revision of the Amphisbaenidae of the Belgian Congo by G. F. de Witte, based on the material in the Musée royal du Congo Belge and the Institut des Parcs nationaux du Congo Belge, many of the specimens having been collected by the author himself. R. Verheyen discusses the migrations of the European population of the ruff and shows that on the northward migration the majority of European ruffs cross the Mediterranean to northern Italy, from which they disperse to their nesting-grounds all over Europe; individual ruffs constantly return to the place of their birth. S. Frechkop discusses the genetic relationships between the anthropoid apes and the other primates. He concludes that it is more satisfactory to substitute for the unconvincing idea of migrations of primates from Africa to the Far East and vice versa, or the unproved idea of hologenesis, the theory of the manifestation of analogous potentialities of evolution (of the same genes) in parallel in Asia and Africa under similar ecological conditions. F. Twiesselmann contributes a long paper on the basic principles of anthropology and stresses the importance of anthropometry in the study of races and populations. P. Jolivet returns to the invertebrates with a study of the evolution of the phytophagous habit in the chrysomelid beetles, and suggests that the passage from primitive polyphagous habits through oligophagy to monophagy has been brought about by a series of restrictive mutations, so that the most striking adaptation produced by selection is the instinctive behaviour that leads to the choice of the food plant.

E. Kesteloot discusses the evolution of the flor and fauna of Flanders and shows that climati changes have caused, and are causing, Atlantic an Mediterranean forms to replace boreal types, an that the coastal belt, which has been greatly change through the past two centuries by afforestation, i the region through which adventitious species, bot of plants and animals, generally become introduced L. Van Meel reports the existence of supersaturation of oxygen in certain natural waters, and suggest that it is produced by the action of ultra-violet light which decomposes the water with the formation o hydrogen peroxide or free oxygen. This radiation i injurious to organisms containing chlorophyll, an the author correlates oxygen supersaturation wit scarcity of phytoplankton.

The final article, by L. Debot, gives an account o the achievements of the Service Éducatif of th Institut royal des Sciences naturelles de Belgiqu during the twenty years since it was set up by Prof Van Straelen.

The first volume contains an excellent photographic portrait of Prof. Van Straelen, and instructiv contrasting aerial views of the Institut as it is to-da and as it was twenty-eight years ago.

These volumes are a fitting tribute to the work o Prof. Van Straelen during more than a quarter of century, and the wide field covered by the numerou articles mentioned above testifies to his man interests and the multifarious branches of the natura sciences which he has taken so active a part i promoting in Belgium. The Institut royal de Sciences naturelles, enlarged out of all recognitio since Prof. Van Straelen became its director, is lasting memorial to his work, and these jubile volumes are the expression of gratitude an esteem from every branch of his staff.

L. Harrison Matthews

# NUCLEAR SPECTROSCOPY

## Beta- and Gamma-Ray Spectroscopy

Edited by Prof. Kai Siegbahn. (Series in Physics. Pp. xxiii+959. (Amsterdam: North-Holland Publishing Company, 1955.) 76 guilders; 152*s.*; 2 dollars.

THE new experimental techniques develope during and since the War have led to a revolution in nuclear spectroscopy. New designs of bet spectrometers give a high precision in energy measurement (one part in two thousand), combined wit excellent resolution. Scintillators provide highl efficient counting devices for gamma rays, so th very weak radiations can be detected. High-spee coincidence circuits facilitate the unravelling complex spectra and the measurements of lifetim of nuclear states down to $10^{-10}$ sec. At the sam time the number of available artificial radioactiv species has increased because of the development nuclear piles, and the larger number of partic accelerators in use.

On the theoretical side, the nuclear shell model an the collective model have provided a basis for th interpretation and classification of complex experimental data. Precise computations of intern conversion coefficients, hand-in-hand with the precise measurement, now make it possible t decide the multipolarity of gamma rays, and so th changes of spin and parity in the nuclear transitio nvolved. A better understanding of the theory of ultipole transitions in nuclei also enables one to btain this information from the lifetimes of nuclear tates. The theory of beta decay has been slower in leveloping and the full nature of the fundamental nteraction is still not known, though it is now fairly ertain that a linear combination of the tensor and calar invariant interactions, with possibly some seudoscalar, is the correct one.

The subject is therefore ripe for a comprehensive urvey. This is what is attempted in the present olume. There are twenty-six chapters by different uthors, dealing with different aspects of beta and amma ray spectroscopy. Some chapters are further ivided into short contributions on related topics by ifferent contributors.

It is inevitable in such a project that there should e some overlap, and it is to the editor's credit that he as kept it down so well, while at the same time overing so much ground. In addition to the techiques of nuclear spectroscopy, which are very lly and usefully covered, the theory of allowed and rbidden transitions, of multipole radiation and ternal conversion, nuclear models, the technique nd theory of angular correlations, the empirical lassification of beta transitions and nuclear isomers, lustrative studies of particular disintegration hemes, there are also sections on such topics as ouble beta decay, positronium, the decay of positrons and the double Compton effect. The study of amma radiation from charged-particle reactions and om neutron capture, both of which give information bout the more highly excited states of nuclei than is sually obtainable from beta radioactivity, are also ach given a chapter.

The book is well printed and well illustrated (though ome of the figures which appear as plates are ollected together away from their proper pages ithout any guide in the text as to their whereabouts). It will be indispensable to any laboratory here any form of nuclear physics is practised, and ndeed in any university library, though its price is kely to restrict its being bought by many dividuals.

A particularly valuable feature is in the numerical ables at the end. They contain the numerical formation needed for almost any evaluation of xperimental data: internal conversion coefficients, ermi functions, X-ray critical absorption energies, ngular correlations, conversion tables from $B\rho$ to nergy in keV., γ-ray absorption coefficients.

The author, and subject, indexes seem to be full nd accurate.

M. H. L. Pryce

# A CHAUCER HOLOGRAPH ?

he Equatorie of the Planetis

dited from Peterhouse MS. 75, I, by Dr. Derek J. rice, with a linguistic analysis by R. M. Wilson. p. xvi+214+14 plates. (Cambridge: At the niversity Press, 1955.) 52*s.* 6*d.* net.

N the course of collecting data for a general history of scientific instruments Dr. Price came across a anuscript in the library of Peterhouse, Cambridge, hich was written in Middle English, was on an tronomical subject, and in which the date 1392 ccurred frequently. He thought that it might be the ising part of Chaucer's "Treatise on the Astrolabe" written in 1391, which was at the time the only instrument tract known to him that was written in Middle English.

The manuscript has been in the library of Peterhouse since 1542 and has been attributed since some date prior to 1542 to Simon Bredon. But he could not have written it since he was dead by 1372, when his will was proved.

The manuscript contains directions for the construction and use of the equatorium (or equatorie, as the manuscript anglicizes the term). This instrument was a planetary calculator, based on the Ptolemaic theory of the motions of the planets, designed to avoid the bulk of the computations involved in deriving planetary positions from the Alfonsine Tables in use at the time. The equatorium, in fact, provides a geometrical construction based on the epicycles and equants of the Ptolemaic theory; to derive the position of a planet at a given time, the mean motus and mean argument are taken from the tables and all else is performed by setting the instrument.

The equatorium, of which there were several different types, was widely used in medieval times; but, in contrast to the astrolabe, few have survived. Only two incomplete examples have been traced; one, in the possession of Merton College, has many features in common with the instrument described in this text. Dr. Price attributes the survival of large numbers of astrolabes to the fact that they could readily be embellished with the art of the metal worker: the equatorium was much more complicated and could not readily escape a purely utilitarian appearance and hence had much less chance of being preserved.

The special interest of this manuscript is that it may be an original work by Chaucer, written by his own hand. The linguistic analysis by Mr. R. M. Wilson shows that it contains many words not recorded elsewhere in Middle English except in the works of Chaucer. There is a reference in it to the "tretis of the astrelabie". The whole of it was written by the same hand, which in its informality is in strong contrast to the formal scribal writing of the period. There are numerous corrections and additions by the same hand. The manuscript may be a translation and adaptation from a Latin original; if so, the original has not survived. There is little doubt that it was written about 1392, probably shortly after the "Treatise on the Astrolabe".

The authenticity of the manuscript as a Chaucer holograph could be established if it could be compared with a genuine specimen of Chaucer's handwriting. Unfortunately there are no certain autograph Chaucer documents known. A document was discovered some few years ago among the Exchequer Bills in the Public Record Office which it is thought may be in Chaucer's hand; it relates to the appointment of a deputy for him, as Comptroller of the Wool Quay in the Port of London, during his absence. On one of the pages of the Equatorie treatise is a note which mentions Chaucer by name; the writing of Chaucer in this note is strikingly similar to the Chaucer in the above-mentioned document, as may be seen from the enlargements given in this volume. Though conclusive proof is lacking that the treatise is a Chaucer holograph, the evidence in its favour is very strong.

In this volume the text is reproduced in facsimile with transliteration opposite, and a translation into modern English is given. The critical commentary includes an analysis of the contents of the manuscrip and of the tables, an account of the Ptolemaic planetary system and of the theory of the equatorium, a history of the equatorium, the linguistic analysis by Mr. R. M. Wilson, and a detailed discussion of the possible ascription to Chaucer. The production of the volume is of the high standard which is characteristic of the Cambridge University Press.

H. SPENCER JONES

# THE PROBLEM OF RACE

## The Colour Problem

A Study of Racial Relations. By Anthony H. Richmond. (Pelican Book No. A. 328.) Pp. 371. (Harmondsworth, Mddx.: Penguin Books, Ltd., 1955.) 3*s*. 6*d*.

## An Essay on Racial Tension

By Philip Mason. Pp. ix+149. (London and New York: Royal Institute of International Affairs, 1954.) 8*s*. 6*d*. net.

THE interest which has recently manifested itself in Great Britain in the problem of race shows signs of becoming steadily more widespread. This is evidenced by the publication of Mr. Richmond's book in the Pelican Series, which will no doubt sell in tens of thousands. The fact that it is also becoming deeper is also to be deduced from Mr. Mason's appointment as director of studies on race relations by the Royal Institute of International Affairs. The books that it has published, however, appear to show that there is not yet a great deal that can be said to an English audience on which remedial action can be based. The present endeavour is to present the facts and remove misconceptions.

Mr. Richmond gives us a comprehensive and scholarly survey, primarily from the historical and political point of view, of the patterns of race relations in South Africa, British Colonial Africa and the British West Indies, and in Great Britain itself, which brings together in a very useful form a large mass of information which would otherwise not be available to the general reader. It is presented cogently, and leads to the conclusion that "so-called 'white civilization' will only be preserved by sharing its fruits with non-Europeans, not by depriving them of its benefits". Mr. Mason's "Essay", on the other hand, is primarily directed towards summarizing the theories and conclusions both of politicians and of scientists, and he seeks to test the validity of their ideas by applying them to the situation in South Africa. The result might have been a work which could be regarded as complementary to Mr. Richmond's; unfortunately, however, Mr. Mason gives an impression that he is 'writing down' to a rather ignorant reader, lacking anything more than a conventional grammar school education, as a target to aim at. Even so, it would have been well if he had demonstrated more clearly that the subject of racial tension is a difficult one to grasp. The recent publications of Unesco show that a great deal of disagreement still exists among physical anthropologists and geneticists on the subject of race, and any glossing-over of this fact necessarily detracts from the value of a work in which the point of view of the scientist is discussed. The concept of race, as applied to human societies, is indeed a very shaky one, and this needs to be made plain.

Mr. Richmond and Mr. Mason agree on one important point, which is that the difficulties that have arisen when representatives of different 'race have been brought into close association with eac other can only be dealt with by a slow process amelioration or reform. "The elimination of pr judice," writes Mr. Richmond, "will almost certain be a long and gradual process." This conclusion echoed in Mr. Mason's statement that "there is quick or easy way to knowledge, and it is only knowledge, and by knowledge based on study, th any firm convictions can be reached. In spite of t urgency, plans for study must be made on the ba that thoroughness must come first and speed second These are the final thoughts of a sociologist and scholar, who share a concern for the welfare of ma kind and an awareness of the rapidity with whi events are now moving. But it must be ask whether these are really the last words that can said on the subject. Social scientists, legislators, a administrators in the United States would probab reply that, given a firm grasp of the objectives th have to be attained, and a determination to atta a substantial proportion of them without delay, mu can be achieved in the immediate future. The succe with which the colour bar has been broken down recent years in the District of Columbia, and t extent to which the educational system of the count is being successfully reorganized on an inter-rac basis as the result of the Supreme Court decisio provide evidence to justify this conclusion. The is much food for thought in this for the Briti citizen.

T. S. SIMEY

# ELECTRIC AND MAGNETIC PROPERTIES OF THIN FILMS

## Conductibilité Électrique des Lames Métalliqu Minces

Par Prof. A. Blanc-Lapierre et Prof. M. Perr (Mémorial des Sciences Physiques—Fascicule 5 Pp. iii+96. (Paris: Gauthier-Villars, 1954.) 11 francs.

## Propriétés Magnétiques des Lames Métalliqu Minces

Par Prof. M. A. Colombani. (Mémorial des Scien Physiques—Fascicule 58.) Pp. iii+78. (Pari Gauthier-Villars, 1954.) 1000 francs.

THESE two small monographs may be regard in a way as similar to the reviews published England in *Progress in Physics*, except that th perhaps assume less knowledge on the reader's pa

Vol. 57 on the electrical properties of very t metallic films is very well written, and the auth take great pains in discussing the advantages a disadvantages of known methods of preparing me films for precise measurement. All interested in way in which the electrical conductivity of thin fil evolves following their preparation, the effects temperature upon the conductivity, the variation conductivity with field strength which is in effect breakdown of Ohm's law, the physical structure such films and the theoretical interpretation of th behaviour, will find much to interest them in t little volume.

Vol. 58, on the magnetic properties of very t films, is also interesting, though one feels t the diagrams might have been produced with same care as in the preceding monograph. Natura ne finds here that much more attention is paid to ilms deposited electrolytically, and it is interesting o note how well Maurain laid the bases of this part f the subject some forty years ago. Since it is found hat in the case of very thin films of ferromagnetic netal the hysteresis cycles are rectangular, it is atural to interpret their behaviour in terms of ingle domain particles, and the relevant theory is dequately discussed in the final pages of the book. s sources for valuable references both little volumes vill be found useful.

L. F. Bates

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# CATALYSIS

**atalysis**

Edited by Paul H. Emmett. Vol. 1: Fundamental rinciples (Part 1). Pp. vi+394. 80s. net. Vol. 2: undamental Principles (Part 2). Pp. vi+473. 96s. et.
New York: Reinhold Publishing Corporation; ondon: Chapman and Hall, Ltd., 1954 and 1955.)

**dvances in Catalysis and Related Subjects**

Edited by W. G. Frankenburg, V. I. Komarewsky nd E. K. Rideal. Vol. 6. Pp. xiii+467. (New ork: Academic Press, Inc.; London: Academic ooks, Ltd., 1954.) 10.50 dollars.

THE present active state of catalysis makes this a very suitable time for the appearance of a new nd comprehensive treatise on this subject, if only s a supplement to somewhat older works such as he "Handbuch der Katalyse" and as a parallel ffort to the current series of monographs included n "Advances in Catalysis".

The general pattern which has been followed is the ow usual and necessary one involving the assembly f a number of articles by individual contributors nder a general editor or editorial panel. Vol. 1 of 'Catalysis" contains eight chapters, most of which give a clearly written account of the present state of nowledge in the field treated. Of these, the chapter y Dr. Emmett on the measurement of the surface rea of solid catalysts will be especially welcomed for ts critical treatment of surface area determinations by he Brunauer–Emmett–Teller and similar methods. n article by H. E. Ries on physical adsorption may e regarded as an introduction to this chapter. The ubsequent series of three sections by K. J. Laidler, n chemisorption, on kinetic laws in surface catalysis, nd on the absolute rates of surface reactions, are ll admirable in their treatment and clarity. This pplies also to the section on magnetism and catalysis y P. W. Selwood; indeed, in view of the importance f paramagnetic characteristics in the theory of the atalytic activity of metals of the eighth group, it ould have been welcome if this chapter had been nger and if it had included recent work on the bserved parallelism between the suppression both f the catalytic activity and of the paramagnetic haracter of these metals by alloying them with iamagnetic metals.

The volume contains two chapters of a type somehat different from the above strictly fundamental reatment of catalytic principles, in that, in these, atalysis is dealt with mainly from an industrial oint of view. Thus, in the section by W. B. Innes on atalyst carriers, promoters, accelerators, poisons and hibitors, a good general description of porous and ther carriers is followed by the tabular presentation of long lists of uncriticized and undiscussed references to patent literature, with the corresponding references to *Chemical Abstracts*. While this extensive use of patent literature might perhaps be justified on grounds of the importance of the industrial uses of catalysis, it is difficult to obtain precise and reliable information from such sources; moreover, in tables of recent literature, some inaccuracies have been noticed, presumably on account of failure to check back to the original papers. The following chapter, on catalyst preparation, by F. G. Ciapetta and C. J. Plank, also has an industrial trend but contains adequate references to journal literature. A minor criticism might perhaps be made with respect to the brevity of the descriptions of the preparation of ordinary catalysts in the text of the article, and to the confinement of detailed preparative directions to a few specialized industrial catalysts.

Vol. 2 is, on the whole, more consistently fundamental in character than Vol. 1. The chapter on theories of heterogeneous catalysis, by H. Eyring and others, contains a comprehensive account of modern views of chemisorptive catalysis, including the thermodynamics and general energetics of chemisorption, and a discussion both of the concept of activated adsorption complexes and of the structure of catalytic surfaces. It must, of course, be borne in mind that, in addition to the chemisorptive type, many reactions are known, both in heterogeneous and in homogeneous catalysis, which obviously operate by cyclic valency changes in the catalyst. The above treatment is amplified by two chapters, both by H. M. Hulburt, on the nature of catalytic surfaces and on that of catalyst–substrate complexes on such surfaces. All these chapters are well planned and, taken together, give a clear review of the theoretical foundations of heterogeneous catalysis. The section on reaction rates and selectivity in catalyst pores, by A. Wheeler, is welcome and timely by reason of the complications which arise by the retention of products within porous catalysts, in that this retention retards the free access of further reactants and, in some cases, modifies the nature of the product.

The structure of some of the sections, particularly in Vol. 1, does not tend to make unnecessary the consultation of original literature. The complete work should, however, become a standard one for inclusion as a matter of course in chemical libraries; and it should be attractive, perhaps specially to industrial chemists, both as a source of technical information and as a synopsis of the theoretical background of catalysis.

"Advances in Catalysis" continues to perform a most useful function by providing, in a convenient form, authoritative and critical summaries of current catalytic theory and practice.

The present volume, which is prefaced by an obituary notice and appreciation of Alwin Mittasch, contains seven further reviews. In the first of these, J. T. Davies discusses catalysis and reaction kinetics at liquid interfaces, with particular reference to the fundamental work of Sir Eric Rideal and others on such reactions. Systems of this nature form an intermediate class between homogeneous catalysis and the far more widely studied case of heterogeneous catalysis at a solid surface; and this review is specially welcome as an emphasis on the increasing importance and interest of reactions, both catalytic and non-catalytic, in the surface film between two liquids. The subsequent monograph, by T. Kwan, of

Hokkaido University, Japan, deals with chemisorption and catalysis. In spite of the greater familiarity of this ground, this section makes stimulating reading and contains evidence of considerable original thought.

A short chapter, by W. P. Dunworth, summarizes recent work on the use of polyvinyl alcohol as a protective colloid for stabilizing finely divided palladium catalysts. This employment of colloids as anti-coagulants dates back to the work of Paal and others at the beginning of the present century; but, unlike the colloids then used (for example, protein degradation products or even natural gums), the newer synthetic plastics now available can be dispersed in non-aqueous liquids. Highly dispersed palladium or similar catalysts, when stabilized in this way, retain their large specific surface and have accordingly a high and stable activity and a low sensitivity to poisoning. P. B. Weisz and C. D. Prater discuss the derivation of catalytic activity constants, of activation energies, and of reaction orders, from measurements carried out with porous catalysts and with special reference to diffusion factors introduced by this porosity. This also is a suggestive article, and includes an attempt to separate the effect of diffusion factors from factors inherent in the true catalytic activity. In a further section, some aspects of acidic and basic catalysis in homogeneous systems are reviewed briefly by M. Kilpatrick. Finally, two modern applications of catalysis in large-scale industry are treated at considerable length in sections on catalytic cracking and on the commercial isomerization of hydrocarbons, written respectively by E. V. Shankland and B. L. Evering.

The volume, taken as a whole, lives up to the high standard of its predecessors. It is, of course, a mixed collection; but the general presentation is good. The editors are to be congratulated on assembling, in the course of the successive volumes, such a representative series of topical reviews, written by authors of many nationalities; but the field of catalysis is very wide and rapidly expanding. The transition of research in catalysis, from a purely empirical approach up to rational planning on the basis of theory and of known regularities, is already well marked. Thus the statement in the obituary notice of Alwin Mittasch that, some fifty years ago, no less than 20,000 different specimens were tested for their activity as catalysts for the synthesis of ammonia, might be contrasted with the certainly far less laborious way in which catalysts for a given reaction can in most cases be selected to-day. This new volume of "Advances in Catalysis" will need no special recommendation on the part of the reviewer.

E. B. MAXTED

## MAN AND ANIMALS

### Animals, Men and Myths

A History of the Influence of Animals on Civilization and Culture. By Morus (Richard Lewinsohn). Pp. 374+31 plates. (London: Victor Gollancz, Ltd., 1954.) 21*s*. net.

THIS is an interesting and readable work which embraces a very extensive field. The author, who uses the pen-name of "Morus", is Dr. Richard Lewinsohn, the head of the Institute of Technical Research in Rio de Janeiro. His book, originally written in German, and now translated into Englis is divided into six parts: (1) Prehistory. Th primitive world. The origin and distribution living forms. The ape-like ancestors of man. ( Domestication and exploitation of animals. Th amenities of the cave dwellers. Animal fable (3) The age of discovery and ideas. Inter-relatio of man and animals. Discovery of new worlds. Th part played by animals in providing the materia for man's clothing. Fabulous animals. (4) Th speculative age. Scientific organization of th animal kingdom. Probability of evolution. The ne southern continent. Experimental zoology. (5) Th age of machines. The Darwinian revolution. Para sitology. Animal intelligence. (6) The age modern chemistry. Genetics. Animal economy an future.

It is obvious that to cover accurately so catholi a syllabus demands from its author encyclopædi knowledge, and from its translator the command an attractive literary style. We congratulate th producers of this book on the possession of thes qualifications, which have enabled them to compile work not, it is true, free from mortal error, bu sufficiently attractive in presentation to guarante that the intelligent reader will be reluctant to put down. The underlying theme is the mutual depend ence of man and animal, which is perhaps over stressed in the statement that "the future existenc or non-existence of animals is in fact more and mor dependent upon the will of man". The illustration are numerous and have been well selected, with few exceptions such as the poor figure on p. 32 after Lewis Carroll, who, great as were his creativ gifts as a writer, was no substitute for John Tenniel as an illustrator. In the translation we must deplore occasional lapses into the figurative language of the boxing ring. For example, the account of the famous meeting of the British Association at Oxford in 1860 is grossly misleading in every particular. The bishop in his manner was eminently suave and restrained. He did not "yell" at Huxley, nor did he "grab a club and smash away". In reply, Huxley did not "land a smasher on the bishop's chin", nor did he describe his attack as "sticking his nose into scientific questions". The present reviewer has not seen the German edition, and hence can only hope that such defects of the English version have no place in the German original.

Among the points requiring attention in a new edition are the following: p. 153, "Avicenna of Cordoba" [*sic*] died in 1037, and was not "one of the most famous doctors of the twelfth century"; p. 189, the term spermatozoa was not introduced by Leeuwenhoek, but by von Baer in 1827; p. 220, Sir Joseph Banks neither discovered nor named the duck-mole. It was discovered by David Collins in 1797, and the first printed description was by G. Shaw in 1799. Collins did not publish his own account until 1802. The Governor of Australia sent two skins of the duck-mole to Banks in 1800, one of which was passed on to Blumenbach, who described and named the species in that year; p. 233, Spallanzani's skilful and delicate regeneration experiments are not aptly described in such language as "he proceeded to slice up a salamander" [? newt] and "tore off" its legs, feet and jaws. Spallanzani's name is incorrectly spelt both in the text and index; p. 272, Darwin did not retire to the Isle of Wight for fourteen months to write the "Origin of Species", nor did he ever write a "thick book on fossil mollusca".

Despite its occasional shortcomings, the book is well worthy of the attention of the uninitiated, who ill derive from it much delightful instruction.

F. J. Cole

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# NATURAL CONTROL OF ANIMAL POPULATIONS

The Distribution and Abundance of Animals
By H. G. Andrewartha and L. C. Birch. Pp. xv+782. Chicago: University of Chicago Press; London: Cambridge University Press, 1954.) 112*s.* 6*d.* net.

THIS large monograph begins by rejecting the relevance of any study of whole animal communities or ecosystems to the understanding of distribution and numbers of animals. It then proceeds to take a firm stand against the general use of mathematical models and, in particular, of ideas connected with biotic relationships and density-dependent processes between populations, as explanations of events in Nature. The authors believe hat the regulation of numbers does not exist in the ense hitherto examined in theoretical and laboratory population ecology. They believe that most fluctuaions consist of the natural recovery of populations each time after minor or major catastrophes, or at any rate changes, which have reduced them, and hat these are usually brought about by weather; hat is, the system of control of numbers in Nature contains only one compensatory process—the innate capacity for increase, pitted against the chaos of outer Nature. This summary of their views is, of course, necessarily a simplification of a tome that contains an extremely large amount of hard intelectual work, valuable case-histories from a number of laboratory and field studies by various people, and a genuine attempt to reduce to logical order the very diffuse field of population ecology (though even here, t is chiefly terrestrial ecology and, within that, the ecology of insects that has provided the main material).

After about fifty pages of preliminary statements, and two chapters on diapause and on dispersal, taking the reader to p. 125, there are two hundred pages about the effects of temperature, moisture and ight, which are interesting in their own right as source material, necessary to the later theory, but not in themselves conclusive as regards the latter. This central section, "Analysis of Environment", continues with about two hundred pages more about biotic relationships such as competition within and between species, predator–prey relationships, food, and so forth. Most of this section about population elationships is written in a highly critical, often polemical, manner, and it forms a sustained and oddly contemptuous attack on what the authors regard as the dogma of the regulation of numbers through varying density-dependent processes based proximately upon biotic links. It does not seem ikely that the reader will be entirely impressed by he implication that nearly all previous research in the subject is irrelevant to the interpretation of field population changes, or that the study of simplified mathematical models and their testing in the laboratory is misleading. There is certainly a real dilemma, recognized by all sensible ecologists, between studying the complexity of naturally interspersed populations with their ecological connexions, subject to variable outer conditions of climate and vegetation (and often the actions of man as a superpower), and the delimitation for study under controlled conditions of parts of this system at a level of precision that will satisfy scientific criteria.

Apart from the last fifty pages, which deal with some genetic matters in ecology, the rest of the book is an attempt to provide a new theory of the control of population density, illustrated by a few examples from the field. The latter include some of the authors' own research upon insects in South Australia. The facts adduced are most interesting, and should be studied dispassionately by ecologists. The trouble one has is that there are as yet practically no field measurements of populations of anything like the refinement possible in the laboratory. For all practical purposes at the present time, we know no more about the behaviour in the field of the innate capacity for increase than Malthus did. The notion of innate capacity for increase, with its stable age distribution, is really quite as highly theoretical and abstract a tool for study as the equation for the logistic curve, or Volterra's predator–prey theories. Apart from the human material originally used, it is so far based entirely upon laboratory work with populations living in supposedly defined conditions. The authors have, indeed, substituted for what they consider a dogma, another just as theoretical and with rather less common sense behind it. In spite of the air of certainty that pervades this large book, there are striking inconsistencies like this. These may not appear obvious at first reading. The style is lucid and the learning great, but the thoughts behind are not always illuminated. It is not clear why so large a part of the book deals with density-dependent processes studied in the laboratory, and yet rejects their application to field events. There are some strange remarks on important topics: for example, that something cannot be a general theory unless it describes a substantial body of empirical facts; that "one would not expect to come across a limiting density in any finite number of observations"; and that only individuals, not populations, can be said to have an environment.

There is, however, so much that is useful and provocative to thought, and it is so sincerely tackled and expounded, that one can forgive the authors a certain amount of word-splitting and special pleading. It is less easy to overlook their evident refusal to understand the way in which scientific thought has to advance in a complex field, by the proper use of abstractions and inductive reasoning. Perhaps it is a good moment for ecologists to try to assess how far our existing knowledge can take us in deciding the relative parts played in the regulation of numbers by self-limitation (though intra-specific competition), other biotic relations, and influences like varying weather, refuges and the like. But I cannot believe that the natural communities of the world will be found to have evolved solely "by guess and by chaos", or that the inter-relations of animal populations have not introduced a gradual order into the structure of animal communities.

The book is well produced, though it could have been half as large and had ten times as many readers; there are, however, some misprints in mathematical formulæ. All research ecologists are recommended to read it in order to try to decide whether, as the dust-cover announces, it provides "a new, satisfying and workman-like theory".

C. S. Elton

# MODERN TRENDS IN CHEMOTHERAPY

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CHEMOTHERAPY, or the treatment of infective diseases by means of drugs, as an empirical method of treatment is no new thing. Two examples that are commonly quoted to illustrate the long history of the chemotherapeutic method are the use of mercury for treatment of syphilis and of quinine for malaria. Chemotherapy as we now understand it, however, is a very different matter; it is a subject for scientific research, requiring for its development the application of many different methods of investigation, and the ever-increasing range of its applications has transformed the treatment of protozoal and bacterial infections in man and animals.

The realization of the potentialities of chemotherapy and the systematic development of the subject have come about during the past fifty years, and they are almost entirely based on the work of Paul Ehrlich, the centenary of whose birth was celebrated in 1954. The present time seems appropriate for a brief review of chemotherapy as it stands to-day and of its probable lines of future progress.

Ehrlich himself had a perfectly clear idea of what he was aiming at in the successful chemotherapeutic drug. He sought compounds which were specifically bound by, and toxic to, infecting organisms, while being relatively harmless to the host; and he was led to believe in the existence of such compounds by his observations on the specific affinity of dyes for certain cells and tissues; his first successful experiments, indeed, were in the treatment of trypanosomal infections of animals with dyestuffs. When these experiments turned out to be without practical significance for the treatment of human infections, Ehrlich turned his attention to other types of chemical compound, and, building on the earlier observation of the trypanocidal action of the organic arsenical compound atoxyl, he was led to his great discovery of the efficacy of arsenical compounds in the treatment of syphilis.

This discovery, with its striking demonstration of the possibility of successful specific treatment of an infective disease by a synthetic drug, was the real starting point of the great effort that has been thrown into chemotherapeutic research. This effort, as was natural, was first mainly concentrated in Germany, where the highly developed chemical industry was inspired by Ehrlich's early successes to devote great resources to the search for new drugs. For a long time there seemed to be little prospect of effective chemotherapy outside the field of protozoal infections; even with this limitation, however, the subject was clearly one of great interest to a country like Great Britain, with large Colonial territories in tropical and sub-tropical regions, and in fact the Medical Research Council has from the outset done all in its power to foster chemotherapeutic research. In recent years this type of research has also become a major interest in the United States, and from that country have come some of the most important discoveries.

Unfortunately, the impetus provided by Ehrlich's discovery, although stimulating a great amount of work, provided no theoretical basis for the systematic development of the subject, and the ensuing attempts to find new drugs remained for long almost entirely empirical. Certain clues were indeed available: one example of successful chemotherapy with a lon history behind it, namely, the use of quinine in th treatment of malaria, has already been mentioned this clue was not, however, directly followed, an the line that was pursued, chiefly by the Germa chemical industry, started rather from the dyestuf among which Ehrlich had observed chemotherapeuti activity in experimental infections. Knowledge o the relationship between chemical structure an biological action was, however, not sufficientl advanced to make this type of approach truly effec tive, and although valuable drugs, such as the anti malarials plasmoquin and mepacrine, resulted fro it, the yield of useful products was discouragingl small in proportion to the expenditure of time an effort.

Even in the early days of chemotherapeuti research, the evidence was available that rea advances could only be made where there was th closest collaboration between chemists and bio logists; the success of the German effort depende not only on the great potential of the Germa chemical industry but also on the importance attache by the pharmaceutical section of this industry t strong biological research departments, an exampl followed in recent years with outstanding success b Imperial Chemical Industries, Ltd., in Britain an by several industrial organizations in the Unite States. Moreover, in Britain we may recall the clos association of Prof. C. H. Browning, of Glasgow with the late Prof. J. B. Cohen, of Leeds, in the development of valuable antiseptics, and with the late Sir Gilbert Morgan and Dr. L. P. Walls in producing the important phenanthridinium series o trypanocidal drugs; we may also recall the long-continued work of Dr. Harold King on chemical constitution and trypanocidal action, which was carried out by him within the biological environment of the National Institute for Medical Research, and the collaboration of Dr. King with the late Prof. Warrington Yorke, of Liverpool, which led to the diamidine drugs, useful in the treatment of kala-azar. These successes may be contrasted with what ca now be seen to have been missed opportunities in researches undertaken by chemists without any definite provision for biological collaboration, or by biologists who were unable to bring their observation to the notice of chemists who might have helped t develop them. Many chemotherapeutic researche have been initiated in departments of organi chemistry, and much work of high quality has been put into these projects with disappointingly little in the way of practically useful results. On the othe hand, already in 1898, in a letter to Carl Weigert, Ehrlich put forward a suggestion which came ver close to the Woods–Fildes theory that will be referred to later; but biochemists were not available to brin his ideas to fruition. Again, penicillin might hav been brought into use at a much earlier date had th potentialities of Sir Alexander Fleming's origina discovery been more fully realized by chemists an biochemists.

In retrospect, it seems that the necessity for close collaboration between chemists and biologists i research on chemotherapy should have been s obvious as to be universally recognized from th utset. That it was not so recognized was due in art to the absence of underlying theory, and to the act that discoveries made by chance or on the basis f slender and even sometimes very dubious reasoning eemed to indicate that the prospects of developing ny comprehensive theory were remote. In these ircumstances, the large-scale, semi-empirical method f screening new synthetic organic compounds ppeared to offer the best chance of success.

Two principal factors have contributed to the very ifferent outlook on chemotherapeutic research that revails to-day. One is the great broadening of the eld of application of chemotherapy that has resulted, rst from Domagk's discovery of the antistreptoccal action of prontosil and the consequent levelopment of the sulphanilamide drugs, and econdly from the discovery of the antibiotics. The ther is the increase in knowledge of the biochemistry f micro-organisms and the realization of the importnce of this subject for the understanding of the node of action of drugs on pathogenic bacteria.

The latter advance is due in large measure to the rork of the Medical Research Council's former Bacterial Chemistry Research Unit under the lirection of Sir Paul Fildes. By patient investigaions over many years, the workers in this Unit had cquired extensive knowledge of the factors important n bacterial growth and metabolism. It was this rork that paved the way for the discovery by D. D. Voods that the sulphanilamide derivatives exercised heir anti-bacterial effect by interference with an ssential bacterial metabolite closely similar in hemical constitution to sulphanilamide itself, namely, -aminobenzoic acid. On the basis of this observation, ir Paul Fildes advanced what was, in fact, the first atisfying theory of chemotherapy; according to his ypothesis, an effective chemotherapeutic agent will e a substance that interferes with some essential netabolic reaction of the pathogenic micro-organism, nd such a substance should be sought among comounds having close chemical similarity with those ormally utilized by the organism in its metabolism. he Woods–Fildes theory is in reality a special pplication of the generalization that emerged from he much earlier work of Prof. J. H. Quastel and his olleagues, in which it was shown that enzymic eactions are inhibited by compounds that are hemically similar to the normal substrates; its evelopment is thus an excellent example of the way which an academic biochemical research can lead an idea of practical importance in medicine.

It is only now that the full value of the Woods–ildes theory is becoming apparent. Early attempts t its application were perhaps too naïve in coneption, and although they produced numerous xamples of interesting biochemical antagonisms, hich clearly fell within the general framework of e theory, they did not lead to the discovery of ractically useful drugs. In recent years, however, reat advances have been made in knowledge of utritional factors that are important or essential for e growth of micro-organisms; with the aid of this nowledge, and with more attention to the practical onsideration that a successful chemotherapeutic gent must attack a metabolic reaction which is more ital to the infecting organism than to the host, we e beginning to see useful results. The most imortant development along these lines that has so r been made is the preparation of synthetic comounds designed to act as antagonists against folic id; substances prepared with this object in view include not only pyrimethamine (one of the more successful antimalarial drugs) but also compounds that preferentially inhibit the growth of neoplastic tissue and thus offer some hope of chemotherapeutic attack on cancer.

In any effective consideration of chemotherapy, it is necessary to avoid too rigid adherence to the original conception of a chemotherapeutic agent as one that is damaging to the parasite and harmless to the host. The parasite is, after all, dependent on the metabolism of the host, and it is at the same time subject to attack by the host's defence mechanisms; one can therefore conceive of the existence of drugs which would arrest the course of an infection, not by direct action on the parasite, but by so altering the metabolism of the host that the parasitic environment becomes unfavourable, or by raising the normal defence mechanism of the host to a higher level of effectiveness.

Recent observations have shown that this conception is of more than theoretical interest. So far as the effect of host metabolism on a parasitic infection is concerned, two examples of the influence of metabolic changes in the host on the malaria parasite are now known. One is the relative resistance of animals on a pure milk diet to malarial infection; this was observed first by Prof. B. G. Maegraith and his colleagues at Liverpool, and further analysis of the observation by F. Hawking and J. D. Fulton in the National Institute for Medical Research has shown that the effect is almost certainly due to the deficiency in milk of certain dietary factors that are essential to the malaria parasite. The second example is given by the interesting suggestion by A. C. Allison that individuals with the sickle-cell trait, whose hæmoglobin is known to be abnormal, are relatively resistant to malarial infection. The first of these observations in particular suggests the possibility of drug treatment that would produce an alteration in metabolism, trivial for the host but disastrous for the parasite.

An example of a chemotherapeutic effect that is apparently exercised at least in part through the host's defence mechanisms is afforded by the action of the anti-filarial drug hetrazan. F. Hawking has shown that hetrazan has no deleterious effect on the microfilariæ in the test-tube, but that treatment with the drug renders them susceptible to very rapid destruction in the body. A more striking instance of chemotherapeutic action exercised through the host emerges from the recent work of P. D'Arcy Hart, R. J. W. Rees and J. W. Cornforth, at the National Institute for Medical Research, on the anti-tuberculous effect of certain high-molecular surface-active compounds (polyoxyethylene ethers of condensation products of substituted phenols with formaldehyde). Here again there is no suggestion of a directly damaging effect of the drug on the tubercle bacillus, but it has been shown by G. B. Mackaness, of the Sir William Dunn Department of Pathology at Oxford, that the monocytes isolated from animals treated with these surface-active agents have acquired the power of inhibiting the growth of tubercle bacilli—a power that is not possessed by monocytes isolated from untreated animals. In this instance, therefore, the natural cellular defences of the body have apparently been artificially reinforced, perhaps by a physical effect of the chemotherapeutic agent.

There is one important section of modern chemotherapeutic research that remains empirical and is likely to continue to do so, namely, the search for new antibiotics; even in the field of antibiotic research, however, there is ample scope for basic biological investigation, particularly of the mode of action of the active compounds. Studies of this nature are important because of the aid they may give in directing synthetic chemical work along profitable lines; moreover, their help is likely to be valuable in the solution of the formidable problem raised by drug resistance, the development of which diminishes or destroys the efficacy of so many otherwise promising chemotherapeutic agents.

It is satisfactory to observe that considerable importance is being attached in Great Britain to the kind of biological research which, as is now clear, must form the basis of further advances in chemotherapy. Apart from researches that have already been mentioned, an example of this is the work of M. R. Pollock and his colleagues, at the National Institute for Medical Research, on adaptive enzyme formation in bacteria and on certain aspects of bacterial genetics; the results of such investigations may be confidently expected to throw light on the nature of the phenomena of drug resistance and drug dependence. A similar remark applies to the study of naturally occurring antagonists to antibiotics; streptomycin, for example, is a drug the use of which readily leads to the development of resistant organisms, and special interest is therefore attached to the quinoline-N-oxides recently shown by J. W. Lightbown and J. W. Cornforth to be streptomycin antagonists produced by *Pseudomonas aeruginosa*. The mode of action of antibiotics, especially in relation to bacterial metabolism, is one of the principal subjects of investigation in the Chemical Microbiology Research Unit of the Medical Research Council, while the work of Prof. H. A. Krebs and his colleagues at Sheffield has provided much of the sort of information about the tissue metabolism of higher animals that we have seen to be necessary for the consideration of chemotherapeutic problems in term of the host as well as of the parasite.

What has been said may suffice to illustrate th way in which biological research has invigorated th whole subject of chemotherapy. From bacterial bio chemistry there is emerging a satisfying theoretica background for the work. In the search for ne synthetic chemotherapeutic drugs, we may expect t be guided in general by this theory and in detail b increasing knowledge of the biochemistry of bacteria metabolism, and by the results of study of the mod of action of naturally occurring antibiotics. Th conception of chemotherapeutic agents has bee widened to include drugs that may exercise thei effects through the host rather than directly on th parasite, and the development of this aspect is bein assisted by investigation of the cellular metabolis of higher animals. Chemotherapy has travelled long way since the days when it amounted to littl more than the empirical selection and biological tes of organic compounds, whether already known o specially prepared for the purpose.

The emphasis that has been laid on the biologica aspects of modern chemotherapeutic research mus not be taken as in any way belittling the contributio that is needed from the organic chemist. The con tribution is indeed greater than ever, because th chemist is needed now not merely to use his intuitio in the supply of new compounds for test, but also a a full and equal scientific partner in a systemati research. The task of the biologist and biochemist i to provide the clues for new advance; the intellectua approach and special skill of the chemist are require in order that these clues should be followed up t advantage. No greater benefit could accrue t chemotherapy than a fuller realization by chemist that modern biological research has converted it int a subject that is worthy of their best endeavour, an is one from which they can expect to gain tru intellectual satisfaction.

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# POLAR WANDERING

## SOME GEOLOGICAL, DYNAMICAL AND PALAEOMAGNETIC ASPECTS

A COLLOQUIUM on the geological, dynamical and palæomagnetic aspects of polar wandering was held recently by the Department of Geodesy and Geophysics of the University of Cambridge, with Mr. B. C. Browne in the chair. Prof. J. W. Durham (University of California) spoke on the palæontological evidence on continental drift and polar wander, and said that continental drift, in the sense in which it is commonly used, involves a shifting of the continents both with respect to the poles and to one another; either or both of these movements could have occurred. Inasmuch as many proponents of continental drift consider it to have continued well into the Tertiary, it seems that this part of the theory can be adequately tested by comparing the Early Tertiary distribution of marine invertebrates with that now existing, as well as by comparison with fossil faunas the geographical relationships of which are well established.

From Thorson's data[1] on the larval life of marine invertebrates, it is apparent, said Prof. Durham, that a large proportion of a marine fauna in warm temperate or tropical seas could migrate across oceanic depths in an east–west direction for distances up t about nine hundred miles if there was a current simila to the present North Atlantic Gulf Stream; only relatively few species could migrate across muc greater distances. At the present time, out of 48 lamellibranchs and 1,104 gastropods living along th eastern American coast from Florida northwards, 8 lamellibranchs and 94 gastropods have also bee recorded in Europe. Most of these species have a essentially continuous distribution from one area t the other; but 21 of the lamellibranchs and 49 of th gastropods seem to have a discontinuous distributio across the three thousand-odd miles of the Nort Atlantic. Likewise, along the warmer parts of th Pacific shores of the Americas there are 29 species tropical molluscs and echinoids which also occur Polynesia and the Indo-Pacific[2]. From the temperat Pacific coast of North America, more than six species have also been reported as occurring in Japa and, of these, the specific identity of more than ha has been confirmed by comparison of specimen These and other instances indicate that a few mol luscan species are very widespread in modern sea d that the occurrence of similar small numbers of lentical species in widely separated fossil faunas nnot be adduced as proof of continental drift. ikewise, if areas are less than nine hundred miles part and connected by seaways, it would seem that ere should be approximately 50–60 per cent, or ore, of the species in common in similar facies.

By comparison with living faunas, the climatic nd bathymetric aspects of Cenozoic fossil faunas, rovided they are of sufficient size, can be rather curately determined. Examination of Early ertiary marine faunas shows[3] that they were of opical character in the State of Washington and ear New York in North America, in the London nd Paris basins, the Volga basin, north-western ndia, southern Japan, near the Cape in South frica, in south-west Australia, southern New ealand, and in Patagonia, as well as in the present-ay tropics. When the warm temperate faunas that ccur in the Aleutian Peninsula and Kamchatka are lso considered, it is apparent, continued Prof. urham, that the Early Tertiary North Pole must ave been in approximately its present position and ot in the North Pacific as the proponents of drift equire. Eocene faunas of the Gulf Coast of North merica have only two identical, and about nineteen nalogous, species in common with European faunas f similar age. On a percentage basis, this similarity no greater than that present in the living faunas. hen contrasted with the 55 per cent of identical or osely related species occurring in the Indian lower-iddle Oligocene and in north-west Italy—areas hich at this time were connected by the well-ocumented Tethyan seaway and about three ousand miles apart—it is apparent that North merica and Europe were as far apart then as now.

In the older part of the geological record, in so far s it is fossiliferous, it would seem that similar riteria should be used—that entire faunas and not ngle species or special groups of organisms should e considered in evaluating continental drift. For xample, the common occurrence in Brazil and frica, but not elsewhere, of the aquatic reptile *esosaurus* has long been one of the strong argu-ents for the close proximity of the two areas during e Late Palæozoic, for it was supposed to be estricted to a non-marine habitat; yet it has ecently[4] been shown to be associated with marine rganisms in Brazil.

The only marine fauna of the older Mesozoic and alæozoic of Africa and South America which is dequately known and studied[4] is that of the evonian Period. At that time the South African nd Paraná basins had 46 species in common out of 20 species recorded from the Paraná basin and 175 the South African basin. This is a greater number an were common to the Paraná and Bolivian asins, which were contiguous but had a different thological facies. The similarity between the South frican and Paraná basins (38 per cent) is not nough for the two areas to have been nine hundred r less miles apart as they are supposed to have been y the adherents of drift. The similarities are more robably to be explained by similar facies and the resence of an Atlantic island 'stepping stone' such s the Cretaceous Mid-Pacific Mountains[5] of the acific, the tops of which are now 5,000 ft. below ea-level and surrounded by oceanic depths, yet were nce at sea-level. Later Palæozoic and Early Meso-oic faunas are either unknown or too poorly known critical areas for it to be possible to form an estimate of their relationships. However, the late Palæozoic glaciation clearly indicates that there must have been climatic zoning at that time, while the recorded distribution of the fusulinid Foraminifera during the same interval would seem to indicate that the zones were more or less parallel to those now existing.

Summarizing, Prof. Durham stated that Tertiary marine faunas clearly militate against any position of the continents and poles markedly different from that now existing, and the available evidence for the Palæozoic is much more in accord with the present positions than those postulated for continental drift. In the subsequent discussion, Mr. R. A. Couper remarked that it is now known that the spores of the Permian plant *Glossopteris* are wind-distributed. Therefore, the geographical distribution of this plant over several continents could be explained without these having to be contiguous or joined by 'land-bridges'.

Dr. W. J. Arkell (Cambridge) discussed the possibilities and limitations of geology as a control in investigations of the type under consideration. Stratigraphical geology is always striving to break down the 'cinema film' of past periods into its component 'shots', and by means of correlation to obtain separate 'stills' for the whole world at as short intervals as possible. It has to be remembered that this process is still in its early stages. For some years Dr. Arkell has been collecting and sifting all the available information for one single system—the Jurassic—to see how many 'stills' could be obtained, and what sort of picture emerged for the world as a whole for this short stretch of 'film'. It represents approximately twenty-five million years. For correlation purposes, the approach had to be through marine faunas, and primarily based on the group of fossils that gives the best results, namely, the ammonites. Into the stratigraphical framework provided by the ammonites, such as it was, had then to be fitted any other evidence available—from corals, land faunas and floras, lithology, and so on.

After collecting and collating all such evidence, it began to be possible to discern faunal realms and provinces, and then to make deductions about climate in different parts of the Earth. One major mistake often made was to suppose that one such pattern of realms and provinces persisted throughout the whole Jurassic period. Actually, the frontiers were continually changing, and the patterns at the beginning and end of the Jurassic were completely different. How much such changes were due to climatic changes and how much to alterations in the distribution of land and sea it is very difficult to say: in any event, the two factors may have interacted considerably, major geographical changes producing climatic changes over large areas and even, possibly, the whole Earth.

One fact which stands out as of special importance in connexion with the present discussion is that at all times in the Jurassic (and Cretaceous) there was a rich and varied ammonite fauna in the Arctic Ocean. From its occurrence on all the lands at present bordering that ocean—in northern Siberia, Franz Josef Land, Spitsbergen, north-eastern Greenland and the Canadian Arctic—and its identity at any given moment in all those places, it is obvious that this fauna lived and bred in the Arctic Ocean, which therefore cannot have had an ice cap as at present.

In the Lower Jurassic the Arctic Ocean molluscan fauna is no different from that found in all the other oceans of the world. There is one universal faunal realm. That the temperature was much more even than at present is proved also by the existence of rich flora in north-eastern Greenland and Grahamland, and by the fact that these floras scarcely differs from those found in Yorkshire and Sardinia.

Dr. Arkell is of the opinion that during the Middle Jurassic the uplift of land all around the Arctic Circle cut off the Arctic Ocean as a completely closed Mediterranean-type sea. At least, when the next transgressions began at the end of the Middle Jurassic and in the Upper Jurassic, a complete differentiated boreal fauna appeared for the first time and spread southward from the Arctic over the surrounding continental margins. Distribution maps show clearly that this fauna originated in the Arctic Ocean and continued to be centred there for the rest of the Jurassic, becoming progressively more differentiated, but sometimes retreating before, or mingling with, temporary advances of the equatorial faunas.

So it is obvious that throughout the Jurassic the Arctic Ocean, which is at present almost fully covered by permanent ice, was the breeding ground of a rich marine molluscan fauna secreting large calcareous shells, and in no wise more stunted or impoverished than their relatives in lower latitudes. In any event, no glacial deposits of any kind are known in the Jurassic. There are two possible explanations of this. Either the general temperature of the Earth was higher even than at present and, in particular, the polar regions were warmer, or the poles were in some other position. There is only one position where the poles could possibly have been in the Jurassic if they have to be assumed to be as cold as now: namely, the North Pole in the North Pacific and the South Pole in the South Atlantic. But even then, to get the North Pole sufficiently far south of rich Jurassic faunas in Japan and southern Alaska brings the equator too far north on the European side. The most likely position for the Jurassic equator is through southern Europe, following a belt of luxuriant coral reefs and sponge reefs. However, it is not possible to deny that the North Pole could have lain in the North Pacific during the Jurassic, because this is a region about which our knowledge is a complete blank, as is the corresponding position for the South Pole, in the middle of the South Atlantic. Moreover, it seems that if the poles were in those positions, it is quite likely that ocean currents would prevent ice caps forming, and that this would have a profound effect on world climates.

There is some evidence that the Arctic has been cooler than other oceans, as is shown by the scarcity of limestones and the absence of corals. If these facts are rightly interpreted, they suggest that the North Pole has been about where it is at present, but that the climate of the whole Earth was warmer and more even. We are then led to seek for a cosmic explanation, such as fluctuations in the amount of radiation received from the Sun.

Mr. T. Gold (Royal Greenwich Observatory) discussed the dynamics of the problem of polar wandering[6]. A movement of the entire Earth relative to the poles of rotation can be achieved by internal effects; only the vector of angular momentum has to remain fixed in space. If we have a stationary sphere resembling the Earth, a beetle weighing one gram could turn it over once by walking $10^{27}$ times around it. If instead we have a rotating sphere, then the beetle can cause any desired angle of movement of the poles relative to the sphere by merely sitting in th right place.

The actual Earth possesses greater stability tha this by virtue of its shape. It is spinning around principal axis of inertia of greater moment than th other two, and any departure from this conditio implies an increase of energy, if the angular momen tum is to remain the same. If the Earth were perfectly rigid body, then no processes that we coul suppose to have occurred could have caused a sig nificant amount of polar wander. But, as it is onl the stiffness of the spheroidal shape that gives such stability, then, should there be no such stiffnes over long periods, there would also be no stability . Earthquake waves and tidal deformations, bein effects that are very fast compared with the slo creep that is required to allow polar wander, canno therefore, be invoked. However, there exists motion with a period of a little more than a yea which has just the required effect of distorting th Earth as a whole, and thereby moving the axis symmetry of the spheroid. This is the so-called 'fre or 'Eulerian' nutation, whereby the axis of rotatio moves by a small angle, of the order of ¼″ relativ to the Earth, with a period of about 14 month Any plastic flow of the body of the Earth in suc periods, in response to the forces resulting fron this slightly misaligned spin, would show itself in damping of the motion. In fact, the motion i heavily damped, such that it would decay, in th absence of disturbances, to $1/e$ in ten periods or les But this damping can also be attributed to othe causes. The fluid core of the Earth has been though to be a source of the damping, but Prof. H. Bond and Mr. Gold have shown that it is too small[7]. I the mantle, where the dissipative action must there fore take place, one can attribute it to certain type of non-elastic behaviour which do not result i permanent deformations. On the other hand, as th shape of the Earth is just the one appropriate to it present speed of rotation, this requires an explanatio in terms of plastic flow. Also, plastic flow is th most common non-elastic behaviour of solids whe they are heated to a temperature not far from thei melting point. If, then, one attributes the dampin to plastic flow, one knows the approximate magnitud of the effect. Here lies the problem: What effec would this amount of plasticity have so far as pola wander is concerned?

If we knew the nature and magnitude of a dis turbance, such as a redistribution of mass on th surface, then we could calculate the rate and exten of polar wander which it would cause. A redistri bution of mass would have the immediate effect o forcing the Earth to spin around a slightly displace axis. The plasticity suggested by the free nutation i such as to cause the figure to be distorted in a directio whereby the shape will approximate to one appro priate to the new axis of rotation, at a rate of abou 10 per cent per year. This is then responsible for secular effect, for the axis of figure cannot b coincident with the axis of rotation unless it happen to be also a principal axis of inertia; a movemen through a large angle might be required to achiev such a coincidence. The rate of the movement i relation to tectonic events can be illustrated a follows: if a continent the size of South Americ were raised by three metres, then it would take abou a million years for the axes to swing around by a angle of the order of 90° to the new position o secular stability.

A movement of the poles on the Earth causes a rtain amount of redistribution of mass in turn. he largest effect is the change in polar glaciation, ıd so in sea-level, and this can work in a sense ther to help or to hinder polar wander. The most teresting effect would be connected with a hindrance, amely, the occurrence of a 'pole trap' where the iduced changes of mass would counteract other isturbances and hold the axis until either a ifficiently large change occurred elsewhere, or until e distribution of land and water in the polar zone ving rise to the pole trap was substantially altered. any such mechanism has been at work, then we ust expect the polar wander during geological time have occurred in a series of jerks rather than as a eady movement.

Mr. J. Parry asked whether the present small drift the Pole could be attributed to any known dynamal processes, and Mr. Gold replied that the rate of elting of the Greenland ice gives an effect which is the correct order of magnitude within the uncer-inties of the data available. In answer to a question y Mr. B. C. Browne, Mr. Gold stated that conti-ental drift would certainly imply the occurrence of olar wander, since, for the continents to slither ound, so great a degree of plasticity is required at polar wander can take place very easily; polar ander, however, does not conversely imply conti-ental drifting, because movement of the poles could cur in a much more rigid earth.

Dr. S. K. Runcorn (Cambridge) described the ferences which have been drawn from the direction magnetization of those rocks the magnetic stability which can be established with some degree of nfidence. The fundamental hypothesis is that the arth's magnetic field, averaged over a period of veral thousand years, corresponds to that of an ial geocentric dipole. Thus it is necessary to sample om a sufficiently long stratigraphical sequence in der to eliminate the effects of secular variation and ndom errors. The hypothesis seems reasonable hen the control exerted by the Coriolis force on the otions in the Earth's core is taken into con-deration[9]. The palæomagnetism of Tertiary lava ows verifies the hypothesis for the Earth's more cent history[9], and the situation is unlikely to have een substantially different at any earlier time.

The palæomagnetic evidence that the polarity of the omagnetic field has often been reversed many times ithin a geological period, without an alteration in e direction of the field, is further evidence that the is of the field is fixed in the Earth in a fundamental ay. Its coincidence with the axis of rotation therere seems natural[9]. The palæomagnetic record prior Tertiary times is fragmentary; but it is clear that, part from reversals of polarity of the field, its mean rection has changed slowly through geological time. he simplest interpretation of this is to assume a andering of the pole of rotation of the Earth rrying the mean magnetic pole with it. From the sults of a palæomagnetic survey of sedimentary rata and lava flows undertaken by the Department Geodesy and Geophysics at Cambridge, the motion the Pole throughout the past six hundred million ears has been traced in outline[10]. The examination the palæomagnetism of rocks in other continents as not proceeded so far as in Britain, but the avail-le data, shown in Table 1, are in approximate greement with the British results.

Dr. Runcorn next considered an explanation of the asonably steady movement of the pole of rotation from the mid-Pacific to its present position. The mechanism is required to have a correspondingly long time-scale. A lack of symmetry in convection currents in the Earth's mantle seems a possible cause; effects within the fluid core are unlikely to persist in the one direction long enough. It is probable that the equatorial bulge of the Earth adjusts itself to any new axis of rotation in a time very short compared with geological time. Thus, in discussing the dynamics of the problem, it is necessary simply to take axes fixed in the spheroidal earth and then to consider how much angular momentum needs to be generated in a certain part of the mantle to cause the remainder of the Earth to rotate through about 90° since later Pre-Cambrian times. A meridional convection current below the non-Pacific hemisphere rising to the south and falling to the north may be postulated, or one of opposite sense beneath the Pacific hemisphere, or several cells of differing intensities. The number of rotations made by such currents since Pre-Cambrian times depends largely on the amount of matter in motion, but has to be more than about fifteen. This corresponds to convective velocities of greater than 2 cm./year. In an earth of exactly spherically symmetrical properties, such a convection system could not occur. The persistent absence or comparative weakness of convection systems in part of the mantle since the Pre-Cambrian may, however, have also caused the present contrast between the largely continental nature of one hemisphere and the oceanic nature of the other, by affecting the extent to which the acidic rocks differentiated.

Mr. Gold commented that the effects he had described earlier depend on the basic fact that the Earth is rotating. The instantaneous effect of such a process as convection in the mantle is very much smaller than that of the process he had described.

Table 1. APPROXIMATE POSITIONS OF THE MAGNETIC NORTH POLE DURING GEOLOGICAL TIME
(Summarized from various sources, refs. 8–14)

| Geological period | Great Britain | North America | Other Continents |
|---|---|---|---|
| Triassic | 47° N., 133° E. (Keuper sands, ref. 11) | — | — |
| Permian | 49° N., 162° E.* (Exeter traps, ref. 11) | — | 80° N., 60° E.** (Basalt lava, New South Wales, ref. 10) |
| Pennsylvanian | — | 43° S., 70° W (Naco Sandstone, Arizona†) | — |
| Devonian | 34° N., 156° E. (Old Red Sandstone, Wales, ref. 11) | — | 0° N., 130° W.* (Pilansberg dykes, South Africa‡) |
| Silurian | — | 20° N., 137° E. (Maryland, ref. 12) | |
| Cambrian | 15° N., 173° E. (Caerbwdy Sands, Wales, ref. 11) | 22° S., 153° W. (Tapeats Sandstone, Arizona†)<br>20° N., 165° E. (Keweenawan, Michigan, ref. 14) | |
| Late Pre-Cambrian | 5° S., 131° W. (Upper Torridonian, north-western Scotland, ref. 11) | 30° N., 148° W. (Hakatai Shales, Arizona†)<br>45° N., 90° W (Diabase dykes, Michigan, ref. 13) | |
| Earlier Pre-Cambrian | 37° N., 109° W. (Diabaig Group, Torridonian, north-western Scotland, ref. 11) | | |

* Mean based on such a small number of extrusive rocks that it is doubtful whether the effect due to secular variation is eliminated.
** Mean based on a single flow.
† Runcorn, S. K. (unpublished).
‡ Gough, D. L (unpublished).

If the Earth were taken to be stationary, the convection currents would cause a slow rotation in the same manner as the beetle crawling around the surface. Prof. O. T. Jones welcomed the results of the palæomagnetic surveys. He stated that, from his recent studies of the red sandstones in the Devonian and Triassic, he had concluded that they have been derived from the erosion of tropical soils. This suggests that the equator, during the two periods, has lain near the British Isles—a conclusion which is in agreement with the implications of Dr. Runcorn's palæomagnetic data.

A. A. Day
S. K. Runcorn

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# A FURTHER FRAGMENT OF THE SWANSCOMBE SKULL

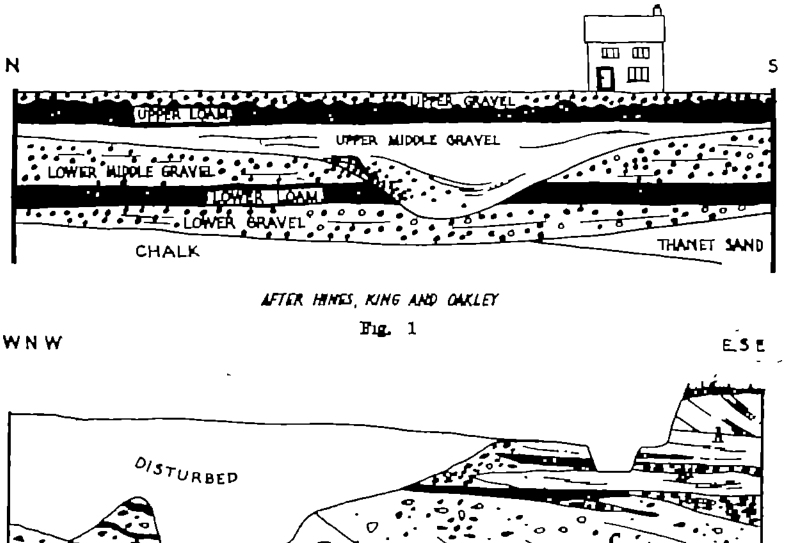
By J. WYMER

THE right parietal of a human skull, found in the Middle Gravels at Swanscombe, Kent, on July 30 of this year, was discovered during excavations under licence from the Nature Conservancy (see *Nature*, Aug. 13, p. 287; for "Mr. Adrian Jones" read "Mr. Adrian Gibson"): a section was to be cleared from near the top of the Upper Middle Gravel, through the Lower Middle Gravel to the Lower Loam, for the purpose of studying the deposits and their archæological content. The spot chosen was close to the site of Mr. A. T. Marston's discoveries of 1935 and 1936, when he found the occipital and left parietal of Swanscombe Man. It is one of the few places in the reserve where undisturbed Middle Gravel deposits exist, although the are almost completely buried beneath dump an scree. Previous work in the pit for five years ha proved the existence of this remaining piece.

The geology of the Swanscombe deposits is we known, having been carefully studied during th years of commercial excavation, when large exposure rendered the task more practical. Now there ar only a few small patches where any of the undisturbe deposits can be seen. All these terrace deposits except perhaps the topmost solifluxion layer, are o great interglacial age, possibly 250,000 years old, an they fill a large channel cut in th solid Thanet Sand and Chalk almost a mile wide. When th River Thames flowed at this level it meandered across its flood plain scouring out new channels an filling in old. Such a channe remains 'fossilized' in the Middl Gravels of Swanscombe, the Uppe Middle Gravel representing a channel cut into the Lower Middl Gravel and afterwards filled wit gravels and sand. It was nea the base of this channel, not fa from its banks, that the Swanscombe Man fragments were found in association with mammalia remains and flint artifacts databl to the middle period of the Acheulian flint industry. The complet section is illustrated diagrammatically in Fig. 1.

The channel of Upper Middl Gravel is obviously more recen than the Lower Middle Gravel below; but they both contain flint industry of Middle Acheulia type. Some authorities consider th Upper Middle Gravel flint industr to be more evolved; but this i debatable. The surface level i 110 ft., and the bottom of th main channel attains a depth c 40 ft.

A thick capping of overburde and the lack of an existing fac made it necessary for the excavatio



AFTER HINES, KING AND OAKLEY

Fig. 1

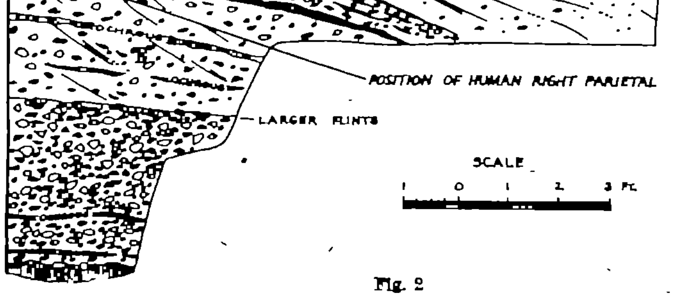


Fig. 2

be conducted downwards by horizontal planes in rder to determine the lay of the strata. The current-edded sand at the top of the excavation was recog-zed as part of the Upper Middle. It was devoid of one or flint artifacts; but a thin seam of gravel mning through it (*A*1 in Fig. 2) yielded numerous nt flakes, as did the thicker seam of gravel below 3), which also contained a small hand-axe, two iniature cores and some bone fragments, as yet nidentified. The very loose sand with stones beneath ntained few artifacts and no bone. Layers *A*1 and were approximately horizontal in a west-north-est–east-south-east direction, but at right angles lowed a slight dip to the south-south-west.

On the second day of the excavation, in the west-orth-west end of the section, a thin band of very hrous gravel was revealed with unstained gravel eneath it. This had a steep dip to the east-south-ast and south-south-west. Immediately, several one fragments and flint flakes were found. Further moval of material showed more inconsistent bands, lso dipping but tending to converge upon the east-outh-east. The gravel continued to be very rich in int artifacts and bone fragments; many of the int flakes were lustreless and sharp, as if freshly truck, others were slightly rolled. Excavation in his region was very difficult because of the proximity f thick, loose overlay, which tended to fall. A hicker band of dark, stained gravel was exposed eneath, and as this was being examined a small iece of bone showed through the lighter gravel at s base. The surrounding material was cleared away y the fingers and the new find, a right parietal, was xposed *in situ*, dome upwards. Its upper surface, t least, was seen to be in soft, soapy condition, and ncient cracks already existed. It was decided to ease all further work in order to decrease the prob-bility of a fall of the disturbed material upon it, ut to leave the bone *in situ*. Photographs were aken and a temporary protection of boards placed ver the parietal in case of a dangerous fall; Mr. Iarston arrived two hours later and confirmed the iscovery. A protective covering of plaster was made ver the bone; but the loose nature of the gravel nd the existing cracks defied attempts to extricate he fragment complete. All the pieces, however, rere retrieved without damage to them and packed arefully in a box that was not opened again until rrival at the British Museum (Natural History) on ugust 2, save for the placing of a saturated wad of otton-wool above to prevent any serious drying out.

Fig. 2 shows the conclusion of the excavation with he Lower Gravel (*F*) exposed, resting upon the enacious Lower Loam (*G*).

Mr. Marston confirmed that his occipital bone was found 51 ft. to the west-north-west of the new find and 49 ft. from the left parietal, the position of the three fragments forming a triangle with sides 51, 49 and 24 ft. In his report on the discoveries (*J. Roy. Anthrop. Soc.*, 67, 350; 1937), his geological section agrees exactly with the new one figured, showing four oblique ochrous layers and, of great significance, the bottom one as the bone layer. The new fragment was barely one inch below this seam in the unstained sandy gravel, a difference of no importance in a river deposit. The only item of interpretation in which the new section differs from Mr. Marston's is that the layer of larger flints at the top of the gravel marked *F* is considered to be the junction of the Lower and Upper Middle Gravels. Mr. Marston features the large flints but accepts the bottom ochrous band (the bone layer) as the junction. The gravel of *F* is more compact and darker than that of the looser, lighter gravel above it (*E*), which contained bone fragments. No bone fragments were found in *F*.

A comparison of the two sections shows that there can be no doubt that the new right parietal was found in the same stratum as that in which Mr. Marston found an occipital and left parietal in 1935–36. This renders the fact that all three fragments fit each other perfectly, belonging to the skull of the same individual, a little less remark-able.

Numerous bone fragments were found in associa-tion with the right parietal, and these are now at the British Museum for purposes of hardening and identification. It is hoped that they may add to the list of fauna from this level. Almost three hundred primary and finishing flint flakes were found during the excavation, of which only twelve showed signs of possible utilization. Four small, primitive hand-axes were also found, typical of the Acheulian flint industry as represented at Swanscombe, as well as the point of a larger, finely finished hand-axe and a magnificent flake 'knife'. A full account of these artifacts will appear in the forthcoming report. Most of them were in a very sharp condition, with only a few minute chippings along the edge and a lustre from rolling in the water. Many, however, are lustre-less and virtually in mint condition. Although separated, the skull fragments show very little abrasion from rolling and there can be no doubt that the flint industry is contemporary.

Inside the triangle formed by the position of the three skull fragments recovered remains a mound, part of which is definitely undisturbed gravel of the skull zone. This area is now efficiently protected, and is to be excavated in the near future.

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# USE OF RADIOACTIVE MATERIALS IN BIOLOGICAL ASSAY

A JOINT meeting of the Society for Analytical Chemistry, the Royal Institute of Chemistry, he Society of Chemical Industry and the Chemical ociety was held during July 11 and 12 in the Bio-hemistry Department of the University of Edin-urgh; the purpose of the meeting was a symposium n "The Use of Radioactive Materials in Biological ssay". Nine papers were read by invited speakers, nd the programme also included a dinner and a isit to the Institute of Seaweed Research.

Public attention now being focused on the peaceful ses of atomic energy and its by-products, it was perhaps not inappropriate that members of four learned societies should meet for the purpose of dis-cussing some of the latest applications of the isotope technique to biological problems. Some speakers, however, had obviously found difficulty in fitting the subject of their paper to the rather narrow field where biological assay and the applications of radio-active isotopes overlap. That the meeting was a success was in the main due to their interpreting the title of the symposium somewhat widely.

After a brief introductory address by Prof. G. F. Marrian, in which he recalled the pioneer work done in the field of radioactive tracers by G. von Hevesy and his collaborators, the present writer gave an introductory paper on the determination of radioactive isotopes in biological samples. For the benefit of those not familiar with the instruments available for this purpose the first part of the paper was elementary in character, and was followed by an account of the more refined technique of gas-counting, by means of which the isotopes of carbon and hydrogen can be determined with high precision when present together in the same sample. A lively discussion followed, and most members present showed that they had an intimate knowledge not only of the virtues but more particularly the vices of many of the types of counter available. During the discussion on gas counting, Mr. F. P. W. Wintringham pointed out that ionization chambers used in conjunction with the most recent types of d.c. amplifiers are ultimately more sensitive than counters, but that they probably require more skill to operate and are not suited for use by assistant staff.

Dr. E. Lester Smith, of Glaxo Laboratories, Ltd., followed with a paper on the principles of isotope dilution assays. He exemplified the use of this valuable technique by means of an imaginary application to the determination of sodium chloride in sea water, and then enumerated the essential criteria for successful application of the technique. The most important of these is the isolation of a pure sample of the compound to be determined, once mixing with the labelled material is complete. This is sometimes very difficult, recrystallization to constant specific activity being often a laborious procedure. A useful application to the vitamin $B_{12}$ field is the determination of the vitamin in crude fermentation liquors. These contain too many interfering substances for colorimetric or microbiological methods to be easily applied, but the problem has been solved by the use of vitamin $B_{12}$ labelled with cobalt-60. A known amount of known specific activity is added to the fermentation liquors, and a pure sample of the $B_{12}$ is isolated using resin-column chromatography. Ultimately the purified vitamin $B_{12}$ is counted in a liquid counter. The chief disadvantage of the method is the four-step purification procedure. In the course of his paper, Dr. Lester Smith also referred to more sophisticated applications of the technique, mentioning in this connexion the use of labelled reagents, for example, iodopiperonyl chloride labelled with iodine-131 for the determination of amino-acids in protein hydrolysates. He also referred to the reversed isotope dilution technique, in which the total amount of a labelled constituent of a mixture is determined by adding a known weight of unlabelled substance, re-isolating it and determining its specific activity. From this and from the weight added, the total activity of the substance in the mixture can be calculated. This is sometimes referred to as the carrier technique, and as such was more familiar to some members of the audience.

Another practical application of the technique to what might be termed a commercial problem was described by Mr. G. C. Ashton, also of Glaxo Laboratories. This problem is the determination of penicillin G (benzylpenicillin) in fermentation liquors. These contain also other penicillins and other antibiotics which virtually rule out microbiological assay. Methods are available in the literature for the preparation of deuterium- or $^{14}$C-labelled penicillin G suitable for isotope dilution applications; but the deuterium-labelled penicillin in particular is too costly and laborious to produce with a sufficiently hig isotopic abundance for practical applications. (Thi consideration does not, of course, apply to tritium which is not only cheaper than deuterium but als cheaper than carbon-14.) In the method described the $^{14}$C-labelled material is prepared by standard procedures. Known activities are added to the fermentation liquors and penicillin G isolated and its specifi activity determined. It was in the accuracy claime for his radioassays that Mr. Ashton provoked mos discussion, his claims for closer than 5 per cent agreements between replicates being questioned by som speakers. His assertion that the counting rate o thick samples continues to increase beyond th usually accepted infinite thickness value was confirmed by Dr. W. F. Pover, of Birmingham, and wa attributed to edge effects.

Dr. A. S. McFarlane, of the National Institute fo Medical Research, Mill Hill, gave an account of th preparation and research applications of radioiodinated plasma proteins. It has been found tha if the protein molecules contain not more than ten atoms of iodine per molecule, they are unchanged antigenically. More than ten atoms iodine pe molecule produces an antigenically different protein with different crystalline properties. When radioiodine is used, it is not sufficient to have an *averag* of less than ten atoms iodine per protein molecule steps must be taken to see that no appreciable proportion of the molecules contains more iodine than this because, having different chemical properties and, in consequence of the high iodine content a relatively high specific activity, their presence wil give rise to erroneous results. The practice at Mill Hill, where radioiodinated proteins are prepared, is therefore to use iodine-131 in the proportion of one atom per protein molecule, and to carry out the reaction under conditions that will ensure uniform reaction. Proteins react very rapidly with iodine at alkaline *p*H, one molecule of hydrogen iodide being eliminated for each iodine atom attached. Fast mixing is therefore necessary, and this is achieved by means of a microjet apparatus in which jets of protein solution and iodine solution flowing in opposite directions meet in a minute mixing chamber. The yield is usually of the order of 60 per cent of the theoretical, and the product is purified on an ion-exchange resin. The final solution as made available for research is isotonic, neutral, sterile and with less than 1 per cent of the radioactivity in the form of iodide ion.

Experiments have been carried out to ensure that the labelled plasma proteins so prepared cannot be 'recognized' by experimental animals. This work has been done by comparing the specific activity – time curves of radioiodinated proteins and biosynthetic $^{14}$C-labelled proteins. These were prepared by feeding high-specific activity $^{14}$C-algal protein to rabbits and then isolating the plasma proteins. It was found that the two curves nearly coincide, the difference between them being of very doubtful significance. A useful property of the radioiodine-labelled proteins is that the label is not re-utilized as is carbon-14. Whereas the metabolic products of $^{14}$C-labelled proteins are re-incorporated into new proteins, the iodine-131 is rapidly excreted once the protein has been degraded. This has the practical advantage that only the protein administered is being traced.

The application of an isotope technique to the assay of aldosterone and other steroids was described in a paper by Mr. R. N. Jones, Mrs. S. A. Simpson nd Dr. J. F. Tait, of the Middlesex Hospital, London, nd read by Dr. Tait. The assay method is based pon changes in the sodium–potassium ratio in drenalectomized rats caused by certain adrenal hormones, notably deoxycorticosterone and aldosterone. Two short-lived isotopes, sodium-24 and potassium-42, of half-lives 15·06 and 12·4 hr., espectively, can be employed for this purpose. The echnical problem which has to be met in this work s either the measurement of each isotope separately n the presence of the other, or the measurement of he ratio itself. This latter alternative has been found by these workers to be the better, and the method used is based on the fact that, whereas an absorber of thickness 300 mgm./cm. placed between the sample and the counter reduces the observed counting rate due to sodium-24 by a factor of 20, it reduces that due to potassium-42 by a factor of only 3. This fact can be applied successfully to the measurement of sodium-24/potassium-42 ratios, and carries with it the advantage that whereas both isotopes decay apidly, the ratio does not because they both have very nearly the same half-life.

The assay is carried out by reference to a graph of he logarithm of the ratio plotted against the ogarithm of the dose of steroid. Aldosterone is found o be 120 times more potent than deoxycorticosterone, which is used as a standard. The method, although very successful, was compared by Dr. Tait with a non-isotopic method, namely, the measurement of sodium–potassium ratios by flame photometry, and the opinion was expressed that in the long run the non-isotopic method would probably prove to be preferable.

Isotope dilution methods for the determination of cortisol and aldosterone, using the technique according to the principles described by Dr. Lester Smith, were also described. Ring-labelled cortisol and aldosterone di-(1-$^{14}$C)-acetate were used. The chief difficulty was in the purification of the extracted compounds, column chromatography being used.

The use of iodine-131 for another bio-assay was described by Mr. Trevor Kinnear of Edinburgh, whose paper was concerned with the assay of thyroid-stimulating hormone. His method is based on the effect of the hormone on clearance of labelled iodine from the thyroids of day-old cockerels. The chicks are injected first with iodine-131 and then, for several days following, with the sodium salt of thyroxine. Control groups are then injected with saline and other groups with various amounts of the hormone preparation to be assayed. The change in activity of the thyroids as measured *in vivo* indicates the rate of clearance of labelled iodine and is a measure of the activity of the thyroid-stimulating preparations.

Another method in which radioiodine is used was described in a paper by Mr. F. W. Jennings and Dr. W. Mulligan, of Glasgow. Their problem is to measure the volume of intracellular plasma in centrifuged red cells. Hæmatrocrit values as determined by the conventional methods are found to give very variable results, especially with the blood of cows and sheep. The isotope method adopted was based on the use of plasma proteins labelled with iodine-131 and subsequent measurement of the residual activity in the centrifuged cells. Variable results were still obtained with cows and sheep; but these were traced to the effect of temperature and time of centrifuging. More uniform results were obtained by the use of cooled centrifuges, the temperature being controlled at 15°.

Mr. F. P. W. Wintringham, of the Pest Infestation Laboratory, gave an account of some of the methods employed for investigating the biochemistry of toxic action in insects. His experimental animal is the common house fly, and at least one of his audience envied him the convenience of the size of his subjects, and admired the technique devised for experimenting upon them. Mr. Wintringham first pointed out that, in general, there are many dangers attendant upon the use of *in vitro* techniques, especially when toxic action is to be investigated. A given agent may inhibit particular enzymes *in vitro*, whereas in the living animal it may either never reach that enzyme or it may reach it by pathways which are absent in *in vitro* preparations. Since the well-being of the whole animal depends on the existence of metabolic pools the components of which are each within a particular range of concentrations, toxins cause accumulations or depletions of various components of these pools. It is to the study of metabolic pools and the action upon them of certain known toxins that an isotope technique coupled with paper chromatography has been successfully applied.

Mr. Wintringham took for his example the labelling of metabolic pools with phosphorus-32. When carrier-free $^{32}$P-phosphate is administered to the fly, all the metabolically active phosphorus-containing organic compounds become rapidly labelled. The fly is then killed and tissue extracts separated on paper chromatograms, and their presence and specific activities determined by scanning techniques. The effect of toxins on the labelling pattern is often spectacular. For example, the effect of methyl bromide is a large diminution in the size of the adenosine triphosphate pool and an increase in the size of the inorganic phosphorus pool. *Cyclo*propane, on the other hand (which is used as an anæsthetic during the injection of the flies), has no such effect. An interesting refinement of the technique is the confirmation of the specific activity of the phosphorus compounds: the original phosphorus-32 activity is allowed to decay away and the papers are irradiated in the pile, when all the phosphorus in the spots becomes radioactive by the $^{31}$P$(n,\gamma)^{32}$P reaction, thus giving, by its radioactivity, a measure of the amounts of phosphorus in the spots as would have been found by a chemical determination. By this means the interesting fact was confirmed that all the phosphorus atoms of adenosine triphosphate are labelled when phosphorus-32 is injected into house flies, whereas in mammalian tissues only the $\beta$- and $\gamma$-atoms are usually found to be radioactive. In answer to a question, however, Mr. Wintringham expressed the view that this does not constitute an important qualitative difference between the metabolism of insects and mammals, but is merely a reflexion of the higher turnover-rates in insects. He believes that, given time, all the phosphorus atoms of adenosine triphosphate in animal tissues would be exchanged; in fact, the similarities between the biochemical pathways of rats and flies are more striking than the differences.

The concluding paper of the meeting was a survey by Dr. J. F. Loutit of the dangers to health entailed in the manipulation of radioactive substances. In general, he was reassuring: only activities greater than 1 mc. of $\gamma$-ray emitters need be regarded as a danger so far as external radiation of workers is concerned, and these dangers can be controlled by the use of pocket dosimeters or film badges. Blood counts are much less satisfactory than such physical methods of measurement. Blood counts remain more or less constant until the subject has had a sufficient dose to produce irreversible damage and no institution in Great Britain now relies solely on this method of control. The dangers from internal radiation, which arise only when radioactive materials are inhaled or eaten, in general entail similar risks: that is to say, quantities of the order of 1 mc. inside the body are to be regarded as dangerous. But here, of course, the chemical properties of the isotope, which determine where it is deposited and how fast it is eliminated, its half-life and the nature of its radiations are also important considerations in assessing the dangers. The bone-seeking isotopes such as strontium are by far the most dangerous, as they irradiate the bone marrow. In concluding, and in answer to questions, Dr. Loutit expressed his opinion that emitters of soft β-radiation such as carbon-14, tritium and sulphur-35 are not particularly dangerous, and precautions similar to those taken b bacteriologists when dealing with pathogenic organisms would protect workers. He reminded th audience, however, that whereas pathogenic organisms accidentally let loose in the laboratory can b destroyed by disinfectants or other agents, radioactivity cannot be destroyed.

In attempting to assess the value of the meeting the present writer is under a difficulty. A symposiu devoted to technique rather than to a field of researc brings together workers on very different subjects whose common interest hangs on the somewha slender thread of common technique. A smalle proportion of those attending the meeting are therefore able to comment pertinently on each piece o research than occurs when the subject is common to all. There can be no doubt, however, that the meetings were much enjoyed by those present.

R. F. GLASCOCK

# NEWS and VIEWS

## Textile Chemistry at Manchester: Prof. R. H. Peters

THE Manchester College of Technology has trained students of textile chemistry ever since 1905, and the pioneer work of Prof. Knecht, of J. Huebner and of F. Scholefield is well known. The industry has always found great difficulty in recruiting skilled technologists, and it has sometimes failed for years to make full use of discoveries which have been made by the big firms and by research associations such as the Shirley Institute and the British Rayon Research Association. It is possible that if the textile industry of Britain could exploit the new synthetic fibres and the new methods of dyeing and finishing, it might have a chance of re-establishing something of its former position of pre-eminence in those world markets in which it cannot compete so long as it restricts itself to traditional fibres and the old-fashioned techniques which are now so well known to its competitors.

The appointment of Dr. Raymond Harry Peters to be the first professor of textile chemistry in the Manchester College of Technology may therefore prove to be of great importance to the textile industry as a whole. Dr. Peters obtained the degree of bachelor of science with first-class honours in chemistry at King's College, London, in 1939 and took his Ph.D. in 1942. He was in the Dyestuffs Division of the Imperial Chemical Industries, Ltd., at Blackley during 1941–47. He took a degree in mathematics in the University of Manchester in 1949 and then returned to Blackley. He became head of the Dyeing Research Section of I.C.I. in 1952. He has published a number of scientific papers and in 1953 he was awarded the medal of the Worshipful Company of Dyers. Prof. Peters will have at his disposal a splendid new dyehouse which has been very well equipped, thanks to the generosity of Courtaulds and the co-operation of a number of firms, in particular Messrs. Mather and Platt, Ltd. He should be able to build up a strong postgraduate research school in co-operation with local industry, and it is much to be hoped that his department will attract students who can be trained in this vitally important branch of technology, and so help the textile industry of Britain to bring itself up to date.

## Electrical Engineering at Swansea: Prof. W. Fishwick

THE chair of electrical engineering which was recently established at the University College of Swansea has been filled by the appointment of Dr. W. Fishwick, who is at present a lecturer in engineering in the University of Edinburgh. After obtaining first-class honours in the Mechanical Sciences Tripos at Cambridge in 1940, together with the Wynne Prize from Pembroke College, Dr. Fishwick joined the staff of the Telecommunications Research Establishment, where he was concerned first with the development of radar equipment and later with radio counter-measures. In 1944 he was commissioned for special duties with the R.A.F. and commanded a scientific intelligence unit operating in North-West Europe. Dr. Fishwick returned to Cambridge in 1946 as a research student under Prof. E. B. Moullin and Mr. C. W. Oatley, where he developed a novel type of mass-spectrometer using radar techniques which was capable of following very rapid changes in gas composition. Upon the completion of this work, for which Dr. Fishwick was awarded the degree of Ph.D., he took up a post with Imperial Chemical Industries, Ltd., at Manchester in 1948, where he was placed in charge of a laboratory for the development of instruments concerned with the automatic control of chemical plant. Two years later he was appointed to his present post at Edinburgh. Dr. Fishwick's more recent researches have been concerned with automatic control theory and with certain machine-tool vibration problems. It is peculiarly appropriate that the first occupant of the new chair should be actively interested in the field of automatic control, for many of the steel, chemical and other plants which are situated in the immediate neighbourhood of Swansea make extensive use of such controls.

## Social Responsibilities of Scientists

IN a paper presented to the American Philosophical Society (*American Scientist*, 43; July 1955), Prof. J. H. Hildebrand, of the University of California, examines the social responsibility of scientists. They should first try to extend the boundaries of knowledge and be able to answer Benjamin Franklin's question, 'Do you love truth for truth's sake, and will you endeavour impartially to find and receive it for yourself, and communicate it to others'?" They should in no way be blamed for not foreseeing every evil use to which their discoveries might be put; "those who decry science should come out into the open and say they prefer ignorance to understanding, darkness to light". Outside their scientific discoveries the mass of scientists are like the mass of other people with all the same human weaknesses and strengths. They should bear their moral responsibilities for the use or abuse of scientific discoveries with the rest of mankind.

## City and Guilds of London Institute

In the seventy-fifth annual report of the City and Guilds of London Institute, attention is directed to the launching of the ninth examining body, now officially known as the Associated Examining Board, for the General Certificate of Education. The establishment of the Board has been welcomed as one of the most significant developments in secondary education in recent years and a development which should undoubtedly prove to be of far-reaching importance in both educational and industrial fields. The new body is the only one of the nine now examining for the General Certificate of Education on which industrial and professional interests are directly represented, and the Board has therefore had in mind the production of syllabuses and the introduction of new subjects suitable for students intending to enter industry and commerce. The Council also reports progress in the number of candidates taking City and Guilds examinations, and of further requests for training courses. The number of candidates who sat for the Department's examinations in 1954 totalled 88,560—an increase of 6,273 over the previous year. Many new subjects were introduced during the year and major revisions of existing schemes were undertaken.

In the City and Guilds College the numbers of full-time undergraduate and postgraduate students have risen considerably; a chair of heavy electrical engineering and a readership in production engineering have been instituted, to be financed from the income which will be received from a share of the Counterpart Funds placed at the disposal of the University of London; and the first allocation of special expansion recurrent grant will allow for the appointment of a professor of applied science (engineering) and a professor of soil mechanics, in addition to other necessary additions to the lecturing staff.

## British Hat and Allied Feltmakers Research Association

The seventh annual report of the Director of Research of the British Hat and Allied Feltmakers Research Association (pp. 19 + 2 plates; from the Association, Manchester, 1954) covers the year ended August 1954 and refers to the fresh conditions of grant obtained for the five years commencing in April 1954. For the first two years the government grant remains unchanged, but for the following three years the industry is asked to raise an annual minimum of £12,000 to attract grant at the rate of £9,000 a year, with up to a further £5,000 on the basis of £100 for each £100 in excess of the stipulated minimum raised by the industry. One of the Association's outstanding achievements has been the development of equations for carrotting fur, although further work and factory trials will be necessary to establish their validity for all grades of fur and different types of carrotting reagents. So far, different equations have been established for the standard 'mercury in nitric acid' reagent and for non-mercuric reagents of the 'hydrogen peroxide–nitric acid' type. The study of wool noil, of the directional felting of wool and the physical properties of fibres continued, and the operation of multi-roller machines in relation to the degree of carrotting and the grade of fur used was investigated. The survey of wool bumping machines has yielded information on the loading of crank bumpers in relation to the wetness and temperature of the mass, and to the rate of felting, which should find immediate application in the industry, while observations on the time of dyeing of wool felt were immediately reflected in the quality of the hats produced. *Ad hoc* research programmes included the blending of fur with protein fibres, the shower-proofing of hats and the stoving temperature in carrotting fur. Other work has been concerned with standardization of raw materials and finished products. A research conference held in conjunction with the annual general meeting, at which papers reviewing the work of the Association were delivered, was an outstanding success.

## Finnish Institute for Occupational Health

The Board of Trustees of the Institute of Occupational Health in Helsinki is made up of members of the Cabinet, the universities and voluntary organizations. Its funds are drawn from industry, insurance companies and workers' organizations and, each year, it publishes a report in English (Occupational Medical Foundation and Institute of Occupational Health. Annual Report, 1954. Pp. 47. (Helsinki: Occupational Medical Foundation and Institute of Occupational Health, 1955)). Besides a general department, it has medical, physiological, psychological and industrial hygiene departments and, in 1954, the number of workers engaged on research projects increased substantially compared with the previous year. Among the original investigations carried out was one into the problem of sickness absenteeism among government workers. Of 44,000 government workers whose cases were examined, the frequency of sickness among groups working indoors has been three times higher than that among outdoor workers. A study of the characteristics of an influenza epidemic and of the effects of immunization showed that previous attacks of influenza had no clear immunizing effects, while the results obtained from immunization were unsatisfactory. Investigations were also made into the reasons why javelin throwers have to give up their sport each year for varying periods, while a statistical study was also made into the relation between age and number of traffic accidents incurred by some five hundred bus drivers. This showed that the number of accidents involving drivers with long experience diminishes with age up to approximately 45–48 years, after which the accident-rate begins to grow.

## Macaulay Institute for Soil Research: Report for 1953–54

The annual report for 1953–54 of the Macaulay Institute for Soil Research, Aberdeen (pp. 55 + 2 plates; from the Institute at Craigiebuckler, Aberdeen; 1955), indicates that the Institute continues actively to promote its aim of advancing the fundamental study of the soil in all its aspects. The Pedology Department surveyed a further 260 square miles of Scottish soils, and continued the study of conditions and practices on upland grazings with special regard to heather management. Improvements of existing analytical methods are reported by the Department of Spectrophotometry, and the use of a double-beam infra-red spectrometer has assisted the positive identification of some substances present in soil organic matter. Investigations on the carbohydrate and nitrogenous constituents of the soil have been continued by the Department of Soil Organic Matter. Other activities of this Department include studies in the transformation of fatty materials in the soil by Actinomycetes, the physiology of aerobic thermophils, lignin decomposition studies and work on peat classification, including pollen analysis. The Department of Plant Physiology, working with sugar-beet disks, finds that phosphate absorption is related to the reducing-sugar content of the cell. It is also suggested that the ratio of phosphorus to iron in leaves gives a clearer picture of the iron status of plants than the individual concentration of these elements, high ratios being characteristic of iron-chlorotic plants. Investigations of soil fertility directed towards improving fertility practice, clarifying the significance of soil properties in relation to crop production and developing methods for evaluating the nutrient status of soils, have been continued.

## Journal of the Institution of Telecommunication Engineers, India

THE first number of the *Journal of the Institution of Telecommunication Engineers, India* (see *Nature*, July 16, p. 100), was published in March, and for the present it will be produced as a quarterly (from the Institution, Curzon Road, New Delhi; Rs. 15 a year or Rs. 5 per copy). It is intended that each issue of this *Journal* will normally comprise an editorial note, two or three research papers, articles of general interest for students, reviews of papers, news and notes, and letters to the editor. The first number contains the texts of the addresses delivered at the inaugural session of the Institution on November 2, 1953: first, the address of welcome by A. C. Ramchandani, chief engineer of All-India Radio; next, the inaugural address by Dr. S. Radhakrishnan, vice-president of the Republic of India; and then the presidential address by B. R. Batra, chief engineer of the Posts and Telegraphs Department. Mr. Batra's second presidential address, delivered on December 12, 1954, is also reproduced. The more technical material published in this issue comprises an article on line fault location by pulse technique, by T. K. Mahadevan; an account of radio measurements at Jabalpur during the solar eclipse of June 30, 1954, by members of the Government Engineering College at Jabalpur; and a paper by S. Sampath on power density diagrams of short-wave aerial arrays. The *Journal* concludes with the annual report of the Council of the Institution for 1953–54, and a list of current members.

## Anguinomorph Lizards

IN 1878 Steindachner described a lizard from Sarawak which he named *Lothanotus borneensis*. Only a few specimens have been collected since then, so that it is still rare in museums. As it was regarded as closely related to *Heloderma*—indeed, it was sometimes put in the same family—it presented a remarkable example of discontinuous distribution. S. B. McDowell, jun., and C. M. Bogert in "The Systematic Position of *Lothanotus* and the Affinities of the Anguinomorph Lizards" (*Bull. Amer. Mus. Nat Hist.*, 105, Art. 1, 1954; pp. 142+43 figs.+6 plates 6 dollars) started to examine this problem but were soon led into wider fields and examined the crania of 306 living reptiles and those of eight related fossi genera. This work is illustrated, *inter alia*, with the detailed drawings of the skulls of twenty-eight species of reptiles, and as the majority of these are origina they furnish a very valuable series for reference These and the other text-figures are excellently drawn and well reproduced. In addition to the claim that *Lothanotus* is allied to *Heloderma*, Nopcsa suggested that it also resembled *Shinisaurus crocodilurus* another rare lizard from southern China, and this point is also specially investigated. The procedure adopted is to give full accounts of the externa features, skulls, and post-cranial skeletons of these species and of the classical lizard genus *Varanus*, and then to make detailed comparisons between them and a series of key forms. Among the conclusions reached is that the Anguinomorpha, as here defined, include the extinct Mosasauridae and constitute a natura infra-order divisible into two superfamilies, the Diploglossa and the Platynota. *Shinisaurus* belongs to the former and, although *Heloderma* falls in the latter, it is in a separate family not closely related to the Lothanotidae. Some of the characters of *Lothanotus* are such as might be expected in a form ancestral to snakes. It is further suggested that the Typhlopodidae should not be included in the Ophidia but should be regarded as a highly specialized line of Anguinomorph lizards the resemblances of which to the snakes result from convergence. Altogether, this is a most useful contribution upon which the authors are to be congratulated.

## Biological Races of *Phytophthora Infestans* in Canada

IN recent investigations of the *Phytophthora* blights of tomatoes and potatoes in eastern Canada, it was found that different isolates of the fungal pathogen did not always yield reproducible effects in inoculation experiments. This led to the view that different biological races of the fungus might be involved—a view fully borne out by further experimental work now reported by K. M. Graham and H. N. Racicot (Soc. de Quebec pour la Protection des Plantes, Thirty-fifth Rept., p. 50; 1953). Thirty-one isolates of *P. infestans* from potatoes were examined. Cytological study showed that the zoospores are uninucleate and that genetically pure lines could therefore be obtained, these being cultured on oatmeal agar. On a host-range comprising both potato and tomato varieties, it was found in comparable inoculation tests that three races of the pathogen could be differentiated, their respective effects being indicated.

## Photosynthesis in Different Phyla

L. Norris, R. E. Norris and M. Calvin have reported on a survey of the rates and products of short-term photosynthesis in plants representative of nine different phyla (*J. Exp. Bot.*, 6, 16, 64; 1955). When short-term experiments on photosynthesis, using carbon-14 dioxide and paper chromatography, were performed with twenty-seven different plants representing nine phyla, there was a remarkable uniformity in the types of ethanol-soluble compounds which became radioactive in the entire group of plants used. The percentage amounts of the different compounds varied considerably among the various

(*Continued on p.* 447)

# BRITISH ASSOCIATION MEETING AT BRISTOL

## SCIENCE AND THE SCIENTIST*

By Sir ROBERT ROBINSON, O.M., F.R.S.
President of the British Association

HE Association held its sixth annual meeting in Bristol in August 1836 under the presidency of Marquis of Lansdowne. No significance need be ached to the fact that the well-known riots urred here in the following year, which is much tter dated by the accession of Queen Victoria. I ted from the report with interest and a certain stful approval that the address was delivered on at occasion not by the president but by Charles ubeny, Fellow of Magdalen College, Oxford, local asurer for Oxford. Daubeny had already been pointed to the University chairs of chemistry and botany. He was well qualified to profess geology o; but his eventual third chair was that of rural nomy. He was a founder member of the Associa- n and had attended the five previous meetings. ndoubtedly one of the chief pioneers and benefactors science in Oxford, he was a man of great originality d tireless energy. Among many notable contri- tions to knowledge, one that deserves the epithet ssical was his discovery that the process of photo- nthesis occurred more rapidly under the influence blue and violet light than under that of the less rangible rays.

In the course of his address, Daubeny referred, ong other things, to various systems of notation chemistry and mentioned in that connexion Dr. hn Dalton, whom he described as the 'venerable' nder of the atomic theory but who was in fact st short of seventy years of age. At the meeting of Association in the previous year at Dublin, lton had given an account of his experiments on distillation of caoutchouc and of the formation a volatile oil which was doubtless crude isoprene. is he called 'double olefiant'. One volume of the porized substance exploded with six volumes of ygen gave four volumes of carbonic acid gas, which rks out for:

$$C_5H_8 + 6O_2 = 4CO_2 + 3H_2O + (CH_2O).$$

re the $CH_2O$ merely represents loss of partly idized hydrocarbon. I mention this matter, rather t of context, because the work seems to have been gotten.

Dalton was not too 'venerable' either to be a vice- sident of the Chemistry Section at the Bristol eting, or to be charged with the duty of examining lesser constituents of the atmosphere. One nders whether the small incombustible residue ted by Cavendish, and which was undoubtedly gon, was known to him.

The next meeting at Bristol was in 1875. The sident was the eminent engineer Sir John Hawk- w, and he delivered a most interesting address on historical development of achievement made ssible by applications of engineering and other ences. The last three sentences will interest you. . . Need we try to extend our vision into futurity ther? Our present knowledge, compared to what is unknown, even in physics, is infinitesimal. We may never discover a new force—yet, who can tell ?"

The meeting was attended by many famous men of science, and among the officers of sectional committees we find Cayley, Thomson (afterward Lord Kelvin), Tyndall, Rayleigh, Williamson, Galton, Armstrong and Tilden; a short list at random that could be greatly extended.

Sir William Crookes was the president at the third Bristol meeting, in 1898, and he delivered an outstanding address on a variety of topics. First on the gloomy prospects for the supply of bread to the people of the British Isles. Here he foresaw with characteristic intuitive genius that the only possible solution would be to obtain nitrogenous products from the atmosphere. At that time the only known method was the combustion of nitrogen with the help of a powerful electric discharge, an experiment initiated by Henry Cavendish, developed by Crookes himself in 1892, and by Rayleigh for the isolation of argon. Crookes even calculated that electricity generated from coal could be used to produce sodium nitrate at £26 per ton and that power from Niagara would reduce the cost to £5 per ton. The figure for Chilean nitrate was £7 10*s*. per ton, estimates which have only relative interest at the present time. If the Haber synthetic ammonia process had not offered a much better alternative, it is possible that Crookes's idea would have been commercially developed. In any event, his thoughts were along the right lines.

Crookes was able to report that on May 10, 1897, Dewar had written to him: "This evening I have succeeded in liquefying both hydrogen and helium." Further, he mentioned that in the preceding few months, Ramsay and Travers (a distinguished Bristolian) had discovered three new rare gases of the atmosphere.

He goes on to speak of X-rays and the early discoveries of radioactivity by the Curies and Becquerel. Speculating on the source of the energy unceasingly radiated, he found it in the translational motion of the molecules and of the atoms within the molecules. He was thus led to the considerable under-estimate that the air in a room of moderate size "contains energy enough to propel a one-horse engine for more than twelve hours", and continues, "The store drawn upon naturally by uranium and other heavy atoms only awaits the touch of the magic wand of Science to enable the Twentieth Century to cast into the shade the marvels of the Nineteenth." How much more true that is than Sir William Crookes imagined.

His final section on psychical research and experimental psychology was restrained but confident. He was conscious of the criticism which he was inviting but did not shrink from giving witness to his conviction that the phenomenon of telepathy, for example, was a real one and that the subject should be studied by scientists.

May I now interpolate that we should all agree with this. Telepathy, and even pre-cognition, are claimed to have been established, and surely it is extremely important to know whether the evidence

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Presidential address delivered at Bristol on August 31 and appearing he September issue of the *Advancement of Science*.

is really good enough to justify these claims. In the first place, we need to discuss how to set to work, and only when that is quite clear to put a plan into operation. It is the first stage which is likely to be the more difficult. Perhaps it should be added that no final verdict can be anticipated. As Dr. Warren Weaver has so aptly remarked, there is no such thing as the voice of science.

The last Bristol meeting was in 1930, with Prof. F. O. Bower as president. He spoke on "Size and Form in Plants" and remarked that this ninety-ninth year of the life of the Association marked the close of the Darwinian epoch. That was intended only in relation to personal links and did not imply that Darwin's influence on science had in any way lessened. Bower naturally referred to Sir William Crookes's remarkable address of 1898 and was able to point not only to the actual production of artificial fertilizers but also to the development of new strains of wheat which enabled areas of lower rainfall to be utilized, and also shortened the period between sowing and reaping.

So far, in asking for your attention to the reverberations of the thunder of the past, I have been on solid ground; but now the situation changes as I turn to my own choice of a topic. I recall the case of the Texas politician who was said, naturally by an opponent, to have "both feet firmly planted in the air". However, even if this is thought to apply, I hope to come to earth occasionally.

One of the troubles of the modern life of scientists is that we are all too busy, and that only a small fraction of our available time and energy can be spent in practising our real vocation. Please forgive a personal reference—it is not really very boastful. I am conscious of a certain talent for tapping a test-tube; but it is a long time since I was able to indulge this bent to much purpose. Lately I have had to be content to encourage others to perform this simple operation with, it should be added, due consideration of what is placed in the test-tube, and observation of what happens.

When the secretary of the British Association, as agent of the Council, asked me for the title of this address, I was more than usually preoccupied and selected "Science and the Scientist", because I thought it clay that could be modelled into almost any desired shape.

However, there was at the back of my mind the feeling that the functions of the two are not always clearly understood and distinguished, so that there is more than a little confusion of thought in some quarters, especially in the use of the word 'science'. The subject is not at all controversial; but I will ask for your indulgence to state once more the generally accepted definition, clearly implied in common consent if not the subject of any recent manifesto.

## The Broad Definition of the Term Science

Science is simply the record, enshrined in the literature, of the system of knowledge and of the conceptions correlating parts of that system.

It is fundamental that such knowledge cannot be based on dogma or authority of any kind, nor on any intuition or revelation, unless indeed it be of the Book of Nature that lies open before our eyes. We need not dwell on the processes of acquiring knowledge by observation, experiment, and inductive and deductive reasoning. The study of scientific method both in theory and practice is of great importance; but this topic requires separate treatment. Furth
it is inherent in the philosophy that the record m
be imperfect and the conceptions erroneous;
potential fallibility of our science is not only ackno
ledged but also insisted upon.

## Approximation to Truth

Still there are degrees of uncertainty, and even
apparent revolution in physics that has occurred
the twentieth century has not so much supersec
the older teaching as supplemented and extended
by wider generalization.

The improvement of knowledge by success
approximations is fundamental, and it is worth wh
to consider some illustrations.

A very simple example of the improvement o
nearly true statement of a relation is that of
Boyle–Charles law. This stated that the volume o
gas is directly proportional to the temperature a
inversely proportional to the pressure. It can
expressed as $pv = RT$. This works very well
most practical purposes; but it is not quite corre
especially at higher pressures. In 1873 van
Waals pointed out that the volume ($v$) taken sho
be lessened by a quantity ($b$) related (but not eq
to) the volume of the molecules themselves, that
$v - b$ for $v$. The pressure ($p$) should be increased
a quantity $a/v^2$ which denotes the cohesion of
molecules.

With the expression,

$$\left(p + \frac{a}{v^2}\right)(v - b) = RT,$$

a much better agreement with the experimental da
was obtained; but it was still not absolutely accur
and more or less successful modifications have be
suggested.

The 'ideal' gas which obeys the Boyle–Charles l
may perhaps be compared to the 'ideal' railway th
conforms to "Bradshaw". The divergence from
ideal in the performance of a railway becomes grea
when the traffic is congested, and this factor is
unlike the $b$ of van der Waals. But railways
much worse than gases, chiefly due to the appeara
of the human factor, which is quite incalculable.

## An Example to Illustrate Limits of Knowled

Where the material can be directly apprehen
by our senses, aided perhaps by devices such
cameras, microscopes and telescopes, there can
little doubt as to the validity of the record; thou
it may need some adjustment of errors of observat
and of the value of any magnitude that is involv
The uncertainties are then largely concentrated
the conceptions and generalizations which have b
based on the ascertained facts. May I be excuse
I refer to the subject I know best in illustrati
The molecular structures of the chemist are
directly perceptible, but must be deduced fr
observations on collections of very large number
molecules; and yet a most remarkable system
been evolved which even forms the conventio
basis of patents and is recognized as valid in co
of law. The degree of uncertainty is indeed not m
increased by the fact that we cannot see th
structures.

Leaving aside philosophical dubieties about real
we can say that the limits of our knowledge in
field are somewhat as follows. That the atoms e

entities, but the problem of the nature and con- ution of the atoms themselves has not been fully ved; rapid progress is being made. We know the angement of the atoms in the vast majority of the cies of molecules which we find in Nature, and we e learned how to construct molecules, even those a highly complex pattern. The defences of some he last strongholds are in process of being breached. brilliant example of modern work of this kind is ng described by the president of Section B (Chem- y), Sir Alexander Todd. It concerns the structure l synthesis of the nucleosides, those vastly im- tant constituents of the nuclei of living cells. en the proteins are being forced to reveal their rets, and though none of them has yet been thesized, we have a foretaste of what is in store the artificial preparation of the oxytocic factor of pituitary by Prof. V. du Vigneaud. And when speak as chemists of nucleosides, proteins, or the tocic factor, we are all the time thinking not so ch of the specimen in the glass tube but of the y the atoms are joined together in each of the ions upon billions of molecules in the tiniest ible fragment of the material. May I be pardoned the *cognoscenti*, I cannot forbear from repeating results of a calculation made by Dr. Harlow pley, the eminent American astronomer, which strates very clearly the huge number of the lecules in any small parcel of matter. In any ume of air four-fifths of the particles are molecules nitrogen, each consisting of two atoms. If, for mple, a deep breath is exhaled, the nitrogen lecules in it are rapidly dispersed and, after a tain period, probably not more than a few years, haps less, they will be equally distributed through- the atmosphere. The mass of the atmosphere is wn approximately, and when even distribution been achieved, each unit volume of air at the face of the earth will contain between two and ee of the nitrogen molecules that were present in original volume distributed. Now to make it re dramatic we select some particular exhalation, ferably a long time back so as to make sure of necessary even diffusion. Thus we could say t when Shakespeare was writing the first line of second act of *Hamlet*, he exhaled a breath; and you care to inhale a breath now, it will contain of the actual molecules exhaled by Shakespeare that particular time. You would be very unlucky ou only got one and, if you were to capture three, would belong to a fortunate minority.

he calculation leads to other interesting results. you exhale a breath now, then, after the lapse of necessary time, every breath inhaled by every ng person on all occasions will contain two of the rogen molecules in that breath of yours.

t must be obvious that many of the molecules be used more than once, and the calculation es no account of the small losses from the atmo- ere due to escape, or the activities of Sir Alexander ck, among other nitrifying organisms.

he question which is often asked, and ought to asked, is: How can you possibly know anything ut the architecture of such exceedingly minute ticles? The answer cannot be given in a few tences but an analogy may help you to appreciate possibility—again with apologies to those *cogno- ti*. A pure chemical substance is a collection of tical molecules. Let us compare a perceptible unt of it to a crate of identical clocks; each k then represents a molecule. We reduce the clocks to a heap of metal filings, take a certain weight of these and apply a strong magnet. This takes out the iron, which we weigh, and thus we get the percentage of iron in the whole of the clocks, which is also the percentage of iron in one clock. But it may be objected, you have started with the hypothesis that the molecules in a parcel of a pure substance are identical. How can you be sure of that? A short answer cannot be given; it depends on the recognition that certain properties, for example, many optical properties, are due to the summed effects of individual molecules, and on the elaboration of techniques for segregating molecules of the same kind; for example, by crystallization, distillation, diffusion, or by adsorption on surfaces.

## Predictions and Conveyances

Justification of scientific theory has been obtained by the success of predictions and by the unanticipated convergence of more than one line of approach. This is a commonplace of every part of science, and the examples to be mentioned could be almost indefinitely extended. In all the cases the degree of coincidence becomes so great as to carry conviction that we have been vouchsafed, if not the whole truth, at least something very closely related to it.

Even the routine predictions of astronomers are a perpetual source of wonder; but the circumstances of the discovery of Neptune were sensational. In 1843–44, J. C. Adams, of Cambridge, found that the perturbations of the orbit of Uranus could be fully explained by the existence of an outer planet and he accurately identified the position in which it should be found.

Quite independently, Le Verrier, of Paris, came to exactly the same conclusions and was more fortunate than Adams in securing the quick co-operation of practical astronomers, with the result that Neptune was discovered in the predicted place in the heavens. It proved to be of the size expected and later was found to follow the expected orbit.

Again, near the beginning of the second decade of the century, Albert Einstein stated that his relativity theory required that the rays of light should be bent under the influence of a gravitational field. He was able to calculate the magnitude of the expected effect. Confirmation came from observations made on the occasions of the two next following total eclipses of the sun. This success was naturally particularly welcome in view of the novelty of the theoretical background, and it doubtless accelerated the development of the new physics based on the work of Planck, Einstein and other pioneers.

The death of Einstein has evoked universal tributes of homage to the man and the philosopher. He was undoubtedly one of the greatest of men of science.

A third example of prediction is the successful release of nuclear energy, especially in the so-called hydrogen bomb. We must not allow the horror of the possible misuse of the weapon to blind us to the spectacular triumph of the achievement. It showed very plainly that nuclear physicists had been thinking on the right theoretical lines. Let us hope that they will continue to do so—100 per cent and not 99·9 per cent. These matters are shrouded in secrecy; but Press reports have suggested that just as the hydrogen bomb is initiated by a Mark-I atomic explosion, so the hydrogen bomb in its turn can initiate a vastly greater uranium explosion. In biological processes energy is taken up in steps by suitable relays to high levels, and an ordinary scientist cannot help wondering whether every possibility of setting fire to the lighter elements has quite certainly been excluded, if nuclear relay is taken to further stages.

Do we really know enough about nuclear reactions to be sure there is no loophole ? Has every conceivable case been considered ?

The physicists appear to be cocksure that this is so ; they claim the 100 per cent. But just as it is necessary that 'justice shall be seen to have been done', I submit that it is desirable that the inner circle of advisers to Governments should not only be right but also be 'seen to be right'. This can only be secured by a relaxation of secrecy on the scientific aspects of nuclear energy developments, and by some form of international consultation before novel and greatly increased releases of energy are attempted.

The second class of welcome confirmations was the illumination of a topic from two or more distinct sources.

This is now a commonplace of many sciences, for example, again, of organic chemistry. Analytical researches lead to the determination of a molecular structure which may be confirmed, possibly after the lapse of years and in a different laboratory, by synthesis of the substance the molecules of which should possess that structure. If the synthetic product proves to be identical with that isolated from natural sources, the whole system of reasoning both on the analytical and synthetic sides receives important support. Even more striking has been the validation of the conclusions of chemists by X-ray crystallography. At first this led to the confirmation of established structures, often with some additional information about the arrangement of the atoms in space. Later the X-ray studies were accessory to the first analytical studies. Thus in the case of penicillin, Mrs. Hodgkin and her collaborators were able to fasten upon one of the two alternative structures which the purely chemical researches indicated. Now the chemical and physical methods go hand in hand, with the crystal analysis tending to take a more important role than in the past, and destined to do so more and more in the future.

Another example may be mentioned. The chemical formula for a metal phthalocyanine had the shape of a four-leaved clover and the metal atom was placed at the centre. J. M. Robertson's electron-distribution diagram from X-ray evidence had the same discoid shape and the metal atom was where expected. Only a few years ago a special electron microscope cast the clover-leaf shadow of a single molecule of copper phthalocyanine on a fluorescent screen. The necessary apparatus is not particularly complicated and can be purchased.

This was by no means the first time that a single molecule had become apparent to our senses. Owing to the great energy of certain particles carrying an electrical charge, and the invention of devices for amplifying very small currents, we have long been familiar with a variety of methods for observation of the effects of single particles : Crookes's spinthariscope, the Geiger counter, the Wilson cloud chamber and—bringing coals to Newcastle—the techniques developed in such an admirable manner by Prof. C. F. Powell and his school in Bristol, for the study of single events at the atomic level—the study of the impact of cosmic rays on the sensitive emulsions of the photographic plate.

In other subjects there are very many examples of the confluence of streams springing from two sources.
Examples are the dating of ancient objects by mea
of radioactive isotopes and the light shed on t
movements of races by the hybridization of plan

The latter reference is to a hybrid cotton pl
found in Peru. There the Porto Rican cotton pl
married the Indian, and the circumstances are c
sistent with the view that Indian voyagers reach
South America in very early days.

## Scope of Science

All branches of knowledge are included in t
definition of science ; always provided that t
record has been made without appeal to authori
There is no philosophical line of demarcation th
separates one branch of learning from another, thou
the demeanour of many so-called humanists sugge
that they perceive one.

A historian, formerly a colleague of mine, o
declared that the absorbing interest of his subj
was due to the badness of the evidence ; but I th
that was only another way of saying that he liked
get his teeth into a difficult problem.

It is not necessary or desirable to pursue t
unprofitable discussion ; our brother scientists on t
Arts side will doubtless work out their own salvati
But it is opportune to add another voice of prot
against the often repeated assertion, that 'culture'
the preserve of students of some particular branch
of knowledge, and is denied to others. What is mea
by 'culture' ? If it is the ability to think clearly a
to express thoughts in language, what evidence
there that physical and biological scientists la
these qualities ?

The acerbity that characterizes much of the an
scientific propaganda strongly suggests that its ba
is defensive rather than offensive.

In the meantime, these persistent attacks do
great deal of harm by suggesting to young peo
that they will become automatons if they dev
themselves to physical science and that in such a l
they will not experience the warmth of hum
feeling.

## The Joy of Discovery

What a travesty of the facts this is ! The scienti
discipline is indeed a hard one ; but it is most rewardi
and full of living drama. Perhaps I may just ha
time to show one picture from the past. It concer
a beginner in research, but that young man was Lo
Pasteur. It will be best to quote his own words fr
"Lectures on the Molecular Asymmetry of Natu
Organic Products" (1860), reprinted by the Aleml
Club of Edinburgh :

"When I began to devote myself to special wo
I sought to strengthen myself in the knowledge
crystals, foreseeing the help that I should draw fr
this in my chemical researches. It seemed to me
be the simplest course, to take, as a guide, so
rather extensive work on crystalline forms ;
repeat all the measurements, and to compare
determinations with those of the author. In 18
M. de la Provostaye, whose accuracy is well kno
had published a beautiful piece of work on t
crystalline forms of tartaric and paratartaric ac
and of their salts. I made a study of this memo
I crystallized tartaric acid and its salts, and inve
gated the forms of the crystals. But, as the wo
proceeded, I noticed that a very interesting fact h
escaped the learned physicist. All the tartrates whi

xamined gave undoubted evidence of hemihedral es.

'Now if we compare the disposition of the hemi- dral faces on all the prisms of the primitive forms the tartrates, when they are orientated in the same nner, this disposition is found to be the same."

Herschel had already connected the hemihedry of artz with the right or left rotatory power of the stals, and Pasteur saw that the hemihedry of the trates could be an outward and visible sign of the ymmetry of the molecules. Hence he was extremely erested in a note of Mitscherlich of 1844 stating at sodium ammonium tartrate and sodium ammon- n paratartrate had identical crystal form and yet ly the former was optically active in solution. He ought Mitscherlich must have failed to notice that e paratartrate was not hemihedral.

"I hastened therefore to re-investigate the crystal- e form of Mitscherlich's two salts. I found, as a atter of fact, that the tartrate was hemihedral, like the other tartrates which I had previously studied, t, strange to say, the paratartrate was hemihedral o. Only, the hemihedral faces which in the tartrate re all turned the same way were, in the paratrate inclined sometimes to the right and somenes to the left. In spite of the unexpected character this result, I continued to follow up my idea. I refully separated the crystals which were hemi- dral to the right from those hemihedral to the left, d examined their solutions separately in the polarng apparatus. I then saw with no less surprise an pleasure that the crystals hemihedral to the ht deviated the plane of polarization to the right, d that those hemihedral to the left deviated it to e left; and when I took an equal weight of each the two kinds of crystals, the mixed solution was different towards the light in consequence of the utralization of the two equal and opposite indi- dual derivations.

"The announcement of the above facts naturally aced me in communication with Biot, who was not thout doubts regarding their accuracy. Being arged with giving an account of them to the ademy, he made me come to him and repeat before s eyes the decisive experiment. He handed over to e some paratartaric acid which he had himself eviously studied with particular care, and which had found to be perfectly indifferent to polarized ht. I prepared the double salt in his presence, with da and ammonia which he had likewise desired to ovide. The liquid was set aside for slow evaporation one of his rooms. When it had furnished about 39 40 grams of crystals, he asked me to call at the llège de France in order to collect them and isolate fore him, by recognition of their crystallographic aracter, the right and the left crystals, requesting e to state once more whether I really affirmed that e crystals which I should place at his right would viate to the right, and the others to the left. This ne, he told me that he would undertake the rest. e prepared the solutions with carefully measured antities, and when ready to examine them in the larizing apparatus, he once more invited me to me into his room. He first placed in the apparatus e more interesting solution, that which ought to viate to the left. Without even making a measureent, he saw by the appearance of the tints of the o images, ordinary and extraordinary, in the alyser, that there was a strong deviation to the left. Then, very visibly affected, the illustrious old man took me by the arm and said :—

"'My dear child, I have loved science so much throughout my life that this makes my heart throb.'

"You will pardon me, gentlemen, these personal recollections which have never been effaced from my mind. In our day, and with our habits, they would offend in a scientific memoir, but they have seemed to me not out of place in an oral account; and perhaps the biological interest of such recollections will constitute one of the advantages of the kind of instruction which the Société Chimique inaugurates to-day.

"Indeed there is more here than personal reminiscences. In Biot's case the emotion of the scientific man was mingled with the personal pleasure of seeing his conjectures realised. For more than thirty years Biot had striven in vain to induce chemists to share his conviction that the study of rotatory polarization offered one of the surest means of gaining a knowledge of the molecular constitution of substances."

Thus was the science of stereochemistry born. The main point of Pasteur's work was that he recognized that the optical rotatory power of the tartrates in *solution* showed that the molecules themselves must be asymmetric. The hemihedry of quartz was recognized as due to the asymmetrical arrangement of symmetrical molecules in the crystal, like a right- or a left-handed screw. But the hemihedry of the tartrates, though due in the crystal to the same cause, persisted in the free molecules, which were therefore characterized by asymmetry in a certain sense, all right-handed or all left-handed. A mechanical analogy is very useful here. If a pipe is almost filled with one screw and water is forced along it, the issuing stream will rotate, clockwise or anticlockwise, according to the nature of the screw. The same thing happens if we pack the tube with small right-handed screws, or left-handed screws, arranged at random. With an equal number of both kinds there would be no rotation of the issuing water. The single large screw corresponds to the quartz crystal, and the higgledy-piggledy small screws correspond to the freely moving asymmetrical molecules of the tartrate in solution.

The philosophy of asymmetry is very intriguing. Only an asymmetric, I should perhaps say dissymmetric, agent can distinguish the right-hand from the left-hand varieties, and of course it was Pasteur himself who sorted out the hemihedral crystals oriented in the two mirror-image forms.

Recently, by a most ingenious application of crystal analysis, Prof. J. M. Bijvoet has been able to determine the configuration of naturally occurring tartaric acid, which is related to that of many other substances in what we call the L-glucose family. The convention used by stereochemists turned out to be correct, which is quite convenient. The chances for this outcome were naturally no better than even.

Admittedly this example of 'atmosphere' relates to a very exceptional occasion and Pasteur was a very remarkable man, one of the greatest scientists of all time.

But all of us who have been privileged to take part in scientific life and research have had similar exciting and may I add, emotional, experiences in our smaller ways.

The explanation of molecular asymmetry in terms of structure was given in 1875 by Le Bel and independently by van 't Hoff. The latter was said by Kolbe "to have no taste for exact science. Mounted on his Pegasus, evidently borrowed from the veterinary stables (van 't Hoff taught chemistry at the College of Veterinary Science at Utrecht) he thinks he can see the arrangement of the atoms in space". Nowadays the organic chemist has not completed a synthetic task until the various parts of the molecule have the desired type of asymmetry. Often a succession of screws has to be laid down in the correct order. Thus there are eight places in the cholesterol molecule which can be the source of asymmetric arrangement and that implies 256 possibilities of difference due only to the right- or left-handedness of the parts. Yet the one particular configuration of the cholesterol molecule has been constructed in the laboratory.

The task was equivalent to finding the right road at each of eight successive bifurcations.

Before straying too far from actual science I would like to say something about the use of speculation, which should always arise from some correlation which was hitherto unknown or unnoticed, or the significance of which has been under-estimated, or thought to have been under-estimated.

In the early stages it may be discouraging to study the literature; one can always find reasons there for believing that a new idea is not worth pursuing, or for that matter for saving oneself the trouble of doing an experiment. Later, having worked up an internal, self-generated pressure of enthusiasm, it is obligatory to face the hard facts already on record. Then, instead of weakly accepting a rebuff we shall at least put up some fight with 'but on the other hand it might be that——'.

At this point it may be realized that something really has been overlooked by one's predecessors, and new crucial experiments must be devised to resolve one dubiety after another. Herein lies the safeguard, the final court of appeal is Nature herself.

The scope of the British Association's interest is not clearly defined in our original "Objects" which I will read, because the early practice of printing them each year has long been abandoned.

"The Association contemplates no interference with the ground occupied by other institutions. Its objects are:—To give a stronger impulse and more systematic direction to scientific inquiry,—to promote the intercourse of those who cultivate Science in different parts of the British Empire, with one another and with foreign philosophers,—to obtain a more general attention to the objects of Science, and a removal of any disadvantages of a public kind which impede its progress."

Our sections now include the chief physical and biological sciences, economics, anthropology and archæology, psychology, and education, as well as engineering, forestry and agriculture. There is also an active Division for the Social and International Relations of Science. All this evinces a real catholicity of interest; omissions are based on practical, rather than on theoretical considerations. For example, clinical medicine and surgery are well served by a number of other organizations.

## The Universality of Science

An important aspect of science is its universality and its fully international character only rendered possible by the axiomatic freedom it enjoys from authority and dogma. True there have been regrettable incidents such as that of the Michurinian genetics, but the body scientific has acquired considerable immunity against such fevers, which are now all b forgotten.

There is no such thing as British, or German, Russian, or Jewish science, though it is true that th genius of many peoples has enabled them to mak characteristic contributions. The French have special lucidity of mind and expression, as well elegance of technique, the Americans excel in orga ization of research, the Germans in thoroughness, th Japanese in attention to detail, while the Jews ha imagination and theoretical insight. There is muc overlapping of course; we may find a Memlin among the Florentines.

It has occurred to me to wonder wherein lies th particular merit of the British. The pioneering spi of our illustrious forefathers is everywhere acclaimed and there is even now little sign of any decline in o initiative. Can it be at least partly the result of n working so hard that no time is left for reflexion We certainly defend our leisure from encroachmen with special tenacity. Again, it may be that we a in a certain sense undisciplined; but I will n elaborate that suggestion.

Science as a common international possession and th world-wide co-operation in its development must b bulwarks of peace. Here we have a realizable asset the greatest possible positive value. The brotherhoo of scientists is a reality. It is fortunately not unique there is a similar fraternity among sportsmen, musicians, chess-players, and other categories of enthusiast not encumbered by the so-called ideologies.

It should be clear from the definition that religion in so far as it is authoritarian and dogmatic, ca make no contribution to science. But it is no parado to say that there is room for both science and religio within the mind of a man. Indeed we have ampl proof that this is so from everyday experience. Man of the greatest of scientists have been deeply religiou men and eminent divines have been excellen scientists. Testimony to the help afforded to th Royal Society and to the British Association b churchmen may be found in the records and is stil apparent on inspection.

At the Bristol meeting of 1836 the presidents o Sections A, B, C and D were all clergymen.

On the other hand, many scientists have been, an are, free-thinkers. Yet, the two groups should b united in the unflinching pursuit of the truth and i a spirit of tolerance.

Titles such as "Science and Religion" tend t confuse the simple issue which relates to "Scientists" and not to "Science". Again, the uncertainties o modern physics are now considered by some to justif mystical analogies.

## Models and Pictures replaced by Equations

It would appear that there are many who feel a irresistible urge to fill up all gaps in knowledge b their own inventions. Such intuitive speculation ca indicate useful working hypotheses, but it is no science *per se*.

Actually physics is a much more complete an satisfactory system now than it was in the later nineteenth century. It is true that we are perplexed b many new problems; but at least we are aware tha they exist. That is an improvement on complacenc founded on ignorance. The human mind can b shown to be inadequate in several ways. Speakin subject to correction by philosophers, it would seem that certain alternatives that are logically mutuall clusive are equally inconceivable by us. The con- ptions of a continuum or a discontinuum, of creation indefinite projection of reality into the past, cannot grasped by the human mind. Yet the fact that find something to be incredible is no proof that does not exist. Hence physicists are content to rive expressions for the description of phenomena th the minimum of extraneous hypothesis.

Fifty years ago an ether was an article of faith ; ere could be no action at a distance without an tervening link, electromagnetic waves must occur something, and so on. But each invented ether as about as incredible as the absence of one. Nearly ty years ago I remember being fascinated by borne Reynolds's "Inversion of Ideas as to the ructure of the Universe". This postulated a very nse ether consisting of minute grains. Matter was negative inequality in this ether, that is, an absence grains, a kind of hole. It could be shown that the verse-square law would govern the attraction of ch holes. Mathematical physicists have evidently und it hard or impossible to use this theory, but I ell remember thinking more or less as follows : es, but what are the grains made of ? They have en invested with some of the properties of matter nd they are a kind of engineer's dream of perfect altonian atoms on a very small scale. The argument quite inconclusive ; but I found then, and have ways found since, that the idea of a continuum, en inside a grain of the ether was, and is, repugnant. nowadays we just arrange to do without this mfortable resource of an ether, though I have been ld that Prof. P. A. M. Dirac may revive the idea some form or another—which few of us will nderstand.

### Scientists' Duty to the State

Another feature of the complex make-up of the ientist is that he is a citizen and owes a duty to the ate. This leads to obvious conclusions in most spects. But where do we stand in regard to the vention of military weapons ?

In war-time few of us entertained any doubts out this ; it was our clear duty to help our country the best of our ability. Now it is a matter for the nscience of the individual, taking into consideration at we have not yet achieved a real peace.

The position is one of unstable equilibrium, and it still seems that as citizens we should do all in our power to strengthen the hands of our leaders, in whom we have placed our trust, and who we believe are sincere in their desire to achieve universal peace among the nations. Even the terrible nuclear-energy weapons must be developed by our scientists in peace-time so as to build up the necessary potential of deterrence, our only defence against extinction.

### Scientific, Technical and Technological Man-Power

I have mentioned only two or three of the personal problems of scientists ; but there are, as is very well known, many national questions affecting scientists, and on these I can say very little in this address. The chief is perhaps the training of scientists, which starts in the schools and involves the supply of science teachers. This matter has been raised in the General Committee of the British Association here in Bristol. We hope to make some small contribution to a solution of difficulties that are the cause of considerable justified anxiety among industrialists.

Finally, I want to say a word about technology and technologists. Dr. E. J. Holmyard and Prof. Charles Singer have, in the first volume of their monumental work on the "History of Technology", pointed out that it all started with handicraft. The modern technologist is still a man with 'know-how' and 'can-do', whether he be technician, craftsman, designer or supervisor, and he is equipped with knowledge of general and special scientific and engineering subjects.

It is generally agreed that we have far too few technologists in Britain, and that our economic survival is improbable unless we take some drastic steps to remedy the situation. The proposals that have been made are admirable so far as they go ; but, in the opinion of many who are well qualified to judge, they do not go nearly far enough.

It is doubtful whether any scheme tied to existing institutions can meet the requirements ; and to come right down to ground-level, I suggest that we need a 'Technology Grants Committee', independent of any other body and with power to expend a very considerable sum of money. This idea has probably already been adumbrated. In which case I think it should be supported.

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# SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

## VACANT LATTICE SITES IN CRYSTALLINE SOLIDS

THE physics of the solid state is a wide field which ranges from abstract subjects rather mote from practical applications, such as super- nductivity, to problems of immediate technical portance such as the development of crystal valves nd the behaviour of the materials of a reactor under eavy bombardment by neutrons. In his presidential ldress to Section A (Mathematics and Physics), rof. N. F. Mott concentrates on one theme—the istence and behaviour of vacant lattice sites in ystalline solids—and shows its importance for a ide range of phenomena. A vacant lattice site is a oint in a crystal lattice from which the atom or olecule, which ought to be present in the crystal ructure concerned, is in fact absent. Vacant lattice sites occur in a crystal in thermodynamical equilibrium, some of the atoms having moved away as a result of the influence of heat motion. They can also be formed as a result of bombardment by fast particles and also by subjecting the metal to cold work.

The first importance of the concept of a vacant lattice site is its role in explaining the phenomenon of diffusion in solids and particularly in metals. When two metals are welded together and a region intermediate between them is formed which is occupied by an alloy of the two, diffusion has taken place. This means that two adjacent atoms in a crystalline solid are able to change places if the temperature is high enough. It is now believed that atoms change places only with the help of a vacant lattice site ; a simultaneous movement of two atoms would involve a very high energy and is improbable, but the loosening of a crystalline lattice near a vacant lattice site greatly lowers the energy necessary.

We are interested, therefore, in measurements of the number of vacant lattice sites in a solid and the rapidity with which they change places. One method of obtaining this information is by the use of radioactive tracers which enables the coefficient of self-diffusion to be determined. Another method which has come to the fore recently is by the use of the 'nuclear spin'—the magnetic moment carried by the nucleus of the atom concerned. When the substance is placed in a magnetic field, the existence of quantized stationary states associated with the nuclear spin in the field enables substances to absorb electromagnetic radiation of radio frequencies. The width of the absorption line depends on the extent to which each nucleus interacts with its neighbours and will vary from one nucleus to another according to the orientation of the magnetic moments of the adjacent nuclei. If, however, the atoms are changing places rapidly, this interaction between nuclei will be averaged out, and the breadth of the absorption line will be greatly decreased. In this way, it is possible to estimate the jump frequency.

Two methods, therefore, both borrowed from nuclear physics, are available for measuring the frequency with which atoms change places. The evidence that they change places with the help of vacancies comes from many sources, of which perhaps the most important is the fact that diffusion in solids is greatly accelerated after they have been bombarded by fast charged particles. It is thought that the vacancies produced by this bombardment remain in existence for a considerable time and, as they move about throughout the crystal, enable atoms to change places much more rapidly and at lower temperatures than would be possible without their presence. It is estimated that one fast neutron will displace as many as six thousand aluminium atoms before it is brought to rest, and one diffusion fragment in uranium as many as twenty-five thousand uranium atoms, so the effect need not be small. As a result of these displacements, the phenomenon known as radiation damage occurs in solids exposed to the radiations in a reactor. Mechanical strength, density and electrical resistance can all be affected. The subject of radiation damage is under active investigation at the present time, and there is still much which we do not understand about it.

Finally, it seems very likely that vacancies play a part in the phenomenon of metallic fatigue. As already mentioned, deformation or cold work is known to produce vacancies in a solid, with effects on its properties in many ways similar to those which result from nuclear bombardment. In fatigue one knows that localized regions of the solid, which show up as visible slip bands, are deformed plastically backwards and forwards many millions of times. Both experiment and modern theoretical concepts lead one to believe that in these regions very large numbers of displaced atoms are formed, so that after a time the crystalline structure of the molecule will be broken down as it would under intense bombardment. A detailed theoretical explanation of fatigue in terms of atomic movements has not yet been formulated; but one very possible view is that this break-up of the crystalline structure and consequent recrystallization would lead to intense local strains, and that it is these strains, perhaps accompanied by the effect of oxygen or other gases, which initiate a fatigue crack.

# NUCLEIC ACID STRUCTURE AND FUNCTION

SIR ALEXANDER TODD points out in h address to Section B. (Chemistry) that, althoug the nucleic acids rank with the proteins and carb hydrates as one of the three major groups of macr molecular substances of vital importance in livi matter, yet until recently they were the subject very little detailed chemical investigation. This ma have been due, in part, to the lack of suitable exper mental techniques for dealing with them, but it w also due to a surprising lack of chemical study of th simple nucleosides and nucleotides from which the are built up and which can be obtained from the by hydrolysis. All this is now changed, and we hav seen in recent years a veritable revolution which h led to a satisfactory formulation of the nucleic aci and a much clearer understanding of their chemic behaviour. This in turn has opened the way to fre advances in biochemical and biological studies whi have brought us closer to an understanding of the function.

Two types of nucleic acid occur in Nature—th ribonucleic acids and the deoxyribonucleic acid Graded hydrolysis of them yields first the nucleotide which are phosphates of the nucleosides, the latt being N-glycosides of certain purine and pyrimidi derivatives. The essential difference between th two types is that the sugar involved in the rib nucleosides is D-ribose, and in the deoxyribonucle sides, 2-deoxy-D-ribose. Both types of nucleic ac can be regarded as polynucleotides, the individu nucleotides being linked one to the other by phosph diester linkages. Based on detailed chemical studi which have clarified the structure and chemistry the nucleosides and nucleotides, a general theory the structure of nucleic acids as 3′ : 5′-linked pol nucleotides has been developed. All subsequent wo appears to confirm this theory, which has becom generally accepted. Synthetic work in the pol nucleotide field is still in its early stages; b dinucleotides of known structure have been sy thesized, and their properties are in accord with th general theory of nucleic acids. Further work is al needed in connexion with the determination of th sequence of nucleoside residues in individual nucle acids, since it is on this sequence that much of the biological specificity must depend.

Since the emergence of a clear structural pictu of the nucleic acids, much attention has been pa to their macromolecular conformation. In this fiel X-ray examination of deoxyribonucleic acids h been a fruitful source of information. According current views, deoxyribonucleic acids appear to exi in the form of two opposed helical polynucleoti chains wound together in a double helix and he together by specific hydrogen-bonding between th purine and pyrimidine bases occurring in ea nucleoside residue. This picture of deoxyribonucle acid existing in a double helical structure has mu in its favour and is now generally accepted in essentials. One of its most interesting features is th indication it gives of how a deoxyribonucleic ac may represent a self-duplicating system. This particularly important, since deoxyribonucleic aci are constituents of the chromosomes, and there evidence to suggest that in bacteria they are th actual genic material which determines heredita transmission. This concept of the nucleic acids replicating systems is also of great interest in co exion with viruses and bacteriophages, all of which ontain nucleoproteins. There has, too, been considerable speculation regarding the way in which ucleic acids may be involved in protein synthesis; is possible to suggest a mechanism for protein synthesis by means of nucleic acid, but no vidence is as yet available to show whether it has ny validity. Clearly, however, we are now at the pening of a new phase in the study of nucleic acid unction, and future developments are likely to have rofound repercussions in biology and medicine.

## GEOGRAPHICAL DISTRIBUTION OF PAST FLORAS

BIOGEOGRAPHY in relation to geological history was the starting-point of Darwin's evolutionary studies, and the opening sentence of the introduction to the "Origin of Species" reads: "When on board H.M.S. Beagle as naturalist I was much struck with certain facts in the distribution of the organic beings nhabiting South America, and in the geological relations of the present to the past inhabitants of that continent". Thus, in his address to Section C (Geology), Mr. W. N. Edwards shows that the biogeography of the past is still worth the attention of the student. Earth-movements and erosion, mountain building and climatic change are all reflected in the altered distribution of floras and faunas over the world, and the past distribution of animals and plants is often cited in support of the conclusions reached, or the theories put forward, by geologists and geophysicists. It is therefore well occasionally to review our knowledge of the relations between faunas and floras on one hand, and continents, seas and climates on the other.

Former land and sea areas can be roughly mapped by plotting occurrences of terrestrial and marine fossils, and geological evidence of past climates can be supplemented from the biological side. Land plants, in spite of arguments adduced to the contrary, are particularly valuable in this respect, especially if one considers ecological types of vegetation rather than individual plants. A review of fossil floras from the Devonian onwards in relation to known geological changes suggests that, although in the Devonian, and to a lesser degree in the Jurassic, world vegetation was fairly uniform, latitudinal zonation is more normal. The supposed uniformity of Jurassic floras is partly illusory, and there are in fact clear indications of zonation in that period; the early Devonian floras are not yet sufficiently well known ecologically for one to say whether they were so uniform as they appear to be. The plant evidence further indicates that since the late Palæozoic there have been vegetational and climatic zones parallel to the present equator. Deviations from exact parallelism, such as the arid belt running from eastern Asia across north Algeria, are due to the past conformation of the land masses of the northern hemisphere being similar to that of the present day. The vegetational succession in the northern hemisphere does not, therefore, lend support to notions of extensive wandering of either continents or poles, at any rate since the Carboniferous. Following the orogeny and glaciation of the upper Carboniferous and Permian, the major influences on plant distribution in the Old World have been the arid belt just mentioned and the Tethys Sea. The latter, which was in existence from the upper Palæozoic to the middle of the Tertiary, must have formed an important migration route for plants, not only along its shores but also by marine currents. Transmarine distribution of land plants would have been particularly easy in a sea which ran for some six thousand miles from east to west in an equable climatic belt of much the same character throughout. Angiosperms may possibly have arisen in the Indo-Malayan region and spread first along the Tethys Sea.

## IMMUNITY AND DEVELOPMENT

THE borderland between immunology and embryology, which forms the subject of the presidential address by Prof. F. W. Rogers Brambell to Section D (Zoology), has proved a fruitful field of research in recent years. The relationship of mother and young in mammals involves special immunological problems, for reactions resulting from immunological incompatibility can cause severe damage or death of the fœtuses, perhaps of the mother also. An adult mammal responds immunologically to the introduction into its system of tissues, cells or proteins from another species, or even from another individual of the same species. These reactions are an expression of the individuality of the adult organism.

The capacity to respond immunologically to the introduction of antigens into the system by the production of circulating antibodies appears relatively late in development. Circulating antibodies cannot be produced in detectable amounts by active immunization of new-born animals. The mammalian fœtus and the chick embryo can tolerate exchange of blood-forming cells of different blood group from a non-identical twin, and become permanent blood-group chimæras. Grafts, even of mammalian tissues, can be grown on the chorio-allantoic membrane of the chick embryo, without apparent reaction.

At a still earlier stage of development, the zygote nucleus comes into being in an environment of maternal protein. The cytoplasm of the egg must contain maternal proteins that would be antigenic in the adult offspring, yet it is in this medium that the zygote nucleus must function and initiate the synthesis of all those proteins which will characterize the new organism. Hence the fœtus and the young animal are tolerant of foreign proteins, cells and tissues to which they would react immunologically when adult. This immunological inactivity obviates the risk of the fœtus reacting to incompatible maternal antigens during pregnancy, but leaves it unable to protect itself against infection at birth. Temporary protection is afforded by the passive transference of antibodies from the mother.

These considerations lead to a discussion of the route by which passive immunity is transferred from mother to young, of hæmolytic disease of the new-born, of the selective passage of proteins through the entoderm and of experimental induction of tolerance to antigens. Most of the topics concern recent work which appears to advance both mammalian embryology and immunity. These studies have thrown new light on the functions of the fœtal membranes in mammals and on the causes of much pre-natal and neo-natal mortality. They have shown that the cells of the fœtal membranes can selectively transport globulin according to the species in which it was synthesized. This selectivity has some resemblance to other known immune responses, such as passive anaphylactic sensitization of smooth muscle; but the mechanism by which it is effected remains to be elucidated. It is exercised at a much earlier stage of development than that at which the organism can produce circulating antibodies. Likewise, in actively acquired tolerance, we have evidence of the embryonic cells being permanently modified by exposure to specific antigens at a stage long before they are capable of reacting by the production of antibodies. Why exposure of embryonic cells to antigen should inhibit the subsequent formation of the specific antibody by these cells, whereas exposure for the first time of adult cells to the same antigen induces the formation of the specific antibody, is another problem that awaits solution. The solution of these problems may be expected to give us a glimpse, at least, of the fundamental cell processes involved in the fabrication of specific proteins. All these phenomena may depend on the 'recognition' of the molecular form of proteins by the cells, a property which might prove to be of wide significance in embryonic differentiation.

Immunological methods open the way for experimental approaches to problems of vertebrate embryology that hold promise of great advances in our understanding of the development of function—of physiogenesis rather than morphogenesis.

## GEOGRAPHY AND ITS HISTORY

THE history of geography has never before been the subject of a presidential address to Section E (Geography); Mr. J. N. L. Baker's address to the Section this year deals exclusively with geography between 1500 and the beginning of the nineteenth century, and is especially appropriate to the city of Bristol, with its connexions with Robert Thorne the younger, Richard Hakluyt, and the merchants of Bristol who searched for the island of Brazil. He points out that the history of geography is a subject that can be approached only with the help of the work of many scholars, including Dr. R. Hartshorne, Mr. G. R. Crone, Dr. J. A. Williamson, Dr. O. J. R. Howarth and, above all, of Prof. Eva Taylor.

The growth of academic geography in Britain has been one of the remarkable facts of the past fifty years; but those who speak of the 'new' geography would do well to consider the present position of the subject, in H. R. Mill's words to Section E in 1901, as "the outcome of the thought and labours of an unbroken chain of workers". The nineteenth-century 'new plans' for geography of Pinkerton and Malte-Brun, like those of Busche and Busching of the century before, drew heavily upon older works. Geographers throughout the past four centuries, at least, have always been dealing with 'the old imperfectly composed' and 'the new lately reformed'. Geography is a subject that is always alive: without that life it is nothing.

In the past, geography has been regarded as an essential part of general education. John Milton, John Locke, Samuel Johnson and Edward Gibbon all showed clearly their appreciation of geography as part of the culture of an educated man, and the works of Bodin, Rousseau, Buffon, de Brosse and others in France suggest that the position was similar there in the seventeenth and eighteenth centuries. In the writings of the period it was assumed that readers would appreciate geographical references: many of Milton's lines, for example, mean little or nothing without a knowledge o geography as understood in his day.

The ability of geography to help in practica affairs is no new feature of the subject. It has alway had a practical side, both in the narrow sense throug its contributions to exploration and navigation and in a wider manner, through its close connexion with classical studies. Annotated editions of the works o classical geographers, and bulky geographical dictionaries, were common and indicate the status o the subject. If modern geographers can make similar contributions to the general culture of our age, they will, in that way alone, justify their existence.

Although for long periods there has been geography, for equally long periods there have been no geographers in the technical sense of the word. There was no accepted meaning for the term 'cosmography', which was replaced by 'geography' in the eighteenth century. Furthermore, geography was not confined to those who wrote cosmographies and geographies. The conclusion is clear that there have been many kinds of geography and many writers of geography, so that present-day geographers should be modest and circumspect in their claims. No geographer need apologize for, or be ashamed of, his subject, with its long and honourable history that offers almost unlimited scope for research. The rewards of such research will be great, because it is only when the geography of our day is seen against the background of its history that its present position can be appreciated and its future prospects assessed.

## THE ENGINEER AND MARINE TRANSPORT

IN his address to Section G (Engineering) on "The Influence of the Engineer on Sea Transport and Trade", Dr. S. F. Dorey points out that during the latter part of the eighteenth century warfare and monopolies were responsible for the British attitude of complacency towards overseas trade and commerce. The lack of competition resulted in stagnation of the design and development of merchant ships. The Americans, however, on achieving political independence, exploited the merits of cheap, fast sailing-ships and captured the bulk of the trade and traffic on the Atlantic and Pacific. Moreover, the progress they made in the design and development of the clippers gave them an almost unsurpassable lead in sail, and it was due entirely to pioneering the steamer that the British were able to offset the advantage gained by the Americans. During the 1830's, steamers commenced a trans-Atlantic service; but their use on longer sea-routes was impeded by the high coal consumption of the machinery. It was not until the 1860's, when the more economical compound engine was introduced, that impetus was given for the expansion of trade to the Pacific.

At about the same time processes for the quantity production of cheap mild steels were evolved, and construction of ships and machinery of mild steel gave rise to greatly improved performance and reliability. Economy of coal consumption improved again with the adoption of the triple-expansion steam engine and enabled steamships to open up trade with the Far East. The development of the liner demanded machinery of high power; but steam reciprocating engines proved unsuitable where more than 40,000 I.H.P. was required for a single ship. The solution this problem was provided by Charles Parsons at e end of the nineteenth century. His steam-turbine wer plants enabled machinery of 70,000 S.H.P. to installed in a liner in 1907, and the service coal nsumption was nearly one-half that of the equilent reciprocating machinery.

Following the First World War, when competition s keen to secure freights, the engineer played his rt in reducing the operating costs of merchant ips. The increased use of oil-firing, the remarkable velopment of the oil engine, and greatly improved iler and steam-engine designs may all be cited. hen trade eased, the drive for still further economy s maintained, and at the same time the power tputs of machinery were increased to meet parular needs. During recent years particular attenn has been given to the machinery of large single-ew tankers and ore-carriers which handle the w materials of the expanding oil, chemical and tallurgical industries. The new types of prime overs are also receiving consideration. The marine s-turbine is still in the development stage and has t reached the degree of long-service reliability and w fuel-consumption enjoyed by the other two main pes of prime movers.

The marine application of atomic energy offers eat attractions, particularly so far as weight and orage of fuel is concerned, but will only become asible by reducing to attractive levels the weight, e and cost of reactors and screening, and the tisfactory solution of control and maintenance oblems. Auxiliary shipboard machinery has also ayed a prominent part in establishing new trades. e introduction of refrigerating machinery, for ample, opened up the meat and farm-produce trade d brought prosperity to Australia, New Zealand d South America. The achievements of marine gineers have had considerable influence on the osperity of nations and, with the aim of improving r living standard still further, the engineer will no ubt continue to play his part, as evidenced by the gh rate of progress maintained during the post-war ars.

## ANTHROPOLOGY—A SCIENTIFIC UNITY ?

DR. D. B. HARDEN, in his address to Section H (Anthropology), comes to the conclusion that the estion whether anthropology is or is not a scientific ity is one that, after careful thought, can only be swered in the affirmative. He has, he says, never en answered in any other way by those who have ken part in developing anthropological studies thin the British Association from its earliest years, is clear by even a cursory glance at the historical owth of the subject up to the time when it attained tional status in 1884 and in the years beyond.

Up to 1846 anthropology, or ethnology as it was en usually called, only appeared sporadically in the sociation's programmes—usually in the Zoology or ology Sections. In that year Section C (Geology d Geography) formed a sub-section for ethnology, d in 1851, when geography became a separate ction (E), it carried ethnology with it. The next ange was in 1869, when anthropology became one of veral departments within Section D (Biology). The nological side of Section E was then abandoned d the Geology Section ceased to carry papers on man palæontology (as it had done from time to time hitherto). This arrangement lasted until 1884, when anthropology was promoted to full sectional status as Section H.

Since then the Section, both in its annual programmes and through its research committees, has spread its net fully and widely over the whole field of anthropology—the study of man in the past and in the present. Its programmes have embodied prehistoric and historic archæology (both British and foreign), physical and social anthropology, ethnology (both of primitive and advanced cultures), folk-lore and comparative religion. The Section's interests are, indeed, broad—as broad as, if not broader than, those of any other Section. So broad are they that it is impossible for them all to be properly represented in the programme every year ; and the more specialist-minded of anthropologists, ethnologists and archæologists are inclined to complain of this and to say that it is no longer worth their while to come to the meetings unless the Section is split into two or more parts, so that more papers in their own special subjects can be fitted in. This, Dr. Harden maintains, is a misguided view, for the British Association has always endeavoured to be a widely ranging body, and its objects would be defeated if one of its Sections became just another specialist conference.

Anthropology touches on so many other sciences and disciplines that there is no one sectional activity within the Association with which it does not have mutual contact at one time or another, as its previous alliances with geology, geography and biology make plain. Anthropology, the study of the human race, is, indeed, by its very nature a microcosm of the Association as a whole ; properly used, the Section programme could be a unifying influence within the Association. Dr. Harden maintains that this aim cannot be achieved by trying to plan programmes which will attract and satisfy diehard specialists in even some, let alone all, of the various branches of the subject, for this will interest neither the specialist nor the more broad-minded student. He proposes that advantage be taken of the existence of other Sections in the British Association to arrange programmes which will show the overlap between them and Section H, and that members of Section H should at the same time hold fast to their unity and pay no attention to any pressure from the partitionists. To accept such pressure, he concludes, and thus encourage specialization, will do disservice not only to anthropology as a unified scientific discipline but also to the Association's own interests and policies.

## THE SENSORY PATHWAY

THE pathway from receptor to brain is in all cases built up on much the same pattern and involves a series of interruptions or relay stations where the message is transferred to a new set of nerve cells. The theme of Dr. R. S. Creed's presidential address to Section I (Physiology) is the significance of these breaks in continuity on the way to the sensorium. What is the reason for their existence ? Why is there not a direct route for through traffic ? Satisfactory answers to these questions cannot be given by simply comparing the nervous system with a network of telephone lines and the relay stations in grey matter with telephone exchanges. As is known from studies of reflex action, much more may happen at synapses between nerve cells or their processes than mere shunting of excitation along certain channels. Inhibition, facilitation and after-discharge may be expected to occur in the sensory, just as they do in the reflex, pathway.

Until recently, it was necessary to rely mainly on subjective human experience in work on the physiology of the senses. Now, as a result of improved electro-physiological methods introduced by Adrian, it is possible to make objective records of events in single units at various levels in the ascending sensory pathway. Such studies not only provide a valuable check on what can otherwise be only rather indirectly inferred, but also give definite information about the anatomical site at which modification of messages occurs. There is still much scope for further advance of knowledge by both subjective and objective methods.

In skin, ear and eye, it is certain that there is considerable overlap in the area of distribution of individual afferent nerve fibres. This has sometimes been thought to raise theoretical difficulties about the neurological basis of localization of stimuli. It is argued that these difficulties are largely illusory and that overlap may actually facilitate accurate identification of the site of stimulation.

The number of receptors is commonly much greater than the number of nerve fibres ascending to the sensorium. This forms the basis for the areal facilitation or summation which is so obvious a feature of natural stimulation of skin and retina. It also, however, provides opportunity for activity in one pathway to inhibit simultaneous activity in neighbouring pathways. There is evidence that this occurs in cutaneous, visual and auditory relay stations.

More puzzling is the multiplication of pathways for which, after preliminary convergence, there is good anatomical evidence in the senses of smell, vision and hearing. Although the sensorium, as analyser, clearly cannot manufacture detail out of material which is undetailed at lower levels, speculative suggestions are made about the possible avoidance of blurring which may result from such divergence.

Finally, the pathways from the two great paired sense-organs of sight and hearing are compared and contrasted. Physiological evidence indicates that in the former there is almost no confluence of the twin pathways from the two eyes even at the highest levels. In the latter, summation occurs to such an extent that a sound heard with both ears has the same apparent loudness as one of double its physical intensity heard with a single ear.

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## THE EFFECTIVE USE OF MAN-POWER

IN his presidential address to Section J (Psychology), Mr. Alec Rodger discusses the effective use of man-power. He speaks as an occupational psychologist, as a scientist and technologist concerned with the discovery and use of knowledge about people as workers of every kind and level. The knowledge the occupational psychologist is specially interested in is knowledge about determinants of behaviour conveniently regarded as (*a*) individual and internal, but (*b*) 'left over' when the physiologist has done all the explaining he can manage. It is useful to call these, broadly, capacities and inclinations. The psychologist's task in his occupational specialization is to put our thinking about them on a soun theoretical basis and to bring it to bear, in a skilft fashion, on the problem of 'fitting the man to th job' (through improvements in methods of vocationa guidance; personnel selection; and occupationa training) and the complementary problem of 'fittin the job to the man' (through improvements i methods and organization of work; equipmen design; and working conditions of diverse kinds).

Before reviewing urgent tasks in these fields o interest, Mr. Rodger stresses the importance o recognizing their essential unity. It is unfortunate he says, that psychologists dealing with one type o problem sometimes display little appreciation o thoroughly-relevant work being done by their colleagues. For example, investigators concerned mainl with fitting the job to the man are inclined to assum that all men are equal, or nearly so, in their capacitie They are therefore apt to overlook individual differences found to be crucial by investigators concerne chiefly with fitting the man to the job. This leads t misjudgment of the importance of the nature an size of the population samples used in thei investigations, and to unwise expenditure o precious research funds on projects too narrowl conceived.

In the field of vocational guidance, where plannin for the effective use of man-power should begin, th most pressing need is for long-term studies designe to reveal, by the application of appropriate criteria the strong and weak points of currently used concept and methods. On such studies will depend th solution of many major problems, including the mos fundamental of all, that of classifying occupation for vocational guidance purposes. What is particularly required is a series of integrated studies of th differentiating capacities and inclinations of successes and relative failures in a variety of occupation This notion is equally applicable to the study o certain personnel selection problems, including som arising in the management field. In the field o occupational training, consideration of individua differences in capacity and inclination may well lea to a radical overhaul of existing arrangements i Britain, not least of the apprenticeship system, whic is archaic and wasteful.

Mr. Rodger, outlining some of the tasks awaitin the occupational psychologist in the field of method and organization of work—the field of 'work-study'— suggests that the nature and extent of the arbitrar judgments involved in time-study urgently requir investigation. Until we know more about the answer to certain questions that arise here, we shall b entitled to wonder whether a good deal of time-stud is not a piece of mumbo-jumbo developed—by agreement between management and workers—to provid an apparently rational basis for the payment o wages the amount of which has already been settle by quite other means. Touching on problems o equipment design, Mr. Rodger thinks it is time w began to take serious account of the fact that automation tends to produce a proportionately highe demand for skilled than for unskilled workers. H concludes by arguing that in the study of all th main factors to be considered in the shaping of wage differentials—skill, effort, responsibility, dirt an danger, to use Mr. Hugh Gaitskell's list—the occupational psychologist should have a contribution t make; for all these demand the investigation of problems of capacity and inclination, which are th occupational psychologist's meat and drink.

# BIOLOGICAL ORGANIZATION

THE biologist is faced with many different but interdependent levels of organization in the stems which are his concern—systems which range om the smallest living particles, like genes and ruses, to the large aggregates denoted as populations d communities, including human society. In his ldress to Section K (Botany), Prof. K. Mather oints out that genetics and cytology have shown us ow the nucleus is organized for the perpetuation d recombination of the hereditary materials. They e beginning to show us, too, how the gene is ganized as a unit of action depending for its aracteristic mediation of a complex biosynthetic rocess on the arrangement of its parts in a special atial pattern. The remainder of the cell, conentionally covered by the title of cytoplasm, is an ggregate of materials, processes and even systems, e properties, origins and maintenance of which e extremely varied. The mitochondria may ell provide a mechanical basis for at least part the cytoplasmic organizations; but balanced ction here must depend more on chemical uilibration than mechanical control as it does in e nucleus.

The nucleus provides the firm foundation on which toplasmic balance can be built; but the cytoplasm an react back on to the nucleus, as indeed we see in ngal heterokaryons, where the genic balance is djusted by cytoplasmic alterations of nuclear ivision. Nucleus and cytoplasm are thus complementary and inseparable in cellular organization, ne securing the constancy needed for control and e other the flexibility needed for adjusted action. somatic differentiation this adjustment is related etween the cells, some differences being built up nd others suppressed to give the characteristic atterns of development. Its success depends on the bility of a constant nucleus to stimulate and manage changing cytoplasm.

Each cell is at once a complex organization in self and a specialized part of the higher organization hich we term an individual. Individuals in their urn are parts of the organizations which we term opulations, within which they are tied together by unctional relations in reproduction (as in dioecy, eterostyly, etc.), protection, survival or the maintenance of genic balance. Being functional, hese bonds may tie together as collaborators n one function individuals which are complete nd therefore competing units in respect of ther functions. Individuals of different species may be tied functionally in symbiotic organizations.

All organization, at its many different levels, epends for its origin and survival on the efficient ivision of labour among the parts (which may themselves be organizations at another level) in the disharge of some function. These parts may be bound ogether temporarily or permanently by a wide ariety of means—morphological, physiological and ehaviouristic. Any organization must have the roperty of continuation or recurrence; this is secured at the genic and nuclear levels by reproduction as wholes, the daughter being already a eplica when it parts from its mother, and full ontinuity being thereby secured from the start. ome parts of the cytoplasm secure their own eproduction in the same way, but others are uilt up only in certain circumstances, so giving the characteristic versatility and capacity for change. The repeatability of pattern in this change is governed by the continuous organs of the cell, especially the nucleus. Some continuing parts of the cell may, however, have entered it initially by infection, depending for perpetuation on their own heredity, now part of that of the cell.

The cellular organization of nucleus and cytoplasm provides the basis necessary for somatic differentiation, nuclear control having developed in such a way as to replace opportunistic responses by ordered changes of the cytoplasm in large measure divorced from the immediate external environment. The organization of populations and the differentiation of individuals within them similarly depend in the general case on the nucleus, which often here has the added function of switching development into its different individual paths by genic segregation. Populations differ from somata, however, in that they may be propagated characteristically by a gradual replacement of parts, so that new members may be adjusted by the action of old ones, as is, for example, the case where some process of learning is involved. In symbiosis each component must depend on its own genetic balance for continuing adjustment, but this must be governed by relations external rather than internal to the individual nucleus. The symbionts must also be endowed with some means of securing their co-ordinated distribution in propagation. This may be secured by the activity of one partner in carrying the other with it, but other means may well also be possible. The mutual adjustments of symbionts, especially their genetical adjustments, offer an important and virtually untouched field of investigation.

No organization is immutable. Changes are continually occurring in the controlling genes. The alterations are mostly degradatory and are weeded out by selection, which may result either from the direct competition of other units of organization at the same level—for example, of cell with cell—or from the failure in competition of a higher organization because of the deficiency of its parts—for example, the failure of an individual because of maladjustment of its cells. Occasionally, however, change will lead to a more efficient organization which will then be at an advantage in selection. Genetical evidence is unanimous that all the complexity of biological organization and its control has arisen in this Darwinian fashion.

Human society differs from most biological organizations in that continuity and control have come to depend on education (in the broadest sense) rather than heredity, though the underlying genetical requirement is still there. This process of education resembles infection rather than heredity in its properties and offers new opportunities while posing new problems. The controlling laws, customs and so on are subject to change, and have undoubtedly evolved in the competition of individuals, communities and societies in the past. The character of this selection is, however, no longer like that of biological levels, and we are seeking to control it. In doing so, we must not forget that our society is but another level of organization superimposed on all the biological systems below it. To flout the principles common to them all and to shut our eyes to their interactions could lead only to disaster.

## THE EDUCATED MAN IN 1955

EACH age and civilization has its appropriate pattern of education, some emphasizing the conservative element, others the forward-looking. In his presidential address to Section L (Education), Mr. J. F. Wolfenden asks if there is, in Britain in 1955, such a pattern discernible, with its attendant type of 'educated man'.

Some hold that the prime distinguishing mark of the educated man is his understanding of human nature, on the ground that the most important fact about this planet is that human beings, each a unique blending of spatio-temporal body with eternal spirit, live on it. The corresponding educational pattern is composed of literature, history, philosophy, economics ; it is not remote or 'literary' if it is fertilized by daily contact with practical human affairs.

This picture appears to leave out non-human phenomena, the subject-matter of natural science. The study of natural science begins as a disinterested inquiry. Nobody in 1955 can ignore scientific thinking and its consequences.

Many people brought up in the 'humanist' tradition not only do not know many scientific facts which are important ; but also, more fundamentally, are incapable of certain modes of thinking derived from scientific studies and indispensable to an understanding of affairs in 1955. This does not mean that the scientist is automatically a more educated man than the non-scientist ; he may be illiterate, incapable of historical imagination or of human insight. But it does mean that there are people who are scientifically illiterate. Nor does it mean that the scientist is the man who should decide politics—local, national or international. That is a misunderstanding of the nature of his training and his skills, especially as he must often, for the purpose of his own studies, ignore human factors.

So far we have been concerned with what will always be the education of a minority. The most important revolution ever to occur in educational theory and practice is the national decision that other forms of education in Britain besides that of the 'grammar-school' type shall be recognized as secondary education. To think in terms of educating everybody is revolutionary. Is there a type of education, based on this view, which will lead to a new kind of 'educated man' ?

To be called educated a person must be able (*a*) to appreciate the achievements of the human race ; (*b*) to move with some facility in the realm of abstract ideas. These criteria cannot at present be satisfied by the 'secondary modern' type of person or of education. This assertion is not undemocratic (though it is un-egalitarian) because the essence of democracy in education is not to provide the same thing for all but to provide the right thing for each.

It may be that there will arise an un-aristocratic culture, based on a new kind of approach to human affairs ; and it may be that a new form of conceptual thinking will emerge, superseding the verbal. But it is hard to believe that this will ever be within the capacity of the majority.

## THE IMPACT OF EDUCATION ON FARMING

IN his presidential address to Section M (Agriculture), Mr. W. B. Mercer points out that agricultural education in Britain grew up during the years of depression at the close of the nineteenth century ; b little progress was made until the Development Fu Act of 1910 made appropriate monies available. T general scheme then devised divided the field in three sections : formal education, research a advisory work among practising farmers. Apart fro such advisory work as the universities and colleg could continue to carry out, the main task of inte preting research and carrying its fruits to the farme fell on the county councils—and at a later stage the National Agricultural Advisory Service.

The scheme has evolved broadly on the lines the laid down, but has been profoundly influenced commercial firms providing agricultural requisite by public corporations such as that for sugar bee and marketing boards ; even more has it bee influenced by State direction and price guarantee which have permitted pioneer farmers to adventu boldly in the development of new techniques. Tec nical progress is very closely linked with commerci prosperity. Though we have never squarely face the problem of optimum agricultural production an man-power, we have always paid at least lip servic to the idea of good husbandry and high output, an our policy in Britain to-day aims at steady expansio of production with a probably declining labour force Thanks to the manner in which advisory forces ar organized and to the many influences which can b brought to bear on any selected theme, it is no possible to mould or modify farm practice at a pac hitherto undreamed of.

Educational work started with soil science an plant nutrition ; animal nutrition came later ; only within recent years have the arts of animal and farm management, the latter with its attendant problem of finance, been subjected to scientific study. Th influence of agricultural education on the severa enterprises which make up modern farming ha therefore varied greatly. Nevertheless, in mos sections of the industry the links in the chain o research — interpretation, exploitation, absorptio into practice—can be traced fairly clearly.

The study of grass as a crop has proceeded fro the early work on hay at Rothamsted and the Cockl Park trials with grazing sheep, the results of whic at first appeared contradictory. It was many year before the real difference between a hay field and pasture with its clovers was appreciated, and severa decades before the value of the grass leaf as distinc from the whole plant was demonstrated. Once thi was grasped, the way was open to intensive gras production, to a study of interactions between cro and animal and to the evolution of an entirely new outlook on grass and entirely new systems of stock management.

In the widely different field of hygienic milk production, the role of the researcher has been technicall much simpler. Here the main problem has bee creation of an attitude of mind among producer rather than projection of a stream of new discoverie

Poultry keeping forms a curious outlier to th general current of evolution. That developed from hobby and a part insurance against unemploymen into an industry mainly by trial-and-error method exploited by practical men, and only when this stag was reached was scientific aid brought in. Commercia poultry keeping to-day is based on Mendelia breeding.

Many different lines of work converge in problem of land and stock management, and experimenta work becomes, therefore, very complex. It is a mos opeful sign of the times that so many men in farming e prepared to undertake the onerous tasks of anagement which intensive production involves.

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## THE FRAGMENTATION OF SCIENCE

N his presidential address to Section X (Assembly of Corresponding Societies), Mr. Ritchie Calder oints out that, by the excess of specialization forced pon them by the rapid advance of research and the ast literature of their subjects, scientists are using nly a part of their faculties and allowing the others o languish. They are becoming intellectual cripples. hey are so busy synthesizing Nature that they have o time to synthesize their own science.

Present-day science, by its emphasis on experiental research, has forsaken natural philosophy, nd in its hurried retreat from scholasticism is orgetting the scholarliness in which it made ommon-ground with the humanities. Over-specialzation gives the scientist the excuse for saying "We have no time for other subjects", and their olleagues in the arts the excuse for saying "How an we understand ?". The fragmentation into more nd more branches, each with its jargon, is dividing cientists from each other and from the wider public. his separation from the wider community is fraught ith danger for our civilization and for science itself. cience, which exists to remove mystery and magic, s creating its own mysteries and magic. People egard science with a kind of superstitious awe, but ount on it for the gadgets. In the absence of proper nderstanding of the methods and processes of cience and of any social integration, the apparent haphazardness of discovery encourages a popular attitude towards science which is distrustful and unhealthy.

The educational system of Britain has become lopsided. Our schools and universities, by too early and continuing segregation, give too little science to one section of citizens and too much to another. This is as much a criticism of the humanities as it is of the science faculties.

The public has an uneasy awareness that the branches of science are out of step. On such an issue of life or death as the hydrogen bomb, it is realized that the physicists have outstripped the biologists—with the sombre risks which Lord Adrian forebode. Prof. A. V. Hill had also stressed the risks of medical science outstripping the means to feed the lives that are saved.

It is suggested that the proposal put forward in the British Association report on Post-War University Education (*Advancement of Science*, 3, No. 9) be re-examined—that there should be honours and pass schools of "Philosophy, Natural and Social" and that this should be reflected in the schools as general instruction on "scientific methods and social implications of science" ; that experts—doctors, engineers, agronomists, etc.—going into the widening fields of mutual aid should temper their expertize by some training in social anthropology, and that we would do well to revive, even at this late date, Comenius' idea of *Pansophicon* (1641), to bring scientists together to assess and explore all natural knowledge and propound it and make it widely known for the adoption by men for their benefit. Then, perhaps, we could get that synthesis of scientific knowledge by which science and humanity could progress together and science become wisdom.

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## NEWS and VIEWS

(*Continued from p. 432*).

plants, as would be expected because of their inherent metabolic differences and the variations in their physiological states induced by experimental conditions. Sucrose became radioactive in very different amounts in two major groups of plants, namely, those containing only photosynthetic tissue, and those containing non-photosynthetic tissue as well. The amount of radioactive sucrose in the former group was much lower than that in the latter. An unidentified compound became radioactive in appreciable amounts in two of the blue-green algæ, but was radioactive in very small amounts, or not visible at all, on the chromatograms of all other plants.

### Changes In Lunar Topography

In a second paper on changes observed on the surface of the moon, Dr. H. P. Wilkins deals with "Bubbles and Streaks" (*J. Brit. Interplanetary Soc.*, 14, 3; May–June 1955). In collaboration with Patrick Moore, Wilkinson has recently investigated a number of rounded hills or 'domes' and has listed about a hundred, most of which have diameters of two to three miles and heights of a few hundred feet. A very remarkable thing about these domes is that they generally have a deep pit at the top, the pits being seated centrally, never at the side; it is extremely improbable that they could have been caused by meteorites, which would strike the sides also, but there are no signs of this. As very few of these domes were found until recently, the conclusion is that the older observers were not as careful in their work as is generally supposed, or, alternatively, they have been recently formed. If the latter hypothesis is adopted, the most likely explanation is that some volcanic activity still remains on the moon, the slow welling out of the magma forming the dome, and the pit at the top representing the vent. One very remarkable piece of evidence tending to confirm this view is the fact that domes now stand on some of the sites where older observers announced depressions. It is suggested that local swellings of the surface may occur in places and that the resulting domes are cavernous. Dealing next with the streaks, Wilkins points out that these were almost entirely overlooked by the older observers; and while admitting that they may be due to faulting or the formation of narrow cracks, he suggests that they may be due to some low form of life, such as lichens or fungus. This suggestion was actually made many years ago by W. H. Pickering, who thought patches in the crater Eratosthenes seemed to move about and to choose their paths in an unpredictable manner. Although Pickering's views were not generally accepted, they are difficult to disprove—even if they are equally difficult to prove; no instrumental equipment at present could definitely disprove the theory of some low form of life on the moon.

## High Altitude Research: Symposium in Gulmarg, Kashmir

At the meeting of the Council of the National Institute of Sciences of India, held in New Delhi in October last, it was decided to organize a symposium on "High Altitude Research" during May 27–28, at the Gulmarg Research Observatory, Kashmir (director, Prof. P. S. Gill). Gulmarg Observatory was selected because of its unique position. Situated at a height of 9,000 ft. above sea-level, it compares favourably with several outstanding high-altitude laboratories elsewhere in the world. The site is also suitable as a base station for work at still higher altitudes up to 11,000 ft. at Khillan Marg, one hour distant, and up to 14,000 ft. at Apharvat, three hours distant. The geomagnetic latitude (23° 32′ N.) and longitude (75° E.) are of special significance in cosmic-ray measurement, for the latitude is that at which the most rapid cosmic-ray changes occur with changing latitude, and the longitude is close to that where maximum effects of the Earth's magnetic field are observed. The symposium proper was held on May 28, the morning session being allotted to biological sciences, and the evening to physical sciences; but the boundary between the two sciences was never very sharp. In all, about seventy papers were read, and the proceedings will be published in the form of a bulletin by the National Institute of Sciences of India.

## Science Students in New Zealand

The Department of Scientific and Industrial Research of New Zealand has carried out a most valuable survey into the supply, quality and employment of graduates in the various scientific disciplines in New Zealand. Included in the survey were 4,852 students (4,068 men and 784 women) who had begun university courses in science since 1950 (New Zealand: Department of Scientific and Industrial Research. Bulletin 113: The Academic Record of Science Students in the University of New Zealand. By I. D. Dick, R. M. Williams and Dermot Straker. Pp. 64. (Wellington: Government Printer, 1955.) 6s. 6d.). Among the information collected was the length of study, the subjects studied and the marks obtained, the kind of degrees taken and the time taken to get them. A broad picture of the employment followed by the science graduates showed that about one-ninth went into the Department of Scientific and Industrial Research, one-ninth into school-teaching, one-twelfth went overseas and one-thirteenth went into industry. Those who joined the staff of the University of New Zealand were of high academic quality, as were those who went overseas; school teaching attracted few with first-class honours degrees.

## Sodium in Empty Ether Bottles

Mr. D. Rainy Brown, of J. F. Macfarlan and Co., Ltd., 8 Elstree Way, Boreham Wood, Herts, writes stating that bottles which have contained ether are returned to the firm from time to time containing traces of metallic sodium, presumably used to remove traces of water. There is a real risk of fire when such bottles are washed. Although precautions are take Messrs. Macfarlan have over a period of years ha accidents, although fortunately none of them we serious. They therefore ask those who use sodiu for drying ether to have special vessels for th purpose, or to ensure that no sodium is left i returned bottles.

## Petroleum Films Bureau

The 1955 edition of the list of 35-mm. and 16-mm documentary and instructional films issued by th Petroleum Films Bureau contains no fewer tha forty-five additions to the previous catalogue. Amon the new subjects available are "Ageless Iraq"; "Th Search for Oil"; "Assam Oil Survey"; "The Digbo Story"; "The Chemistry of Oil"; "The Modern O Refinery"; "Red Ruin" or prevention of rust "Individual Aircraft Series", including the Comet Valiant, Brabazon and Hawker Hunter. All 16-mm films are 'non-flam' stock; 35-mm. films are 'flam stock. Applications from educational establishment scientific and technical societies, youth clubs an the like to borrow films should be made to th Petroleum Films Bureau, 29 New Bond Street London, W.1.

## University of Liverpool

The following appointments in the University o Liverpool have been announced: Dr. J. D. Cragg reader in electronic engineering, to the Robert Rankin chair of electronic engineering; Mr. D. L. Hughes head of the Veterinary Science Division, Boots Pur Drug Co., Ltd., Nottingham, to the chair of veterinar pathology, in succession to Prof. R. E. Glover, wh has become head of the Royal Veterinary College London; Dr. F. D. S. Butement, a principal scientifi officer at the Atomic Energy Research Establishment Harwell, to the newly established post of senio lecturer in radiochemistry in the Department o Inorganic and Physical Chemistry.

## Announcements

The autumn conference of the British Occupationa Hygiene Society will be held at the London School of Hygiene and Tropical Medicine on November 4 the subject will be "The Use and Abuse of Protective Equipment". Further information can b obtained from the Honorary Editor of the Society Dr. C. N. Davies, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

It has been the practice for some years past fo members of the atomic energy projects of the three countries, the United Kingdom, the United States and Canada, to meet to discuss problems of common interest in the field of health and safety. It is proposed to hold another of these meetings at the Atomic Energy Research Establishment, Harwell, on September 19 and 20, specifically to consider programmes of genetic research. In certain quarters this has been reported as an international conference on radiation-genetics; this is an over-statement of the case. As with previous meetings, this will not be a formal conference with prepared communications, but rather a working party to consider how best to plan future research and to integrate the available effort. It will differ from previous meetings in that a few invitations have been sent to geneticists not actively connected with the three projects. With these as consultants, it is hoped that the most profitable programmes will be devised for future research.

# TWELFTH INTERNATIONAL CONGRESS OF APPLIED PSYCHOLOGY

WITTGENSTEIN once argued that no paper read to a scientific society should last more han fifteen minutes, because anyone who had anyhing to say on any subject could easily say it in that ime. He would probably have regarded with some orror the Twelfth International Congress of Applied sychology, which met in London during July 18–23. ew of the speakers named on the programme took ss than half an hour, and there were more than a undred of them. Yet only four special lecturers had een asked to talk for more than twenty minutes. erhaps many of the others felt that, having come rom the ends of the earth, or thereabouts, they could ustify themselves—to themselves, or to the bodies hich in certain cases had paid their expenses—only y going on and on. Nor was the unbargained-for ime always well spent. In fact, and as usual, the eople who spoke the longest had the least to say.

Nevertheless, the Congress was a good one, and on he whole it took satisfactory account of an important oint made by the president, Dr. C. B. Frisby London), in his opening speech, when he stressed he need, in applied psychology, for paying more ttention to the attitudes displayed to the investiator by the investigated. There was less discussion f his equally important contention that, in the implementation of the results of research, the psychologist ust beware of the hazards of leaving all the work o others. Dr. Frisby said he does not see, in the sychological field, the possibility of an equivalent to he engineer, who can interpret the discoveries of the hysicist. There is, in fact, a danger that attempts may e made by others to apply procedures found useful n situations which psychologically are very different. t the same session, the Lord President of the Council, ord Salisbury, wisely urged that psychologists should e ready to "come down every now and then from he rarified air they normally breathe and be ready o explain, in words the general public can underand, what they are doing and why they are doing . . . . It is because the ordinary man is bewildered hat he is distrustful. He feels there must be a catch n it".

Sir Frederic Bartlett (Cambridge), in a lecture on Timing", gave an admirable exposition of the outcome of recent experimental studies of skill. Two or ore related sequences of events are involved whenever a skilled performance of any kind or level occurs. ne provides the performer with information; the her consists of what he does about it. One is a ceptor sequence; the other is effector. In 'good' ming, each effector constituent enters the sequence such a point that it produces the maximum of sired effect with the minimum of associated effort. inimal effort has two empirical signs: an absence both forced hurry and forced loitering. Experiment as shown that timing is principally controlled by djustments of the relatively stationary intervals in fector sequences. During these intervals, central, erceptual and intellectual activity is demanded; d it is from this that timing derives its remarkable nge of rapid adaptability. In human social affairs, r Frederic argued, timing is just as important as it in the simpler, bodily skills.

Prof. E. Mira y Lopez (Rio de Janeiro) reported e results of experiments on the effect of foresight d attitude on mental output. His subjects had been asked to predict their own health, work, wealth, social prestige, domestic happiness and individual contentment one week, one month, one year, ten years ahead. His main early findings were that the accuracy of prediction depended more on the nature of the facts predicted, and the predictor's psychological make-up, than on the passage of time; that pessimistic predictions about health were more often confirmed than optimistic ones; that predictions about work output were more often accurate than predictions about social prestige, wealth or domestic happiness; and that in the case of neurotic and psychotic subjects fear seemed to dominate their motivation. All this led to a further inquiry into the association between 'force of belief' and accuracy of prediction. A study of attitudes towards psychological tests produced the conclusion that "extrinsic factors, especially of a conative kind, may influence performance in a battery of aptitude tests almost as much as the factors theoretically involved in its normal execution". There is nothing new here, but the additional evidence will be useful.

At the beginning of a symposium on "The Evaluation of Methods in Applied Psychology and the Problem of Criteria", Mr. J. M. Faverge (Paris) strongly advocated the setting up of good criteria at the design stage of investigations; and in doing so he uttered a warning—never unnecessary, it seems—against the hazards of small samples in psychological research. Prof. J. C. Flanagan (Pittsburgh), who followed, spoke some more very good sense on both these points. He said that for the psychologist in the field there is no more fundamental question than, Are we really helping people to solve their problems? The ultimate criteria must always be of the 'on the job' variety; but intermediate criteria, too, are required. In industry, complications often arise through contamination resulting from informal discussion between people responsible for collecting predictor data and others responsible for collecting criterion data.

Prof. R. Bonnardel (Paris), in another symposium, on "The Organization and Application of Research", made a good and uncommon point in arguing that the industrial psychologist is really the only one of his kind who has much chance of studying normal people in the normal conditions in which they spend most of their waking lives. Growing co-operation between practitioners in the field and psychologists in university departments is improving our ability to make use of the opportunity. However, Prof. Bonnardel shared the view of Prof. L. S. Hearnshaw (Liverpool), expressed elsewhere, that the former are still too little inclined to classify, while the latter are apt to classify prematurely. Dr. H. E. Page (Washington), who followed, spoke from a wealth of experience in the administration of science in the U.S. Office of Naval Research. After describing how this organization works, he talked discreetly of some of its major difficulties. One arises from the very great influence exercised by a very few psychologists, through their membership of controlling committees of one kind and another. He did not claim that this is necessarily a bad thing; but he maintained that it is an exceedingly important one. Another difficulty concerned the implementation of research findings. Dr. Frisby had hinted that this is intensified by the entry of untrained people into the psychologist's territory. Dr. Page suggested—without mentioning Dr. Frisby's comment, which he may not have heard—that perhaps the psychologist is himself to blame for this. Indeed, he seemed to extend the main point made by Lord Salisbury, for he went on to say: "More scientists should learn to employ the language and concepts of their users. Many have no desire to do this". He added that the personality of the translator may be more important than his knowledge of information theory.

Prof. O. Klineberg (Paris), who took the chair at a symposium on "Attitudes, Opinions and Behaviour", made a useful and all-too-brief contribution of his own when he took two of his main speakers to task for suggesting that it is unnecessary for psychologists, sociologists and others in this field to agree on the use of terms. It is indeed difficult to discern just what Prof. R. Clémens (Liège) had meant when he said that psychology and sociology differ largely in emphasis. Dr. H. Durant (London) had side-stepped the issue by dismissing it as "partly semantic". It will be interesting to discover, some day, how much of the present-day confusion in this area could be got rid of by the simple expedient of clearing our lines of communication in the way Dr. Klineberg proposed.

The Congress, which met in plenary session for major symposia each morning, and split into six parts each afternoon, for four minor symposia and two series of individual papers, was housed in the Beveridge Hall of the Senate House, University of London, in various theatres in Birkbeck College, and in the Masaryk Hall of the School of Slavonic Studies. One of the four special lectures was given by Prof. C. Pellizzi, head of the Human Relations Division of the European Productivity Agency, which had generously provided simultaneous translation facilities in the Beveridge Hall. Another, delivered at the closing session, was by Prof. M. S. Viteles (Philadelphia). Entitled "The New Utopia", this last lecture provided the applied psychologist with yet another warning that he must be careful how and where he walks. He may find it difficult to avoid making value-judgments of considerable importance to himself and others; but he should at least know when he is doing so. "We cannot allow the fact that our young science is making some contribution to the solution of present-day problems to encourage us to think of ourselves as the architects of the New Utopia."

Among the social events was a banquet at the Hurlingham Club, with a speech by Lord Halsbury in five languages.

ALEC RODGER

# UNIVERSITY AFFAIRS IN GREAT BRITAIN, 1953–54

THE "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1953–54", issued by the University Grants Committee[*], shows a further decline of 872 in the number of full-time students—to 80,602, compared with 81,474 in 1952–53 and 85,314 in 1950–51. In the English universities there were 646 fewer full-time men students but 184 more women than in 1952–53; for Wales there were 146 fewer men and 44 fewer women, and for Scotland 201 fewer me
and 19 fewer women. Overseas full-time student
from within the British Commonwealth increased b
368 to 4,607; but part-time students (1,819) wei
23 fewer than in 1952–53. Students from foreig
countries increased by 144 to 3,373 full-time, and b
77 to 1,379 part-time, students compared with 1952
53. There was no appreciable change in the percentag
distribution of full-time students among the facultie
students of technology increased by 43 to 10,03
but those of pure science decreased by 30 to 17,00
the percentage distribution being 12·4 and 21·
respectively, compared with 43 per cent for art
16·4 for medicine, 3·2 for dentistry, 2·6 for agr
culture and 1·3 per cent for veterinary scienc
Although the percentage of arts students was slightl
higher, the number of students (34,673) was smalle
by 243. Full-time advanced students of pure scienc
increased by 245 to 3,290, of technology by 224 t
1,381, of arts by 290 to 3,596, of agriculture by 9 t
290, and of veterinary science by 5 to 12, while thos
of medicine and dentistry decreased by 64 to 89
and only 2,698 students were working for a teacher
diploma compared with 2,900 in 1952–53. Of th
full-time students, 63,560 were reading for a fir
degree, 4,350 for a first diploma, and 12,166 (includin
those working for a teacher's diploma) were engage
in research or other advanced work, the correspondin
figures for 1952–53 being 64,753, 5,064 and 11,65
respectively.

The proportion of assisted students was slightl
higher (71·9 per cent compared with 70·4 per cent i
1952–53), though still smaller than in 1951–52 (72·
per cent); for England as a whole it increased fro
72·9 to 74·2 per cent, and in Wales from 81·1 t
88·5 per cent, but in Scotland only from 55·7 t
56·8 per cent. Parliamentary grants, however, wer
70·5 per cent of recurrent income and only 12 per cen
comes from fees, 4·3 per cent from endowments, 3·
per cent from local authority grants and 1·6 per cer
from donations and subscriptions. For 1951–52 th
corresponding figures were 14·8, 5·2, 4·1 and 1·9 pe
cent, respectively, with 66·5 per cent from Parlia
mentary grants. The ratio of staff to students co
tinued to improve, the full-time teaching staff num
bering 9,514 compared with 9,098 during 1952–5
The increase was chiefly in lecturers (285), but the
were 37 additional professors, 69 more senior lecture
and 12 more readers, assistant professors and i
dependent lecturers, with a further decrease of 12
in assistant lecturers and demonstrators to 1,162.

Of the full-time students, 62,173 were in Englan
4,431 in Wales and 13,998 in Scotland, the distr
bution in English universities and university colleg
being 14,867 at Oxford and Cambridge, 18,125 a
London, and 29,181 at others. Except at Bristo
Leeds, Reading, Southampton and Oxford, whe
there were slight increases, there were slight decrea
in the number of students at English universiti
and university colleges, but only at Manchest
(– 159), Oxford (+ 159) and North Staffordshi
University College was the change more than o
hundred and only for the last was it significant i
relation to the total (495 for 1953–54). In Scotla
there were decreases at Aberdeen (– 95), Glasgo
(– 156) and Edinburgh (– 56), and increases
Glasgow Royal Technical College (+ 76) and S
Andrews (+ 9). The proportion of full-time studen
in Britain residing in colleges and halls of residen
increased to 28·1 per cent; of these 22,625 student
8,069 were at Oxford and Cambridge, 11,565 at oth

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[*] Universities Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant—Academic Year 1953–54. (Cmd. 9477.) Pp. 44. (London: H.M.S.O., 1955.) 2s. 6d. net

English institutions and only 1,189 in Wales and ,802 in Scotland. The proportion of men in residence was 23·5 per cent and of women 42·0 per cent, compared with 22·9 per cent and 41·3 per cent, respect- vely, in the previous year, while 32,987 students 40·9 per cent) were in lodgings and 24,990 (31·0 er cent) at home, compared with 40·0 per cent and 2·7 per cent in 1952–53. Of the 21,153 students dmitted for the first time during 1953–54 (a decrease f 202 on 1952–53), 19,585 were reading for a first egree and 1,568 for a first diploma ; and of those eading for a first degree, 1,382 were less than ighteen years of age and 10,546 were nineteen or more. Of the full-time students, 35,071 out of 47,398 men and 11,036 out of 14,775 women in England were receiving assistance by way of scholarships, xhibitions or other awards from public or private unds ; for Wales the corresponding figures are 2,799 ut of 3,141 men and 1,124 out of 1,290 women ; and or Scotland, 6,024 out of 10,254 men and 1,931 out f 3,744 women. Of the 60,793 full-time men students, 6·3 per cent were in arts, 22·2 per cent in pure cience, 17·0 per cent in medicine and 16·3 per cent n technology ; for the 19,809 women students the orresponding figures are 63·7, 17·6, 14·7 and 0·7 er cent, respectively. Medicine and dentistry claimed 9·6 per cent of the 4,682 part-time advanced tudents, arts 35·6, pure science 9·3 and technology ·8 per cent, respectively, compared with 49·1, 33·8, ·5 and 9·0 per cent, respectively, during 1952–53.

The recurrent income of the universities and niversity colleges of Great Britain increased by 1,413,941 to £31,112,024, of which £21,924,115 was rom Parliamentary grants, £3,724,585 from fees, 1,332,917 from endowments, £1,130,280 from grants rom local authorities and £495,996 from donations nd subscriptions. Of the total income from public unds of £23,054,315 and £8,057,709 from other ources, the University of London received £6,957,728 rom public, and £2,462,874 from other, sources ; the University of Cambridge similarly received £1,436,133 nd £1,332,864 ; for Oxford the corresponding figures re £1,383,461 and £636,418 ; Manchester, £1,125,886 nd £270,863 ; Durham, £999,429 and £324,969 ; Leeds, £933,533 and £268,480 ; Liverpool, £917,590 nd £254,203 ; Birmingham, £900,815 and £240,216 ; Bristol, £819,537 and £319,179 ; Sheffield, £579,598 nd £170,268 ; Nottingham, £500,005 and £105,136 ; nd Reading, £546,373 and £65,241. No other English university or university college had an ncome exceeding half a million pounds, but for the our universities in Scotland the corresponding figures re : Aberdeen, £509,000 and £126,529 ; Edinburgh, 1,093,169 and £373,686 ; Glasgow, £1,114,126 and 332,078 ; and St. Andrews, £545,260 and £116,100. The University of Wales, including the Welsh National School of Medicine, received £1,149,707 rom public funds and £302,169 from other sources. Non-recurrent Treasury grants during the year, in espect of capital expenditure, mainly on buildings, ites, equipment and professional fees, amounted to 5,516,356 compared with £5,746,470 in 1952–53.

Of the total expenditure of £30,260,235—an increase f £1,559,801, or 5·4 per cent on 1952–53—adminis- ration accounted for 7·3 per cent, departmental maintenance 69·4 per cent, maintenance of premises 2·7 per cent, and miscellaneous expenditure 9·4 per cent. Capital expenditure met from income amounted o £358,289 and allocations to reserve to £342,397 ; or 1952–53 these figures were £334,516 and £334,015, espectively. Departmental maintenance, which includes salaries of teaching staff, payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums and the supply of materials, apparatus, books, specimens, etc., increased by £1,244,181 to £21,005,981, the major increase being 13·2 per cent on departmental wages of technicians and laboratory assistants. Salaries and superannuation of teaching staff amounted to £13,616,426 compared with £13,169,879 in 1952–53, but expenditure on repairs and maintenance of buildings only increased by 4·1 per cent to £1,953,017, although that on rates, insurance, heat, light, water, etc., was up by 9·0 per cent to £1,953,017.

Library expenditure, excluding general maintenance of library buildings, etc., and rates, heat, light, repairs, etc., amounted to £1,203,231, or 4·0 per cent of the total expenditure compared with £1,118,428 or 3·9 per cent in 1952–53, 3·8 per cent during 1951–52 and 3·7 per cent during 1950–51. Of this, £600,647 was for salaries and wages, £147,669 for periodicals and £97,229 for bindings. Of the £290,581 expended on books, £75,652 was in the schools and colleges of the University of London, including £11,732 at the Central Library, £11,890 at the London School of Economics, £9,132 at University College, and £5,963 at the School of Oriental and African Studies. The University of Oxford spent £36,088 on books ; Cambridge, £18,587 ; Manchester, £14,256 ; Liverpool, £9,959 ; Birmingham, £8,686 ; Leeds, £9,150 ; Durham, £10,829 ; Bristol, £8,441 ; and Southampton, £7,509. Expenditure on books and periodicals at a number of English universities and university colleges decreased rather than increased during the year, and increases in general are scarcely in proportion to the mounting costs of both books and periodicals. Only the Universities of London (£39,814), Oxford (£13,530) and Cambridge (£12,448) spent more than £10,000 on periodicals, and only Birmingham (£7,110), Leeds (£5,108) and Manchester (£6,250) more than £5,000. The University of Wales spent £12,805 on books and £8,040 on periodicals. In Scotland, Edinburgh spent £13,930 on books and £7,212 on periodicals ; Glasgow, £12,943 and £9,559 ; St. Andrews, £10,650 and £4,336 ; and Aberdeen, £8,089 and £3,939.

# INTERNATIONAL SCIENTIFIC RADIO UNION

## PROCEEDINGS OF THE ELEVENTH GENERAL ASSEMBLY

THE eleventh General Assembly of the International Scientific Radio Union was held at The Hague during August 23–September 2, 1954, when some three hundred delegates from twenty-two countries participated under the chairmanship of Father P. Lejay, who was re-elected president of the Union until the next Assembly in 1957.

The main functions of the Union are to promote and organize radio research requiring international co-operation, and to encourage the setting-up of common methods of measurement with standardized apparatus. The work is carried out by seven Commissions, and these are concerned with specific aspects of radio research defined by their titles, which were carefully considered and revised at the recent assembly. The present titles, together with the names of the chairmen elected for the session

1954–57 are as follows: I, Radio Measurement and Standards (Dr. B. Decaux); II, Radio and Troposphere (Dr. R. L. Smith-Rose); III, Ionospheric Radio (Dr. D. F. Martyn); IV, Radio Noise of Terrestrial Origin (Mr. J. A. Ratcliffe); V, Radio Astronomy (Dr. M. Laffineur); VI, Radio Waves and Circuits (Dr. S. Silver); VII, Radio Electronics (Prof. G. A. Woonton).

The proceedings of the eleventh General Assembly are being published in eight parts available in either French or English. The first seven parts are to be devoted to the Commission activities; while Part 8, which has just been issued, contains a full account of the administrative proceedings with information on other activities of the Union (10, Part 8 (1955); pp. 125; obtainable from the General Secretary of the Union at 42 Rue des Minimes, Brussels; 14*s*. 6*d*. or 100 Belg. francs).

Although the Union does not now publish the scientific papers which are read and discussed at a General Assembly, a list of titles and authors of the 296 papers and reports submitted at The Hague meeting is given in Part 8; and it is to be noted that the reports of national committees will be published in full in Parts 1–7 according to the Commissions to which they refer. The Union also publishes, six times a year, an *Information Bulletin*, in which are recorded the activities and progress of the Union between successive General Assemblies.

The administrative proceedings (Part 8), referred to above, contains all the resolutions and recommendations adopted by the General Assembly of 1954. Among these is a recommendation accepted from Commission I that the value of 299 792 ± 2 km./sec. should be used in all scientific work for the velocity of electromagnetic waves in a vacuum. It was further resolved that all national laboratories in a position to do so should co-operate in making a comparison of standards of power measurement at frequencies of 3,000 and 10,000 Mc./s.

A full report of the discussions which led up to these recommendations is contained in Part 1 of the proceedings, which was published a few months ago (10, Part 1 (1955); pp. 57; 8*s*. 8*d*. or 60 Belg. francs). This Part 1 contains all the national reports submitted to Commission I, together with the minutes of the meetings of the Commission at The Hague and the resolutions submitted to the General Assembly for adoption. In response to a request received from the International Radio Consultative Committee, it was recommended that members of the International Scientific Radio Union should make observations on the service areas and mutual interference zones of standard frequency transmissions, and also on the type of modulation used by the stations at present in operation. A study of the results of such observations should be of great assistance in the establishment and operation of an effective standard frequency and time service on a world-wide basis.

Among the other activities of the Union reported in Part 1 of the proceedings is an account of the meetings of the committee appointed to consider the programme of work for the forthcoming International Geophysical Year during 1957–58, and brief accounts of the meetings of the Mixed Commission on the Ionosphere and of the Joint Commission on Radio Meteorology held in 1954. The Union committee on the International Geophysical Year has considered various matters relating to the proposed programmes of observations in connexion with meteorology, aurora, ionospheric absorption and 'winds', radi star scintillations, meteors, atmospherics and terrestrial noise. It has also given preliminary consideration to the question of presentation and publication of the results obtained, and mad recommendations on all these matters to the international committee on the International Geophysica Year, which will meet again shortly to formulate th recommended world-wide programme.

It is clear from the two parts (1 and 8) of th proceedings already available that they compris excellent surveys of the relevant fields of radi research, fully documented with references to th original scientific published papers, and the appearance of the remaining parts dealing with the work o Commissions II–VII will be awaited with interest b students and research workers in the field of scientifi radio.

R. L. Smith-Rose

# PRODUCTION AND MEASUREMENT OF ULTRA-HIGH VACUA

BEFORE 1950, pressures of the order of $10^{-7}$ mm of mercury were considered high vacua, an although, undoubtedly, lower pressures were obtained it was not possible to measure them because the mos sensitive vacuum gauges were no longer reliable a such low pressures. To-day, it is possible to produc and measure pressures of $10^{-9}$–$10^{-11}$ mm. of mercury to estimate pressures as low as $10^{-13}$ mm. and, in th case where interest is concentrated on the chemicall active gases present in the space to be evacuated, t estimate partial pressures of these gases of the orde of $10^{-14}$ mm.

A brief but interesting review of these recen developments, together with a summary of th operation of basic pumping apparatus, is given b Dr. J. A. Becker in the January number of the *Bel Laboratories Record* (33, No. 1; 1955). The combination of fore-pump, mercury diffusion pump an cold trap enables pressures of less than $10^{-8}$ mm. t be reached. With the McLeod gauge, pressures dow to about $10^{-6}$ mm. can be accurately measured, an with the ionization gauge, introduced in 1916, lowe pressures by extrapolation can be determined. Th ionization gauge fails, however, when the pressur reaches $10^{-8}$ mm., and work since 1950 has show that ionizing currents, produced by soft X-ray striking the plate of the gauge, and the emission o photo electrons together with an electron curren that reaches the plate even when the plate is at negative potential with respect to the cathode, whic are independent of the pressure, constitute th limiting factors. Bayard and Alpert have propose an arrangement by which these currents may b minimized. The plate is reduced to a fine wire an surrounded by a cylindrical grid with the filamen placed outside the grid. With this modified type o ionization gauge, pressures of $10^{-11}$ mm. of mercur have been measured.

To attain these ultra-high vacua it become important to know the amount of, and sources o residual gas present in the system to be evacuated and Dr. Becker describes four such sources. The are the release of gas from the cold trap; th diffusion of dissolved gases out of the glass and meta parts of the system; the release of gases adsorbe ı the surfaces of the parts of the system and the ffusion in time of gases from the atmosphere rough the glass envelope. Some recent studies of ttering phenomena and observations on the lsorption of gases on clean tungsten, tantalum and olybdenum surfaces conducted in the Bell Labora-ries in connexion with vacua of $10^{-11}$–$10^{-14}$ mm. are iefly referred to. Evaporated films, however, do ›t pump rare gases like helium and neon, and to move them use is made of the ion gauge, which, in ldition to its use as a manometer, can also act as a ımp. Its speed of pumping is much lower than that a mercury diffusion pump or of evaporated films, ıt it has the particular advantages that there is no wer pressure-limit to its pumping action and that can be incorporated in the tube being evacuated.

# COUNTING AND SIZING OF PARTICLES WITH THE FLYING-SPOT MICROSCOPE

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METHODS for counting and measuring micro-scopic particles by the use of the flying-spot ucroscope have been tested with blood, nerve cells, ust particles and prepared standard sprays. The rstem involves scanning the preparation with twin ›ots of light, differently polarized, and passing the ulses generated by twin photocells to an anti-›incidence circuit and then to a counting unit. The rcuit ensures that a count is registered only on the reep at which one of the spots crosses the particle ; hen both cross it the pulses are made to cancel each ther[1,2]. Every time that a pulse passes to the ›unter, the spot on the display tube is made more ıtense. This provides a visual display that shows hich particles have been counted (Fig. 1).

*Red cell counts.* Red cell counts were carried out ıth the co-operation of Prof. M. Maizels. Twenty samples of blood were counted by the routine visual method in the hospital laboratory. Two sub-samples were taken from each blood and counted both visually and by the machine in our Department. The visual counts were made with the standard method of recording corpuscles that lie upon the lines of a hæmocytometer. The machine counts were made on a microscopic field of known area, including about six hundred corpuscles. Each machine count was repeated three times on the same field, and the mean taken.

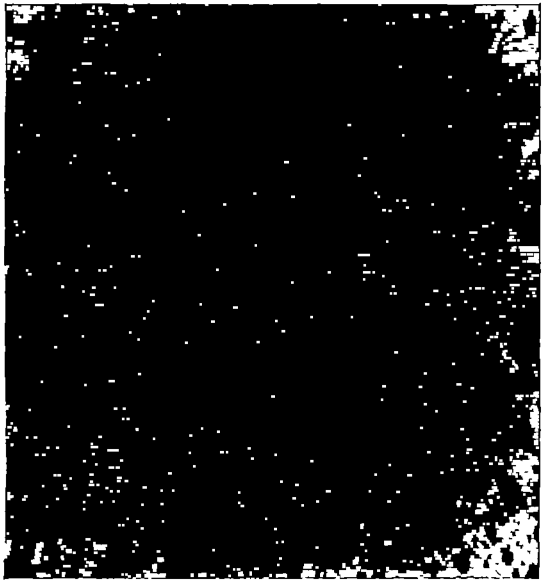

Fig. 1. View of test slide with machine presumed to be counting all particles. The bright spots indicate that a pulse has been passed to the counter

Table 1. HUMAN RED CORPUSCLE COUNTS ($M$/c. mm.)
Columns 2, 3 and 4 are visual counts, 5 and 6 machine counts. Counts 3 and 4 were made by a different observer to count 2. The counts in columns 3 and 5 and 4 and 6 were from the same fillings of the slide.

| (1) Sample | (2) Visual Hospital | (3) Visual Lab 1 | (4) Visual Lab. 2 | (5) Machine 1 | (6) Machine 2 |
|---|---|---|---|---|---|
| 1 | 3·9 | 3·8 | 3·6 | 3·9 | 3·8 |
| 2 | 5·1 | 4·4 | 5·2 | 4·5 | 5·3 |
| 3 | 4·1 | 4·0 | 3·8 | 3·7 | 4·0 |
| 4 | 2·5 | 2·4 | 2·6 | 3·0 | 3·0 |
| 5 | 1·2 | 1·1 | 1·1 | 1·3 | 1·3 |
| 6 | 3·2 | 3·1 | 3·2 | 3·0 | 3·3 |
| 7 | 3·6 | 3·7 | 3·4 | 3·5 | 3·5 |
| 8 | 3·5 | 3·8 | 3·4 | 3·5 | 3·6 |
| 9 | 3·9 | 3·8 | 3·8 | 3·7 | 3·7 |
| 10 | 4·5 | 4·5 | 4·5 | 4·8 | 4·6 |
| 11 | 4·8 | 4·7 | 4·8 | 4·6 | 4·6 |
| 12 | 4·7 | 4·4 | 4·3 | 4·4 | 4·4 |
| 13 | 4·9 | 4·8 | 4·7 | 4·7 | 4·7 |
| 14 | 4·6 | 4·7 | 4·5 | 4·7 | 4·7 |
| 15 | 3·3 | 3·3 | 3·2 | 3·4 | 3·3 |
| 16 | 6·7 | 7·0 | 6·8 | 7·1 | 6·2 |
| 17 | 4·2 | 4·1 | 4·1 | 4·1 | 4·1 |
| 18 | 4·5 | 4·3 | 4·2 | 4·2 | 4·2 |
| 19 | 4·2 | 4·2 | 4·2 | 4·2 | 4·2 |
| 20 | 5·2 | 5·2 | 5·2 | 4·9 | 5·0 |

Table 1 and an analysis of variance show that although the bloods differed greatly, there were no consistent differences resulting from the methods of counting, whether by the hospital laboratory, a second visual observer or the machine.

The replication of the visual and machine counts enabled estimates of variance to be made ; there were no significant differences, but the machine variance was possibly the smaller. The standard deviation is about 0·17 $M$/c. mm. by both methods, giving a coefficient of variation of about 4 per cent.

We may conclude that machine blood counts, though much quicker, are as accurate and consistent as visual ones—perhaps more so. The time involved in preparation of the specimen is equal in the two cases, but the counting takes 4 sec. with the machine, at least 4 min. for the visual observer. The repetition of counts on a given field, which is so quickly under-taken by the machine, gives a further protection against error.

Table 2. COUNTS OF THE NUMBER OF PARTICLES RECORDED BY THE MACHINE AND THE TOTAL OF NUCLEI (AND NUCLEAR FRAGMENTS) MADE BY VISUAL OBSERVATION

Each count is for a strip 500μ wide extending from the pial surface to the white matter of the rat's cerebral cortex, stained with gallo-cyanin

| Total particles Machine count | Nuclei Visual count |
|---|---|
| 1,336 | 1,253 |
| 1,183 | 1,220 |
| 1,172 | 1,303 |
| 1,164 | 1,181 |
| 1,410 | 1,434 |
| 1,044 | 1,389 |
| 1,197 | 1,170 |
| 1,296 | 1,357 |
| 1,464 | 1,503 |
| 1,389 | 1,357 |
| 1,289 | 1,242 |
| 1,018 | 1,048 |
| 1,315 | 1,258 |
| 1,240 | 1,104 |
| 1,349 | 1,087 |
| 1,372 | 1,069 |

Table 3. STEEL DUST PARTICLES

| (1) Slide No. | (2) Total number of particles per strip (all sizes) × 10³ Visual 1 | (3) Visual 2 | (4) Machine 1 | (5) Machine 2 | (6) Total of particles 0·5 μ–5 μ per strip × 10³ Visual 1 | (7) Machine 1 | (8) Machine 2 |
|---|---|---|---|---|---|---|---|
| *J3/1/1B* | 497 | 525 | 490 | 510 | 28 | 107 | 119 |
| *2B* | 512 | 475 | 522 | 496 | 30 | 200 | 186 |
| *3B* | 506 | 476 | 639 | 520 | 23 | 174 | 150 |
| *4A* | 928 | 496 | 869 | 792 | 75 | 204 | 248 |
| *6A* | 862 | 682 | 714 | 804 | 99 | 212 | 240 |
| *7B* | 334 | 220 | 354 | 250 | 46 | 110 | 106 |
| *8A* | 1,045 | 869 | 765 | 810 | 108 | 217 | 164 |
| *10A* | 599 | 550 | 515 | 487 | 76 | 158 | 128 |
| *13B* | 349 | 385 | 362 | 405 | 47 | 152 | 181 |
| *19A* | 516 | 473 | 494 | 484 | 60 | 170 | 120 |
| *21A* | 818 | 784 | 898 | 860 | 68 | 210 | 248 |
| *25A* | 640 | 675 | 590 | 620 | 77 | 214 | 158 |
| *33B* | 209 | 315 | 374 | 348 | 44 | 104 | 88 |
| *34B* | 639 | 475 | 560 | 496 | 80 | 171 | 192 |
| *37A* | 416 | 286 | 540 | 492 | 44 | 118 | 141 |
| *38A* | 607 | 435 | 395 | 463 | 96 | 196 | 157 |
| *39B* | 316 | 343 | 378 | 393 | 68 | 124 | 139 |
| *40B* | 615 | 555 | 492 | 569 | 107 | 215 | 140 |
| *42A* | 951 | 510 | 365 | 400 | 119 | 132 | 156 |
| *43B* | 461 | 420 | 432 | 392 | 45 | 118 | 182 |

*Counts of nerve cells in sections.* The value of the method for counting nerve cells was tested with sections of the cerebral cortex of the rat stained with gallocyanin to show nuclei and Nissl substance. Counts were made with the machine of all the particles in a series of strips between the pial surface and the white matter, followed by a visual count of all the nuclei and parts of nuclei in the same strips. The figures show a general agreement, and the mean difference does not differ significantly from zero.

*Dust particle counts.* Counting of dust particles may be particularly difficult if there are many near and below the limit of resolution. The maintenance of a constant criterion for counting of imperfectly resolved objects is difficult for both human or machine counting, but is likely to be more variable for the former. Machine counts of such dust were usually considerably higher than those of human observers.

Table 3 shows the results with a series of thermal precipitation samples of steel dust particles. Columns 2 and 3 show visual counts made by observers in Sheffield and London without consultation on standards. There are considerable differences between the counts by visual methods and between these and the machine counts; but the mean differences over columns 2–5 are not significantly different from zero. The replicated machine counts for columns 4 and 5 agree better with each other than do the visual counts of the two observers. Column 6 shows a visual count of the particles of less than 5μ in this material and 7 and 8 are replicated machine counts of this value. The last two agree well with each other but are higher than the visual counts. Presumably this machine is taking a different criterion of what is to constitute a particle at the limit of resolution.

Table 4. COUNTING AND SIZING OF CIRCULAR PARTICLES ON A TEST SLIDE

Field 600μ × 500μ, 16 mm. objective, 10 × eyepiece. Top, visual counts by three different observers. Centre, counts of different parts of the sample by the machine. Bottom, comparison of means

| Visual | 1 | 2 | 3 |
|---|---|---|---|
| Total | 415 | 430 | 407 |
| Up to 5μ | 183 | 202 | 182 |
| 5–10 | 145 | 133 | 133 |
| 10–15 | 48 | 45 | 44 |
| 15–20 | 20 | 30 | 27 |
| 20–25 | 10 | 10 | 11 |
| 25–30 | 7 | 8 | 8 |
| > 30 | 2 | 2 | 2 |
| **Machine** | **1** | **2** | **3** |
| Total | 408 | 396 | 416 |
| Up to 5μ | 189 | 180 | 192 |
| 5–10 | 136 | 121 | 150 |
| 10–15 | 41 | 50 | 44 |
| 15–20 | 21 | 24 | 15 |
| 20–25 | 12 | 11 | 15 |
| 25–30 | 7 | 8 | 8 |
| > 30 | 2 | 2 | 2 |

Mean of 3 counts

| | Visual | Machine |
|---|---|---|
| Total | 418 | 408 |
| 0–5μ | 189 | 184 |
| 5–10 | 137 | 136 |
| 10–15 | 46 | 45 |
| 15–20 | 26 | 20 |
| 20–25 | 10 | 13 |
| 25–30 | 8 | 8 |
| > 30 | 2 | 2 |

Table 5. STRIPS OF RAT CORTEX SHOWING HOW THE PROPORTION OF PARTICLES ATTRIBUTABLE TO GLIAL AND OTHER NUCLEI CAN BE ESTIMATED BY COUNTING LARGE PARTICLES SEPARATELY

| All nuclei Visual count | All particles Machine count | Neurons Visual count | Particles more than 7·5μ Machine count |
|---|---|---|---|
| 1,197 | 1,252 | 727 | 725 |
| 1,296 | 1,291 | 760 | 689 |
| 1,457 | 1,372 | 790 | 781 |
| 1,056 | 1,098 | 840 | 630 |

*Sizing.* Estimates of size are made with this system by comparing the pulses generated with pulses of known duration in such a way that successively smaller and smaller particles are rejected from the count[1,3]. In this way the particles in the test-slide shown in Fig. 1 were measured into 5μ-size groups. Table 4 shows comparison of these measurements with those made visually on a photograph at 300 × by three observers. The agreement is remarkably good.

The same method has been used for estimating the number of neurons, as distinct from all particles, in strips of cerebral cortex of the rat, by counting separately the particles greater than and less than 7·5μ.

Table 5 shows that there is moderately good agreement between the estimates obtained in this way and the counts of neurons made visually on the same strips.

*Conclusions.* These results show that the method is capable of providing reliable counts and measurements of a variety of particles. Difficulties have been met in balancing the gain factor in the amplification channels from the two photocells when the contrast of the specimen is poor. Other difficulties arise if the particles overlap or touch, and with objects of shapes involving long re-entrants. For some purposes estimates of the errors due to such factors can be made. The special usefulness of the machine is its speed of operation, making it possible to take more numerous counts than would be practicable by direct vision. For routine counts of easy material, such as blood, it provides substantial economies. For difficult material such as dust, containing particles at the limit of resolution, it may well be that the machine provides approximations that are more consistent than those of a human observer.

Our thanks are due to the Nuffield Foundation for its support, and to Prof. M. Maizels and Mr. F. Fellingham of University College Hospital and Messrs. Maturana, Michie, Sholl, Stanier and Taylor for their help with counting and otherwise, and to Cinema-Television, Ltd., for assistance with equipment.

[May 28

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Molecular Arrangement in Crystals of the Southern Bean Mosaic Virus Protein

About ten years ago, it was shown[1] that electron icroscopic examination of 'psuedo-replicas' could veal the ordered particle arrangement on the surface f a macromolecular crystal. The necessary preparaons were made by metal-shadowing the dried ystals lying on a glass surface, coating with colloion, freeing this composite layer and dissolving e crystalline deposit from the replica thus produced. he molecular order on several kinds of crystal was en in this way; but a broader application of the ethod was limited by factors such as the fragility f the collodion film and the need to work with proteins ot denatured by vacuum desiccation and the vaporation of metal.

The possibilities inherent in this approach to roblems of crystal growth, as well as structure, have een so great that continued efforts have been made improve this initial technique. Thus 'silicon onoxide' films have been employed[2] to reproduce olecular order in crystals of certain proteins. We ave now found that evaporated films of carbon[3] rmit a very significant advance in both the quality replication and the kinds of macromolecular crystals at can be successfully studied.

Molecular order was first demonstrated using ystals of the southern bean mosaic virus protein[1]. this case, however, as in practically all others, e initial method did not replicate enough different ces to permit a conclusive deduction of the molelar arrangement within the crystal. The numerous ystal faces that can be seen when carbon films are ed for preparing specimens of this substance are ustrated in Figs. 1 and 2. These better results e to be attributed in part to the advantageous echanical and electron optical properties of the carbon membranes, and in part to their chemical inertness and the possibilities this offers of various purifying procedures.

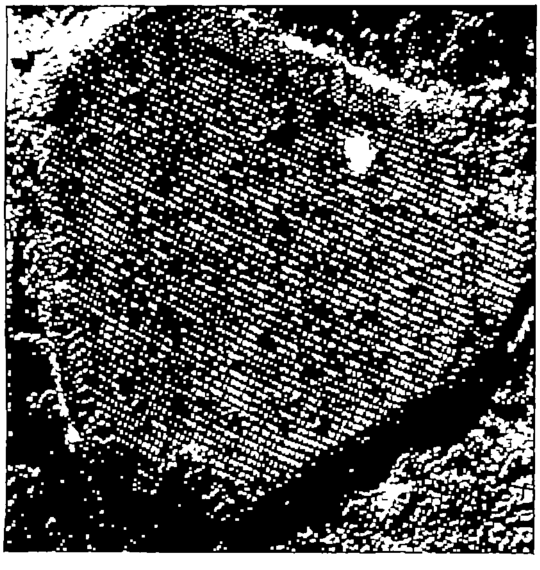

Fig. 1. An electron micrograph of a complete southern bean mosaic virus crystal showing the molecular arrangement on several of its faces. The large face is 110. Magnification × 30,000

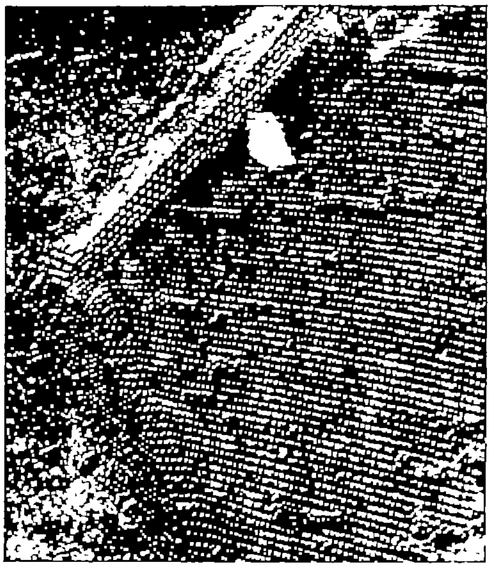

Fig. 2. An electron micrograph of the molecular distribution on several faces developing on one corner of a southern bean mosaic virus crystal. Two [110], [120], [111] and one [100] faces are shown here. Magnification × 30,000

The accompanying electron micrographs are typical of approximately a hundred thus far made of crystals of this virus protein. The crystal symmetry, as determined from measurements of inter-particle spacings and of angles between the edges of crystal faces, proves to be very nearly, if not exactly, cubic. The principal face has invariably been that of a dodecahedron. Faces of the several forms that have been seen have been identified by their relative positions on the crystal and by the particle configurations and spacings they exhibit. This identification has been confirmed by comparisons between the electron micrographs and models built of cork balls which, using the chosen molecular arrangement, reproduce the observed faces. The crystals shown in the figures exhibit faces of the forms [100], [111], [120] and [113], in addition to the dominant [110].

The molecular arrangement in this case is a cubic close packing of essentially spherical molecular particles of diameter about 230 A. The edge-length of the unit cube, containing four of these molecules, is about 325 A.

We have been using this improved method of specimen preparation for studying crystallographic problems connected with the growth of these crystals and for determining the molecular arrangement in a number of other crystalline proteins. These investigations are continuing and will be described in detail elsewhere.

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June 24.

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## Terminal Groups of Tobacco Mosaic Virus

THE protein of the tobacco mosaic virus is composed of peptide chains. The first step towards a knowledge of the number and kind of these peptides would be the determination of the carboxylic and amino terminal groups.

Harris and Knight[1] found that the only amino-acid liberated by treatment of the native virus with carboxypeptidase was threonine. Assuming a molecular weight of $40 \times 10^6$ for the tobacco mosaic virus, the number of terminal threonine residues would be 2,700. We have confirmed this experimental result using our tobacco mosaic virus strain[2]. Since objections can be raised against the enzymatic method, Braunitzer[3] determined the carboxylic-terminal groups by the hydrazine method of Akabori[4] and found 2,500 threonine residues but no other amino-acids. Braunitzer[5] has also recently shown that the last three amino-acids at the carboxylic end of the peptide chains are proline–alanine–threonine. These results have also been obtained by Niu and Fraenkel-Conrat[6], so that the number and kind of the carboxylic-terminal groups remain no longer in doubt.

The question of the amino-terminal groups is still under discussion. In the native virus amino-terminal groups are not detectable. After treatment of the virus with trichloracetic acid (*p*H 1·8, 30 min., 85° C.) proline was the only amino-terminal amino-acid that could be detected by the methods of Sanger[7] and Edman[8]; but no carboxylic-terminal amino-acids besides threonine could be observed by the method of Akabori, which makes it unlikely that an α-peptide bond is split by trichloracetic acid[3,8,9].

Repeating our experiments, Fraenkel-Conrat and Singer[10] found evidence for much terminal proline; but they also found with both methods a "host of other terminal amino-acids". Therefore, they suppose that an unspecific hydrolysis of many labile peptide bonds is effected by trichloracetic acid. The contrast between these findings and our own is due to the difficulty of determining the end-groups of the protein. The method of Sanger is complicated, because dinitrophenyl-proline is unstable and decomposes to dinitrophenol during hydrolysis with 6 *N* hydrochloric acid; but the degradation can be partly suppressed by hydrolysis in a nearly anhydrous medium[11]. In both cases, 90 per cent of the dinitrophenyl products are accounted for by dinitrophenol and dinitrophenyl-proline. Partial hydrolysis yields dinitrophenyl-proline, one dinitrophenyl-prolyl-dipeptide, one dinitrophenyl-prolyl-tripeptide[3], and under certain conditions some yellow compounds, which can easily be taken for dinitrophenyl amino-acids.

The method of Edman gives clearer results when properly applied. Fraenkel-Conrat and Singer[10] contented themselves with the measurement of the total absorption of the produced thiohydantoins and with the identification of the free amino-acids obtained by hydrolysis of the unseparated thiohydantoins. It is known that thiohydantoins of pure amino-acids yield more than one amino-acid on alkaline hydrolysis[12]. After hydrolysis of synthetic proline-thiohydantoin (pro-th) with barium hydroxide we found at least four spots on the paper-chromatogram which were ninhydrin-positive and could be taken for amino-acids. Therefore this method is not suitable for identification. We preferred to separate the thiohydantoins by paper-chromatography first and then to determine the pure compounds after elution.

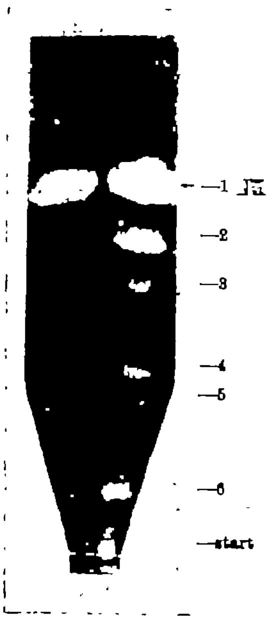

Fig. 1. Chromatogram of the thiohydantoins from tobacco virus protein (right-hand side) and of proline-thiohydantoin (left-hand side)

Fig. 1 is an ultra-viol photoprint of a typic chromatogram: spot 1 ha the same $R_F$-value as pro-th as can be seen from th reference chromatogram t the left. For the identification we hydrolysed th eluate from the spot wit concentrated hydriodic aci (140° C., 90 min.). In thi way we obtained nearly pur proline together with a smal quantity of a by-product In a control experiment wit synthetic pro-th the sam amount of the same by product was obtained. Spo 1 accounts for 65–70 pe cent of the total extinction Spot 2 is a degradatio product of pro-th, produce during the formation o pro-th in acid solution. I accounts for nearly 15 pe cent of the total extinction the other weak spots together to no more tha 10–20 per cent. The spo on the starting line ha not the typical absorption curve of a thiohydantoin The $R_F$-values of the other weak spots correspon to alanine-th, glycine-th and serine-th. These result show that 80–90 per cent of the end-groups i tobacco mosaic virus treated with trichloracetic aci are proline residues, corresponding to 2,400 per mol tobacco mosaic virus.

The impurities (10–20 per cent) need not necessaril be due to an unspecific hydrolysis of tobacco mosai virus. Control experiments[13] with synthetic peptide showed that glycine and perhaps alanine react wit phenyl*iso*thiocyanate, even if they are not terminal These control experiments with synthetic peptide could not be reproduced by Fraenkel-Conrat an Harris[14]. On repeating our experiments with syntheti peptides, we found an error in the chromatographi technique. Phenylthiourea has the same absorptio curve and nearly the same $R_F$ as gly-th, so that th measured amount of gly-th was too high. The presen experiments confirm that non-terminal glycine resi dues react with phenyl*iso*cyanate, but the extent of th reaction is not so high as previously supposed. Afte five hours reaction (40° C., *p*H 8·5) between phenyl *iso*thiocyanate and leu-gly-gly the thiohydantoin o the non-terminal glycine constituted 10 per cent o the total thiohydantoins. The corresponding rati for ala-gly-gly was 30 per cent under the sam conditions. The peptide bonds were not hydrolyse by hydroxyl ions under these conditions. When th time of reaction was shorter, the amount of gly-t was correspondingly smaller, so that it is not surprising that Fraenkel-Conrat and Harris were unabl to detect it.

The determination of the end-groups by fou different methods shows that the protein of tobacc mosaic virus is composed of nearly 2,500 peptid chains with identical terminal groups, as we postulate earlier. It is possible that the sequence of the othe amino-acids in the chains is identical too. The trypti digestion[15] of the protein suggests that every peptid chain contains the same ten digestible peptide bonds.

ne of the eleven fragments, containing twenty-one nino-acids, was isolated in the form of a crystalline, parently homogeneous, dinitrophenyl-derivative.

According to our experiments, the basic unit of e protein has a molecular weight of 15,000–17,000 d contains 130–150 amino-acids. This is in agreement with the analytical data of Knight[16] and with e observations of Schachman and Hersh[17] that the otein of tobacco mosaic virus dissociates in the esence of detergents into subunits of molecular eight 10,000–20,000.

The masking of the amino-terminal group in the tive virus is not due to the nucleic acid, as we eviously supposed; but we hope to elucidate its ture shortly.

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## Lunar Occultation of a Radio Star and the Derivation of an Upper Limit for the Density of the Lunar Atmosphere

On April 26, 1955, the moon's position was favourable for the observation from England of the passage f the moon across the large-diameter radio source the constellation of Gemini. This radio source, o. 2C.537 of the Cambridge survey[1], having A. 06h. 13m. 37s. and Dec. 22° 38′ (1950.0), has een identified by Baldwin and Dewhirst[2] as the alactic nebulosity *IC.443*, photographs of which, ken with the 48-in. Schmidt camera at Palomar, veal a filamentary structure contained within a rcular region of 24·5′ radius.

The Besselian elements of this and other occultations have also been computed by Link and Neuzil[3], ho have indicated the value of such observations determining the detailed distribution of radio rightness' across the source and in investigating the resence of a lunar atmosphere.

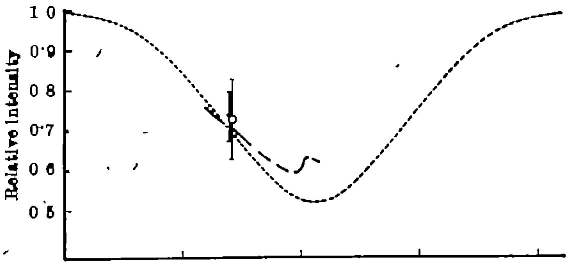

Fig. 1. Relative intensity during the occultation of April 26, 1955, ⊢●⊣ and ⊢○⊣ are measurements at $\lambda = 7 \cdot 9$ m.; — —, measurements at $\lambda = 3 \cdot 7$m.; · · · · · ·, curve predicted from the measurements of Baldwin and Dewhurst

Observations of the source were made at Cambridge t wave-lengths of 7·9 and 3·7 metres, during April 4–28 inclusive. Two independent sets of observations ere made at 7·9 metres, using large fixed-aerial ystems which provided information for about ten inutes near the meridian transit of the source. At ·7 metres the two pairs of the large Cambridge radio lescope[4] were used as interferometers of low solving power. In order to extend the period of observation, phasing cables were introduced into one pair of aerials, so that the reception pattern was deviated 8½° from the meridian. In this way it was possible to observe the source continuously for 25 min.

The results obtained are illustrated in Fig. 1. This shows the relative intensity observed at the time of transit, using the two 7·9-metre systems, together with the limits of error. The full line shows the results obtained at 3·7 metres; the gaps are due to intermittent man-made interference which caused a deflexion many times greater than the normal noise-level of the record. In the absence of interference, the accuracy of the results obtained at 3·7 metres is believed to be better than 5 per cent. The dotted line indicates the relative intensity predicted from Baldwin and Dewhirst's distribution derived on the assumption of circular symmetry.

Both sets of observations show good general agreement with the latter curve, but the reduction is less; the most probable explanation of this effect is that more radiation originates in the bright arch on the north-following side (Fig. 2), than in a symmetrical model.

An examination of the 3·7-metre curve shows, in addition, a marked irregularity near the time of maximum phase (16h. 30m.). Consideration has been given to the possibility that this discontinuity might be due to the reception of enhanced solar radiation scattered by the lunar surface; the absence of any evidence for solar activity some hours before and on succeeding days indicates that this explanation is most improbable and suggests that the effect must be explained in terms of irregularities in the 'bright-

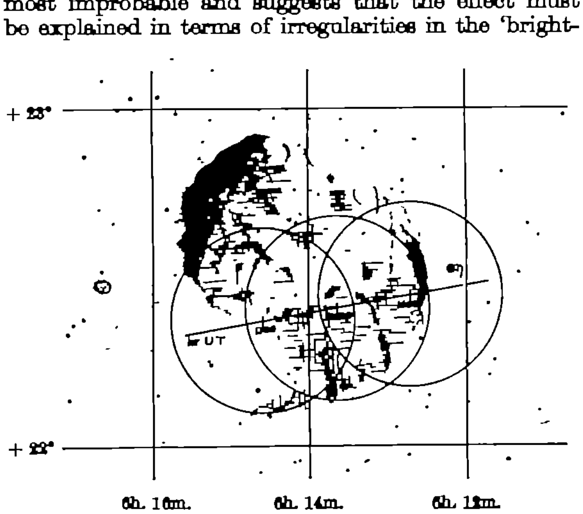

Fig. 2. Moon's position, as seen from Cambridge on April 26, 1955, in relation to *IC.443*. The centre of the radio source is indicated by a cross

ness' across $IC.443$. At this time the moon's west limb is uncovering a part of the well-defined filament on the extreme preceding side, near $\eta$ Geminorum (Fig. 2). The rise in radio intensity indicates that the radiation from this area is about five times greater than that expected from the circularly symmetrical distribution of Baldwin and Dewhirst.

Both this result and the magnitude of the intensity observed at the time of maximum phase are therefore consistent with the hypothesis that the radio emission originates mainly in the regions of strong $H\alpha$ emission.

If the identification of the increase of radio intensity with the uncovering of the bright area is correct, then the relative times of these occurrences may be used for estimating the density of the lunar atmosphere. Two effects would delay the radio occurrence: diffraction at the moon's limb, which at 3·7-metres wave-length produces a delay of about one minute, and refraction in the lunar atmosphere. Link[3] has computed the latter effect for a number of different models of the lunar atmosphere.

The observations show that the total delay cannot exceed 4 min., and the electron density in the lunar atmosphere cannot then exceed $10^4$ cm.$^{-3}$ if the scale-height lies in the range 50–1,500 km. Although the composition may differ considerably from the terrestrial atmosphere, it seems probable that, on the moon's sunlit side, the degree of ionization would be as great as that of the $F$-region. On this supposition the density of the lunar atmosphere must be less than $10^{-12}$ of the density of the terrestrial atmosphere at sea-level, a figure 1/1,000 of the previous upper limit derived by Dollfus[6] from optical measurements.

This work was carried out at the Cavendish Laboratory as part of a programme of research supported by the Department of Scientific and Industrial Research, to which one of us (G. R. W.) is indebted for a maintenance award. We also wish to thank Mr. J. H. Blythe for the use of one of the 7·9-metres aerial systems.

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## Reliability of Atomic Masses in the Chromium – Germanium Region

FOR the past thirty years, beginning with F. W. Aston's observation of small deviations from his whole-number rule, the mass spectrograph has been used for determining atomic masses. One of the first significant results of this work was the experimental proof[1] by Bainbridge in 1933 of Einstein's mass–energy relationship. This led to the frequent use of atomic masses to check the correctness of experiments which measured the energy balance in nuclear transformations. In the intervening years the accuracy with which atomic masses can be determined by mass spectroscopy has greatly improved: however, the techniques for studying nuclear reactions have more than kept pace. As a result, when a discrepancy now exists between mass spectroscopic and transmutation values, th mass spectroscopist often finds himself playing th part of uncomfortable defendant, rather than that ( patronizing judge. Such is our position in th communication.

In a recent communication[2] from the Universit of Glasgow, J. M. Reid and I. F. Wright have reporte experiments disproving the existence of the 0·56-MeV γ-ray which has been rumoured to follow the positro emitted by copper-62. This result, which has als been obtained[3] by R. H. Nussbaum *et al.*, gives ris as Reid and Wright point out, to a serious di crepancy (~ 0·65 MeV.) between the value of th copper-63 and nickel-62 mass difference compute from transmutation data and that calculated on th basis of recent precision mass measurements. The also remind us that a similar discrepancy exists in th case of the zinc-64 and nickel-64 mass difference, an properly advise the cautious use of mass values in th region of the Periodic Table. As mass spectroscopist we are naturally concerned about these matters, an actually have been aware for some time of the exist ence in this region of several such inconsistencie including these two. This communication is intende to direct attention to these inconsistencies and t suggest that a particular element, nickel, may be th principal cause of them.

In the hope of discovering some systematic dis crepancy between mass spectroscopic and trans mutation data, we have calculated a large numbe (thirty) of mass differences in the region chromiu to germanium, using both sources of informatio The mass spectroscopic differences have been ob tained, primarily, from the masses obtained[4,5] at th University of Minnesota by Prof. A. O. Nier and hi collaborators and, quite secondarily, from some de rived[6] in our own laboratory. The calculation of th transmutation differences would normally be physically exhausting undertaking, since it woul involve the use of a great deal of information scattere widely throughout the scientific literature. Fortu nately, at the suggestion of the Sub-committee o Nuclear Constants of the National Research Counc (U.S.A.), this information has recently been com pletely tabulated. In our calculations, we hav therefore made exclusive use of the table of "Nuclea Disintegration Energies", compiled[7] by D. M. Va Patter and W. Whaling, and the "Table of Tota Beta-Disintegration Energies", compiled[8] by R. W King, both appearing in the October 1954 issue c the *Reviews of Modern Physics*. The numerica results of these calculations are not included here since they present a rather formidable array; bu we can provide them for those particularly intereste

These calculations reveal that, between stabl nuclides of the same element (for example, iron-57 iron-56, nickel-61 – nickel-60, etc.), the transmutatio and mass spectroscopic differences are reasonabl consistent, particularly if one assumes that the actu mass spectroscopic errors are somewhat larger tha the stated statistical ones. The only serious in consistency exists in the case of the zinc-67 – zinc-6 difference.

In the case of mass differences between stabl nuclides of different elements (for example, iron-54 chromium-53, gallium-69 – zinc-68, etc.), the situatio is quite different and far less satisfactory. Here onl four of the sixteen calculated differences agree withi the stated probable errors, and many are far outsid the limits, in particular, those differences involvin one or other of the isotopes of nickel. In these fiv ses (nickel-58 – iron-57, nickel-) – iron-57, copper-63 – nickel-62, ckel-64 – copper-63, and copper-– nickel-64), without exception, e agreement is poor and always such a direction as to indicate at the masses of nickel determined ass spectroscopically are too low y ~ 60 × $10^{-6}$ atomic mass units. here appears to be no other large stematic effect.

On this basis, we are putting forard the hypothesis that the nickel asses are in error, and hope in e near future to make some xperimental attempts to confirm allay this suspicion by investiating the behaviour of nickel ions the mass spectrograph under arying conditions of pressure. In e meantime, we feel that, within e framework of the foregoing marks, the atomic mass values for e other elements in the chromm – germanium group may be sed with reasonable confidence.

This work is supported by the ffice of Scientific Research, Air esearch and Development Command, U.S. Air orce, the National Research Council of Canada and e Ontario Research Foundation.

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## Radioactive Fall-out in Kingston, Canada

During the recent nuclear tests carried out by the Jnited States Atomic Energy Commission, we have hecked the radioactive fall-out in Kingston, a small Ontario town situated some 2,200 miles north-east of he testing grounds. Our sampling period extended rom February 15 to May 28, 1955, and included all he test explosions reported by the Press.

For a large part of the sampling period the ground vas covered with snow; samples were taken from the op layer of the snow, melted and 600-c.c. samples iltered and the filter paper counted with a thin-window β-counter. When the snow left, rain was ollected and 600-c.c. samples were filtered and ounted. When all precipitation failed, dust was ollected on a tray, washed off, filtered and counted.

A record of the activity with the background ubtracted is shown in Fig. 1. Arrows along the bscissa indicate the day that a test was conducted, and in all cases except April 9 only one bomb was fired. Two explosions were detonated on this date. The largest reported explosions were set off from 500-ft. steel towers and were equivalent to 30 kilotons T.N.T. These were fired on March 7 and 22 and on May 5 and 15. They were detected, but they did not display as high an activity as smaller explosions on March 1 and April 9 and 15.

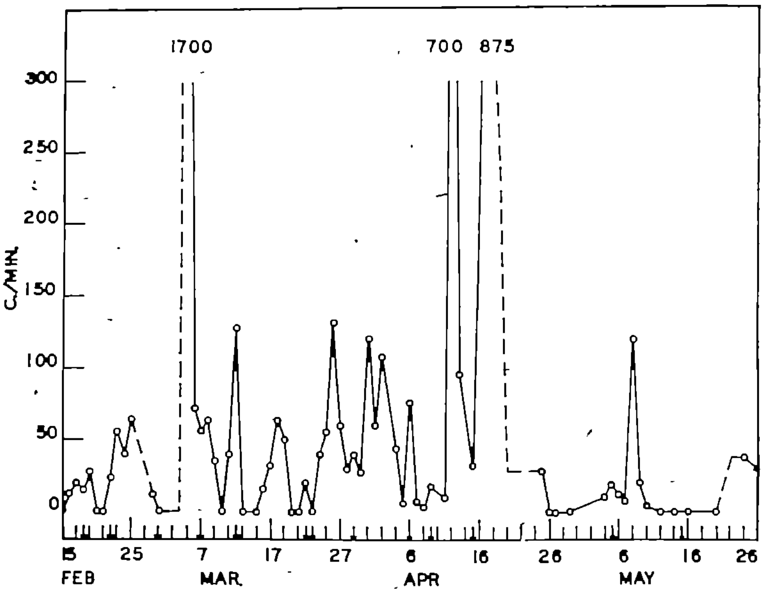

Fig. 1. Plot of counts per min. above background versus time. Dotted lines indicate lack of data because of equipment breakdown. Circles are experimental points and arrows indicate nuclear tests as reported in the Press

Meteorological factors seem to outweigh the magnitude of the bombs at such a great distance from the site of the explosion. The high activities detected on March 6 and 7 were found in fresh snow and the activities detected on April 12 and 18 were found in fresh rain. There is generally a one-to-one correspondence between tests and activity peaks, except for an unexplained peak at April 6, which may be due to some previous explosion.

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## Long-Period Fading in Medium-Wave Radio Signals

Considerable work has been done on the interpretation of periodic fading observed in continuous-wave radio signals reflected from the ionosphere. Appleton and Beynon[1] observed both slow and fast types of periodic fading in the records of short-wave radio signals which were interpreted by them as due to magneto-ionic origin. Tantry and Khastgir[2] reported long-period fading in the medium-wave records and assumed it to be due to interference of lower trajectory ordinary and extraordinary waves. This interpretation has been confirmed by Satyanarayana and Dharambir Rai[3] by using polarized receiving aerials. The object of the present investigation was to study the periodicity of this slow type of fading in medium-wave records, and compare the observed periodicity with the

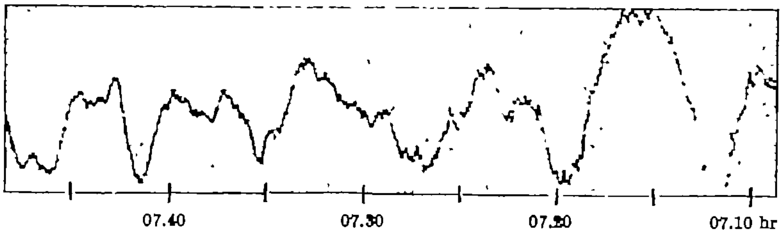

Fig. 1

values obtained from a theoretical calculation of the path-lengths in the ionosphere.

Records of variations of signal strength of continuous-wave transmissions on 1·42 Mc./s. from Madras received at Waltair (600 km. distant from Madras) during the morning hours have been obtained using the conventional type of continuous-wave recording equipment. Hourly records were taken daily during 0700–0800 hr. I.S.T. over a period of one month during May 1954. The records thus obtained showed a long-period fading of the order of 7 min. per cycle on which are superposed other types of short-period fading. A typical record obtained on May 14, 1954, is reproduced in Fig. 1. The long-period magneto-ionic fading on which is superposed a quick fading is clearly seen in the record. It may also be noticed that the fading period gradually decreases with time. On an average, nine peaks are observed in the one-hour records.

The expected periodicity in the records is then determined by using a method of theoretical calculation of the path-lengths in the ionosphere based on the magneto-ionic theory due to Appleton[4] and Hartree[5]. Appleton[6] has applied the magneto-ionic theory for the calculation of path-lengths of both the magneto-ionic components for the case of vertical incidence only; but Booker[7] has worked out the theory for the most general case of propagation at oblique incidence and obtained a quartic equation, which has enabled us to obtain the appropriate curves for the ordinary and extraordinary components of the radio wave for a frequency of 1·42 Mc./s.

The magnetic field at the level of the *E*-region has been assumed to be 5 per cent less than the ground value and the scale-height has been taken to be 15 km. The equivalent paths for the ordinary and extraordinary components in the *E*-region have thus been calculated for 0700–0800 hr. I.S.T. using a method of graphical integration and assuming Chapman's distribution for the electron density in the ionosphere. The critical frequency values at these times for the month of May have been taken from the data reported by the Physical Research Laboratory, Ahmedabad. Table 1 gives the calculated values of total equivalent paths from the transmitter to the receiver along with the path-differences between the two components expressed in terms of the wave-length λ of the radio signal.

From the table it is evident that the path-difference changes by 8·6 wave-lengths during the one hour of recording, giving rise to an average period of 7 min. per cycle, which is in good agreement with the observed values, as can be see from the record reproduced Fig. 1. This apparent good agre ment is possible because of th assumption of a value of 15 kı for the scale-height followi Pfister[8], who assumed this val in order to account satisfactori for the variations with latitude the heights of maximum ion conce tration of the *E*-region. Calcul tion of the path-lengths on the basis of parabol and cosine law distributions of electron density in tl *E*-region have given values which are much differe from the observed results.

Table 1

| | 0700 hr. | 0800 hr. |
|---|---|---|
| Path of the ordinary component | 4,104·6 | 3,852·9 |
| Path of extraordinary component | 3,956·9 | 3,713·8 |
| Path difference between the ordinary and extraordinary components | 147·7 | 139·1 |

Full details of this investigation will be publish elsewhere. We are indebted to the Council of Scienti and Industrial Research for financial assistance this research work.

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## Flexural Rotational Slip as the Main Deformation Process in the Torsion of Zinc Crystals

Hitherto there has been no successful elucidatio of the mechanism by which torsion of single crysta occurs. We have now, however, established that i zinc the main deformation process is rotational slip but in general with pronounced flexure of the sli lamellæ—a process we propose to call 'flexur rotational slip'.

For torsion about [0001], when this is nearl parallel to the axis of the cylindrical crystal (in th case examined, [0001] was 9¼° from it) practicall pure rotational slip on (0001) is indicated by: (1) th final spiral form of lines initially scribed lightly o the surface, parallel to the torsion axis [0001] (2) the form of the slip lines on the surface of th twisted crystals; (3) the practically perfect cleavag of the twisted crystals even after 90°/cm. twist (4) electron diffraction photographs from thes cleavages, virtually identical with those from cleave undistorted crystals; (5) optical reflexes from prism type etch facets.

The experimental results under (1), (2), (3) and (5 show that the torsion is macroscopically practicall uniform; those under (2), (3), (4) and (5) show th rotational slip of (0001) lamellæ; and those under (4 show these lamellæ are virtually undeformed an greater than 200 A. thick, while from those under (5 they are probably much thicker than this. Plasti torsion of 1-cm. lengths cleaved from this 0·97 cm diameter crystal (bonded by 'Araldite' resin to bras flats mounted in a lathe) first occurred at abou

1 kgm. cm. couple, which had to be increased to tain larger torsion, for example, to 2·75 kgm. cm. ter 7°/cm. torsion.

A crystal having [0001] at 38° to the rod axis was risted (held in split collars in chucks) in a lathe to °/cm. twist. Cleavage then gave highly smooth rfaces, optically and in electron diffraction closely milar to those from undistorted crystals, except at they were saddle-shaped. While calculation owed that a shape of this form would be expected be taken up by the inclined (0001) lamellæ if the d had been isotropic and in homogeneous torsion, e actual shape of the cleavage differed appreciably om that calculated. The difference is clearly due slip on (0001), associated with the very limited ange' possible in the dimensions of the lamellæ. nis also modifies the flexure imposed on the lamellæ, ading to deviation from circular cross-section of the d to the observed three-lobed form (the lobes rresponding to three rounded protruberances iralling around the rod surface).

These features were even more pronounced in a ystal having [0001] at 62° to the rod axis, and risted through 66°/cm. Curved slip lines (*S*-shaped side view) were prominent; and though a first eavage resulted in a fracture nearly normal to the d, along (0001) planes of the twins developed there ring the fracture, a good cleavage was then hieved by impact of a knife parallel to the slip lines, nfirming that these were still traces of (0001) planes.

These results for zinc establish for the first time at the main process during torsion is rotational p, in general with macroscopic flexure of the otherse undistorted slip lamellæ. Previous observations r example, in aluminium and iron[2]) now suggest at flexural rotational slip can also occur in cubic ystals even in compression or extension, the slip nellæ being not necessarily parallel to the same ane as in normal translational slip. We are testing ese points further.

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## Complex Formation between Montmorillonite and High Polymers

PREVIOUS workers[1] have shown from X-ray easurements that organo-clay complexes may be med by certain organic compounds entering tween the montmorillonite sheets. In the course mvestigating the interaction of various high lymers and montmorillonite, a new kind of comx has been observed, involving the edge faces of clay crystals only. This type of complex, tentaely called a 'peripheral' complex, has the same xis spacing as pure montmorillonite when dry, but fers markedly in its swelling pattern in dilute t solutions.

Up to the present, peripheral complexes have been med only from carboxylated polymers containing positively charged groups along the chains, such sodium alginate, carboxymethylcellulose and polyylic acid. The complexes were prepared by adding a known amount of polymer to an aliquot of a suspension of sodium saturated Wyoming bentonite and then drying the polymer-clay mixture to form an orientated clay disk 0·04 mm. thick. It was necessary to adjust the *p*H of the suspension to about the half neutralization point of the polymer before complex formation occurred, the latter being indicated by a rapid increase in the viscosity of the suspension. The swelling of flakes 0·5 cm. square cut from the disk was then observed in $N/2$ sodium chloride and distilled water (see Figs. 1 and 2 of flakes in water). A flake prepared from clay alone would, of course, disperse immediately in water.

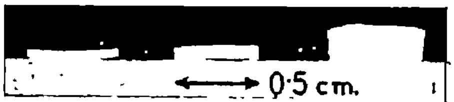

Fig. 1. 15, 7·5 and 4·0 per cent polyvinyl alcohol in water
Fig. 2. 125 per cent maleic acid vinyl acetate copolymer in water

In the case of inter-lamellar complexes, if a large amount of a polymer, such as polyvinyl alcohol, were added, swelling was small both in water and $N/2$ sodium chloride. However, flakes containing a concentration of polymer just sufficient to prevent dispersion, although still swelling little in $N/2$ sodium chloride, did expand appreciably in water. Flakes of peripheral complexes swelled to a limited degree in $N/2$ sodium chloride, approximately equal to the swelling of flakes made from clay alone, whereas in water highly vertically expanded gels were formed. The addition of further polymer did not reduce the vertical swelling but led to a marked lateral expansion in the case of more flexible polymers like polyacrylic acid. A similar swelling pattern has been observed with polymers added to pure illite and kaolinite.

It is suggested that in the peripheral complexes the polymer links the edge faces of the clay crystals by a series of hydrogen bonds to the oxygen and hydroxyl atoms exposed at the edges of the crystals. Further, it is considered that the polymer chains provide only the lateral links holding the clay crystals together, the vertical attractive force necessary to balance the repulsive osmotic pressure being due to electrostatic attraction between the crystals themselves. A full discussion of the experiments and the forces involved will appear elsewhere. The work is of practical importance in that commercial 'soil conditioners' increase the cohesion of soil crumbs by either one of the above methods.

I wish to thank Mr. L. F. Long for taking the photographs.

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## Separation of Rare-Earth Elements

The fifteen rare earths, together with actinium, yttrium and scandium, represent 20 per cent of the stable elements. Their properties are less known than those of the other elements mainly owing to the difficulties in their isolation.

The most important step towards the preparation of pure rare earths was the application of ion-exchange chromatography with complexing agents by Tompkins *et al.*[1], Spedding *et al.*[2] and Boyd *et al.*[3] in 1947. The ion-exchange work also provided comparative results on the complex chemistry of the rare-earth elements. One may even consider that these are the first valid results in rare-earth chemistry, as such data as melting points of acetylacetonates previously measured must now be regarded with suspicion because the purity of the rare earths then employed has since been demonstrated to be usually less than 80 per cent of the major constituent.

Elution sequences were hence used for comparisons of rare earths and transuranic elements with such complexing agents as citric acid or hydrochloric acid[4].

Other separation methods were also evolved and depended again on differential complexation of the rare earths, for example, paper electrophoresis[5,6] and paper chromatography[7,8] where separations were recorded with citric, tartaric and lactic acids, hydroxyquinoline and acetylacetone as complexing agents. It is easy to envisage further separation methods based on complex formation: gas-liquid partition chromatography with volatile complexes (for example, acetylacetonates), inverse phase partition chromatography with complexed rare earths, alumina chromatography with complexing developer, etc. These would all be not only of analytical but also of chemical interest as they could provide data for the volatility or extractability, etc., of the complexes employed.

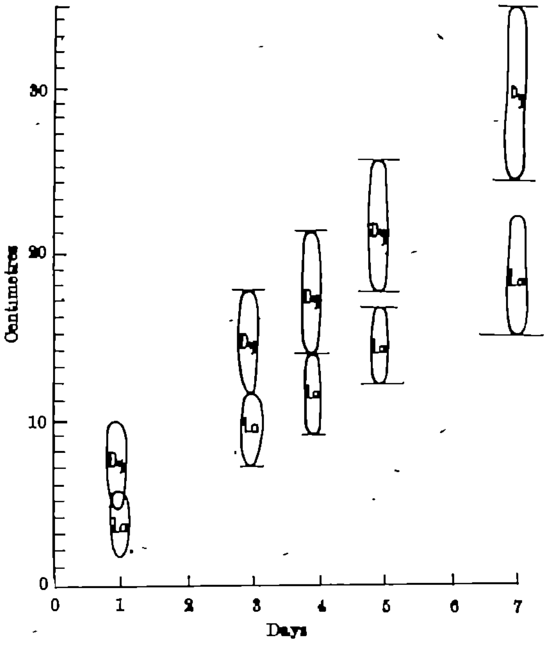

Fig. 1. Separation of lanthanum and dysprosium with ethanol–10 per cent 2 *N* hydrochloric acid as solvent. Descending development and the solvent allowed to run off the paper. The spots shown are larger than those obtained in other experiments as the paper was somewhat overloaded to permit detection with ease even with very diffuse spots

The complexing methods have not, however, contributed to knowledge of the hydrated (or no complexed) rare-earth ions. Alumina chromat graphy has provided some data in this direction but ion-exchange separations with non-complex rare earths did not prove successful[10].

An interesting paper by Gotte and Patze on t paper chromatography of fission products[11] mentio the partial separation of lanthanum and yttrium wi ethanol containing 30 per cent of 2 *N* hydrochloric ac as solvent. The authors of the aforementioned pap also state that other rare earths all stay with lant anum, thus suggesting a specific separation yttrium from the rare earths.

As in all ion-exchange series, yttrium is usual found between dysprosium and holmium, it w decided to investigate this anomaly of yttrium in t non-complexed state.

Owing to the lanthanide contraction, the differen of the ionic radii between lanthanum and dysprosiu will be about as big as the difference betwe barium – strontium or cæsium – rubidium. Th when a solvent is used in which (as in the case Gotte and Patze[11]) the $R_F$ difference between bariu and strontium is 0·16, the difference between lant anum and cerium would not be likely to exce 0·016. Thus in the search of a solvent for rare ear separation it is best to examine mixtures of lanthanu with a high atomic weight rare earth such as dy prosium or holmium where the difference of the ion radii is of the same order as that between, for e ample, barium and strontium. In our previous wo with non-complexed rare earths we did not consid this question, and reached a conclusion similar that of Gotte and Patze, namely, that rare eart do not separate with solvents such as ethanol–nitr acid (M. Lederer, Thèse, 1954).

In the experimental work mentioned below, employed a lanthanum–dysprosium mixture as t indicator for the exploratory work with vario solvents. This mixture has the ionic radius differen discussed above, and when the chromatogram sprayed with hydroxyquinoline, lanthanum produc a green fluorescent spot (in ultra-violet light), a dysprosium yields a black fluorescent spot. Hen even very small partial separation effects are readi observed.

We first examined the solvent ethanol – 30 p cent 2 *N* hydrochloric acid proposed by Götte a Patze[11] using descending development and allowi the solvent to flow over the paper for several day Thus instead of $R_F$ values we shall only state t distances moved, usually with lanthanum as referenc In the above solvent the following mixtures we separated :

| | | |
|---|---|---|
| Lanthanum – yttrium | lanthanum spot<br>27 1–30·3 cm. | yttrium sp<br>22 6–36·0 c |
| Lanthanum – dysprosium | lanthanum spot<br>24 7–28·8 cm. | dysprosium s<br>29·6–35·1 c |
| Lanthanum – ytterbium | lanthanum spot<br>27 8–30·7 cm | ytterbium s<br>31·2–34·8 c |

As seen, not only do lanthanum–yttrium separate co pletely but also lanthanum–dysprosium and lant anum–ytterbium are well separated. However, t lanthanum spot moves rather rapidly, and for separation of rare earths closer to each other th lanthanum–dysprosium it was considered desirab to look for a solvent with generally lower $R_F$ valu so as to permit better separation by longer develo ment with the solvent running off the end of the pap

Ethanol containing 10 per cent of 2 *N* hydrochlor acid appeared to be the best choice of the ethan hydrochloric acid mixtures yielding already comple

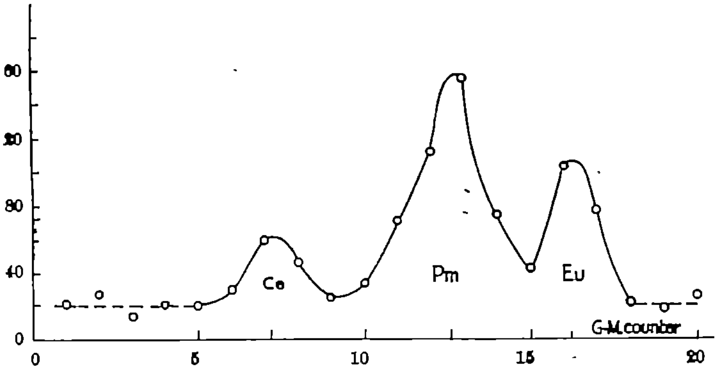

Fig. 2. Separation of cerium, promethium and europium. Solvent: ethanol, 90; 2 $N$ hydrochloric acid, 10. Descending for 5 days

ıthanum–yttrium separations with a development only 29 cm. (solvent front). The $R_F$ values under ese conditions are as follows:

| Ion | $R_F$ value | Ion | $R_F$ value |
|---|---|---|---|
| ıthanum | 0·11 | Dysprosium | 0·196 |
| etium | 0 16 | Ytterbium | 0 17 |

order to investigate if prolonged development l improve the separations, two sets of experiments re conducted: (1) The development of a lanthum–dysprosium over various lengths of time and the chromatography of mixtures of closer rare ths.

(1) The separations of lanthanum–dysprosium was ried out for various times between one and en days, and the fronts and rears of the spots are own in Table 1.

In the above experiments the amounts of rare ths were relatively large, so as to make detection ier with very diffuse spots as are formed on proged development. These results are better visuald by Fig. 1.

(2) To make detection easy, mixtures of two or ee rare earths were prepared so as to give adjacent ts of different fluorescence when sprayed with droxyquinoline and viewed under ultra-violet light. e mixtures thus studied were lanthanum–europium–rium, lanthanum–yttrium and lanthanum–dyssium with spots of lanthanum, yttrium, ytterbium, etium, erbium and europium run on the same sheet paper.

On four different chromatograms running for three four days the mixtures lanthanum–europium–rium, lanthanum–yttrium and lanthanum–dyssium were always completely separated into tinct spots. $R_F$ values of lanthanum, europium and rium did not change from the pure solution to the xture. From the few rare earths so far examined appears that the indicator mixture lanthanum–sprosium was fortunately chosen, as the $R_F$ values erbium, ytterbium and lutetium are inferior to se of dysprosium. Thus from the results so far to nd, the movement of the free ions does not follow e sequence of ionic radii, but reaches a maximum near dysprosium–yttrium. The following distances moved in three days on one particular chromatogram may be cited: lanthanum, 7·0 cm.; europium, 8·8 cm.; yttrium, 9·4 cm.; dysprosium, 11·3 cm. (lanthanum mixed with dysprosium, 7·1 cm.); and erbium, 10·2 cm.

Table 1

| Time of levelopment | Lanthanum spot | | Dysprosium spot | |
|---|---|---|---|---|
| | Front (cm.) | Rear (cm.) | Front (cm.) | Rear (cm.) |
| 1 day | 5·3 | 1·6 | 10 0 | 4·5 |
| 3 days | 11·3 | 7·0 | 17·5 | 11 4 |
| 4 ,, | 13 7 | 9 2 | 21·0 | 13 7 |
| 5 ,, | 16 7 | 11 9 | 25·3 | 17·9 |
| 7 ,, | 22 0 | 15·2 | 35 0 | 24·4 |

At this stage of the work a practical problem was suggested to us, namely, the purification of a source of promethium obtained from the fission products at Harwell and known to contain cerium and europium isotopes as impurities. A hydrochloric acid solution of about 1 mc. of the promethium was chromatographed for five days with ethanol containing 10 per cent 2 $N$ hydrochloric acid and separated as shown in Fig. 2 into three peaks of activity. A detailed study of the gamma spectra indicating the purity of the fractions obtained will be published later.

The results so far already indicate, however, numerous applications, and appear to be the first successful chromatographic separations in which the rare earths are separated as free ions instead of as complexes.

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# Effect of Sunlight on Mixtures of Vegetable Oils and Pigments

SUNLIGHT, according to recent work in these laboratories, is much more active in producing peroxides in the extracted crude lipids of certain vegetables (Lee, F. A., unpublished data), than in ordinary oils[1]. It is known that peroxides are produced when chlorophyll dissolved in oils or in oleic acid is exposed to light[2,3] and that, in the presence of chlorophyll, certain oils autoxidize[4]. Since the crude lipid preparations from green vegetables contain carotenes as well as chlorophyll, the effect of sunlight on colourless or nearly colourless oils mixed either with carotene or with carotene and chlorophyll was investigated. Chevallier *et al.*[5] studied the changes taking place in mixtures of triolein and carotene. They found that β-carotene retards the oxidation of triolein in the dark, but accelerates it in the light of a mercury-vapour lamp. In addition, chlorophyll dissolved in triolein prevents the oxidation-accelerating action of β-carotene in the presence of mercury-vapour light. In that work the chloro-

Table 1. EFFECT OF PIGMENTS ON PEROXIDE FORMATION IN ALMOND AND BRAZIL NUT OILS EXPOSED TO DIRECT SUNLIGHT

| | Unexposed blank | Untreated exposed | Chlorophyll added ¼ mgm. | Carotene added† | Chlorophyll ¼ mgm. carotene† |
|---|---|---|---|---|---|
| Almond oil | | | | | |
| extracted | 5 | 56 | 565 | 57 | 65 |
| expressed | 17 | 63 | 577 | 106 | 252 |
| Brazil nut oil | | | | | |
| extracted | Trace | 107 | 559 | 95 | 85 |
| expressed | 8 | 147* | 639 | 133 | 133 |

* Average of two rather poor checks. The accuracy of this figure may be open to question.

† Carotene added as follows: 3 mgm. to ether-extracted oils, 1 mgm. to expressed oils.

Note: The figures for the exposed samples in this table are net values, in that the figures for the unexposed control and the figures for the pigments exposed alone were subtracted.

phyll and the β-carotene solutions were separated by glass. The chlorophyll solution completely absorbed the violet and blue rays emitted by the lamp.

Almond oil was prepared by shelling fresh sweet almonds, removing the integuments by carefully scraping, cutting into small pieces and drying by lyophilization. Following this, they were ground and extracted with redistilled, peroxide-free, anhydrous ethyl ether for twenty-four hours in the dark. Brazil nut oil was prepared in a similar way.

20-mgm. samples of each of these oils were transferred to white porcelain evaporating dishes 100 mm. in diameter. One set was analysed for peroxide immediately, using the method described in previous publications[6,7]. Another set to which nothing was added was exposed to direct sunlight (10,000 ft.-candles) for an hour along with the other samples. Pigments were added to other lots, as shown in Table 1.

Another set was run in which the conditions were the same with the following exceptions: the nuts were not lyophilized, and the oils were expressed with a Carver press instead of being extracted with ethyl ether, and 1 mgm. of carotene was used instead of 3 mgm. The data are presented also in Table 1.

On exposure to 10,000 ft.-candles of sunlight for one hour, chlorophyll causes approximately a tenfold increase in the peroxide value of almond oil and five-fold increase in the peroxide value of Brazil nut oil. Probably because of its reducing action, carotene retards the production of peroxide. The peroxide values of carotene-oil mixtures were about equal to those of the untreated oils. With the addition of mixtures of carotene and chlorophyll, a higher peroxide value was obtained for almond oil and either a lower or an equal value for Brazil nut oil than with the addition of carotene alone.

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## Relationship between Orotic Acid and Animal Protein Factors of Casein

FOR several years the various manifestatio
induced in rats by the deficiency of new dieta
factors present in crude casein, that is, animal prote
factors of the casein, have been investigated in tl
laboratory. A natural diet, such as that propos
by Randoin and Causeret, namely: ground cere
(wheat, maize, barley, oats, rye), 88 per cent; whe
germ, 5 per cent; crude casein, 5 per cent; calciu
lactate, 1·5 per cent; sodium chloride, 0·5 per cen
carrots and fresh vegetables *ad libitum* twice a wee
enables normal growth and reproduction for ma
generations; but a series of changes occur wh
the crude casein is replaced by a casein purified
repeated washings with water[1–4]. These changes m
be summarized as follows: (1) alteration of the bod
weight curve; (2) high mortality in the newly bor
(3) histological lesions of the cells, mainly
the hepatic cells where lysis and necrobiosis occu
(4) cutaneous lesions and high incidence of ne
plasms in the surviving rats of the first generatio

These changes are accentuated in a second gener
tion and might be referred to as a 'late deficiency
They seem to be elicited by the gradual exhausti
of the reserve of the so-called animal protein facto
present in the organism fed on a normal diet and a
transmissible from the mother rats to their offsprin

Investigations conducted in our laboratory hav
demonstrated that these factors are not identifiab
either with the vitamins essential for the rat, i
cluding $B_{12}$[1,2], or with methionine and cystine[3]
with the various mineral elements present in th
Osborne–Mendel salt mixture[3].

Recently, our attention has been directed to th
significance of orotic acid in this type of deficienc
This has been occasioned by the fact that: (*a*) sma
quantities of whole cow's milk, which, as alread
known, is one of the richest natural sources of orot
acid[6], are able to solve one of the most dramat

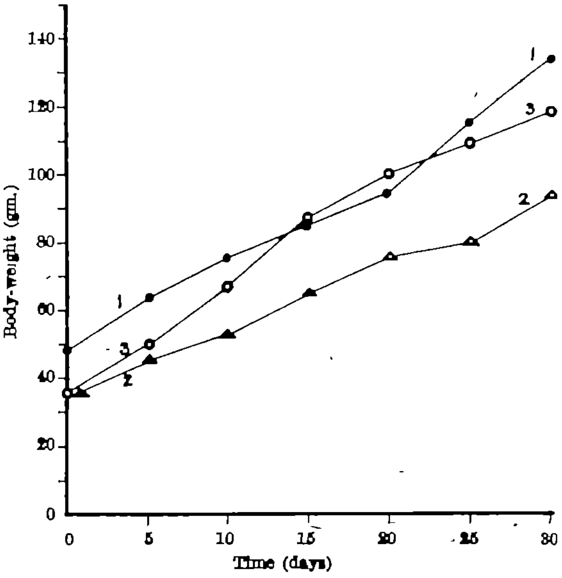

Fig. 1. Body-weight curves for rats fed on: (1) —•—•—, Randoin and Causeret diet containing crude casein; (2) —△—△—△—, Randoin and Causeret diet containing purified casein devoid of the animal protein factors; (3) —○—○—○—, Randoin and Causeret diet containing purified casein devoid of the animal protein factors and supplemented with orotic acid.

Each curve represents the mean body-weight values for twenty animals, male and female in equal number pects of the deficiency, namely, the high mortality the newly born[1]; (b) in our purified casein, which ems to be solely responsible for the lesions observed, e orotic acid content is much decreased[7].

We have therefore now investigated the influence orotic acid upon the body-weight curve of rats cking the animal protein factor.

Rats of the Sprague–Dawley strain, devoid of the imal protein factor, being the sole survivors of the st generation, were fed from weaning (21 days of e) on our deficient diet, which was supplemented th 1,000γ of orotic acid (manufactured by Bio- emical Inc., Co., Cleveland, Ohio) per 100 gm. of od. The results obtained are shown in Fig. 1.

The body-weight values for rats fed on a normal andoin and Causeret diet containing crude casein, d supplemented with 1,000γ orotic acid per 100 gm. diet, are not included, since orotic acid failed show any influence in these conditions.

From the above results, it appears evident that otic acid may be one of the growth-factors for ts deficient in animal protein factors, but not for rmal rats. This suggests a possible relationship tween orotic acid and the animal protein factors casein.

Further work is in progress in our laboratory in der to ascertain the role of orotic acid in the merous lesions induced in rats by the deficiency casein animal protein factors.

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## A New Method for the Microbiological Assay of Thiamin (Vitamin $B_1$)

THIS purpose of this communication is to present few experimental results obtained during the course f some investigations carried out to determine the utritional requirements of a fungus, *Tuberculina ersicina* (Ditm.) Sacc., isolated in 1949 by Dr. B. 'Oliveira from aecidia of *Puccinia rubigo-vera tritici*, nd since maintained in the fungus collection of the lant Pathology Department of Estação Agronómica acional, Sacavém, Portugal. These results seemed o be of special significance, and may eventually lead o the development of a new method of bio-assay of hiamin (vitamin $B_1$).

Several vitamins were tested as growth-promoting actors for *T. persicina*, namely, thiamin, biotin, iboflavin, pyridoxin, nicotinic acid, inositol and antothenic acid (this latter in the form of its calcium alt). The vitamins were added aseptically to a ynthetic basal medium (autoclaved for 20 min. at 07° C.) of the following composition: $KH_2PO_4$, 1·5 gm.; $MgSO_4.7H_2O$, 0·5 gm.; $KNO_3$, 2·0 gm.; dextrose ('Difco'), 15·0 gm.; agar ('Difco'), 15·0 gm.; distilled water, 1,000·0 ml. The final pH was adjusted to 5·2. Purified agar (according to Robbins and Ma's technique[1]) was consistently used throughout the experiments to avoid possible sources of error. After incubation for twenty days at 20° C., it was noticed that the plates to which thiamin had been added not only showed good growth of the fungus colony but also displayed an unusual pigmentation of the medium, whereas those lacking this factor remained colourless, even when all the others were present.

In further experiments, devised to ascertain the optimum levels of thiamin concentration for pigment production, liquid cultures were used preferentially; series of flasks were thus prepared by adding various amounts of vitamin $B_1$, within the range $5 \times 10^{-4}$ γ/l. to $5 \times 10^{4}$ γ/l. to the basal medium without agar. The cultures were incubated for thirty days, at the end of which time very striking differences in the coloration of the liquids were observed. When measured spectrophotometrically, these differences seemed to be directly related to the amount of vitamin $B_1$ present in the original culture medium. There was almost no pigment formation in the liquids of the control flasks, nor in those in which the thiamin concentration was lower than $5 \times 10^{-3}$ γ/l. Above $5 \times 10^{2}$ γ/l. of thiamin, there was a marked decrease in pigment formation, as may be seen from Table 1.

Table 1

| Thiamin concentration (γ/l.) | Optical density at λ = 3700 A. | Thiamin concentration (γ/l.) | Optical density at λ = 3700 A. |
|---|---|---|---|
| 0 | 0·083 | 5 | 0·900 |
| $5 \times 10^{-4}$ | 0·083 | $5 \times 10$ | 1·300 |
| $5 \times 10^{-3}$ | 0·082 | $5 \times 10^{2}$ | 0·280* |
| $5 \times 10^{-2}$ | 0·203 | $5 \times 10^{3}$ | 0·250* |
| $5 \times 10^{-1}$ | 0·430 | $5 \times 10^{4}$ | 0·178* |

* Culture medium diluted to 1 : 10 to permit a good reading.

Further experiments are being carried out to determine the influence of the different sources of carbon and nitrogen on pigment production by *T. persicina* in the presence of thiamin. Results will be discussed in a future publication.

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## The Duplication Mechanism of Deoxyribonucleic Acid

RECENT investigations have shown it to be more and more probable that genes are deoxyribonucleic acid molecules. Furthermore, Watson and Crick[1] have given strong arguments for assuming that these molecules consist of two polynucleotide chains wound helically in a large number of turns around a common axis and tied together by hydrogen bonds between pairs of corresponding purines and pyrimidines, so that adenine can pair only with thymine and guanine only with cytosine. In order to explain the duplication process of the deoxyribonucleic acid molecule, Watson and Crick have suggested that the two polynucleotide chains may be separated and each chain catalyses the synthesis of a complementary chain. The difficulty in this process is the separation of the two parallel helices which are highly intertwined and locked together by a large number of hydrogen bonds, the breakage of all of which would need a large amount of energy. To overcome this difficulty, Delbrück[2] has suggested a somewhat different mechanism, whereby the two chains are separated and later re-combined by a series of breaks and reunions in a zipper-like fashion. However, this mechanism also seems both too complicated and somewhat improbable since, for example, all these breakings of bonds would again need a considerable amount of energy.

A simpler mechanism for the duplication of deoxyribonucleic acid molecules is made possible by the recent suggestion of Gamow[3], that there seems to exist a one-to-one correspondence between the double polynucleotide chain of a deoxyribonucleic acid molecule of the Watson and Crick type and the single polypeptide chain of a protein (or enzyme) molecule of the Pauling and Corey type, whereby the linear information contained in a deoxyribonucleic acid molecule is translated one-to-one into that of a protein molecule, each one of the possible (about twenty) quadruples of purines and pyrimidines corresponding to one of the possible (about twenty) amino-acids. By this one-to-one correspondence, Gamow shows that a protein (or enzyme) molecule can be built up 'on the inside' of the double helix of a deoxyribonucleic acid molecule so that the order of the amino-acids is uniquely determined by the order of the purine–pyrimidines. However, since this correspondence is one-to-one, this process may obviously be inverted, the protein molecule now serving as the template or mould for the building up of a deoxyribonucleic acid molecule 'around' the protein molecule as axis, so that the order of the purine–pyrimidines is now uniquely determined by the order of the amino-acids. The new deoxyribonucleic acid molecule would therefore be an exact replica of the original one, apart from possible 'casting errors' which would lead to a 'mutated' form of the original gene deoxyribonucleic acid molecule.

In the mechanism here suggested, the protein 'pictures' of the gene deoxyribonucleic acid molecules built up by the Gamow process would thus serve a double purpose: (*a*) as suggested by Gamow, they may be the enzymes which catalyse, and thus control, the biochemical reactions in growth and development of the cytoplasm of the cell; (*b*) they may be the templates or moulds for the duplicati
process of the gene deoxyribonucleic acid molecul
Furthermore, the duplication of virus deoxyrib
nucleic acid molecules can proceed by this same mec
anism, thus explaining the fact that viruses can on
duplicate themselves when their deoxyribonucle
acid gets inside the cells of other organisms, becau
only here can the virus deoxyribonucleic acid mol
cules find both the protein material for the templat
and the nucleic acid material for the casting
replicas.

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April 1.

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## Anti-tumorigenic Action of Iodinated Compounds

As one of us (F. B. O.) had observed that th
administration of a mixture of aqueous solutions
potassium iodide and potassium iodate induce
favourable effects in cancer patients, we decided t
carry out an experimental study in rats.

White rats received an implant of spindle-cell sa
coma of a strain obtained by courtesy of Prof. E. Cru
Coke, of the Institute of Physiological Chemistry of th
University of Chile. Animals were given a dose
0·2 ml. per 100 gm. body-weight of a solution contai
ing 0·482 *M* potassium iodide and 0·083 *M* potassiu
iodate, three times a day, via oesophageal tube. I
this way, 43 mgm. of iodine per 100 gm. of body
weight was administered to each of these animal
every 24 hr. Previous experiments with ninetee
animals thus treated, giving the iodine solution eithe
two weeks before or on the same day as the implanta
tion of spindle-cell sarcoma, showed that the treat
ment produces a marked inhibition on the growth
the tumour; in more than 70 per cent the tumour
disappeared leaving no traces, whereas twenty-on
untreated animals developed large tumours and die
Of the first nine animals treated, six still survive–
116 days after treatment was suspended.

We then used another experimental series consist
ing of two groups of thirty-eight animals each. I
one group, the treatment was begun forty-five day
before the implantation of the sarcoma. The tumour

Table 1

| | Animals | | Weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
| First series | Control | No. of survivors<br>Size of tumours* | 11<br>1·9 | 11<br>3·9 | 8<br>5·7 | 5<br>6·0 | 3<br>7·4 | 1<br>6·5 | 1<br>6·8 | 0<br>— |
| | Treated | No. of survivors<br>Size of tumours* | 10<br>1·8 | 10<br>2·0 | 10<br>1·9 | 8<br>0·6 | 8<br>0·2 | 8<br>0·1 | 8<br>— | 8<br>— |
| Second series | Control | No. of survivors<br>Size of tumours* | 10<br>— | 10<br>1·4 | 10<br>2·6 | 5<br>3·3 | 5<br>6·8 | 4<br>7·5 | 1<br>8·2 | 0<br>9·5 |
| | Treated | No. of survivors<br>Size of tumours* | 9<br>— | 9<br>1·1 | 9<br>1·9 | 9<br>2·8 | 9<br>2·4 | 9<br>2·3 | 6†<br>3·0 | 6<br>— |
| Third series | Control | No. of survivors<br>Size of tumours* | 35<br>1·5 | 35<br>2·1 | 30<br>2·7 | 26<br>3·3 | 22<br>4·2 | 14<br>5·0 | 9<br>4·9 | —<br>— |
| | Treated‡ | No. of survivors<br>Size of tumours* | 34<br>1·5 | 34<br>1·5 | 34<br>1·2 | 34<br>1·3 | 34<br>1·5 | 34<br>1·8 | 34<br>1·6 | —<br>— |

* Average of greatest diameter of the tumour in cm.
† Three animals died accidentally.
‡ In thirty-two animals of this group there were no traces of the tumour by the seventh week of observation.

w in thirty-four animals of each group. During observation period of sixty-four days, thirty-four the non-treated rats died on account of large nours, ranging from 15 to 45 gm. in weight. All treated animals are still alive. Besides the four ated rats in which there was no initial tumour wth, all the treated animals of this group show traces of the tumour at present, due to its gression.

The iodide–iodate solution at the specified dose d rate of administration has been well tolerated, the extent that it has produced no hindrance of dily development.

Studies of the metabolism of these and other logenated substances, their influence on the weight different organs and their action on various mours, as well as the effect of smaller doses of the linated solution, are being carried out.

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## Oxidative and Photosynthetic hosphorylation by Chloroplast Fragments

Recently, Arnon, Allen and Whatley[1,2] described otosynthetic phosphorylation by isolated whole loroplasts; but chloroplast fragments were only ebly active in their experiments. On the other hand, have prepared a chloroplast fragment fraction hich caused oxidation of Krebs's cycle acids sociated with phosphorylation[3]; but this preparaon was inactive in photosynthetic phosphorylation. modifying the preparative procedure, I have now tained a chloroplast fragment fraction which used disappearance of inorganic phosphate either the presence of citrate or in the light.

Spinach leaves were ground, and the particles were ntrifuged and washed as described previously[3], cept that 0·02 *M* potassium ascorbate was used in ese procedures instead of citrate (cf. the legend of ig. 1). The fraction precipitated between 250 *g* d 1,000 *g* was referred to as the whole chloroplast action, and chloroplast fragments were sedimented 1,000–10,000 *g*. As shown in Fig. 1, the whole loroplast fraction decreased inorganic phosphate pon illumination, while, in the dark, the content inorganic phosphate remained nearly constant en in the presence of citrate. On the contrary, e chloroplast fragment fraction caused disappearnce of inorganic phosphate either in the presence citrate or upon illumination.

The conditions necessary for the photosynthetic hosphorylation by the chloroplast fragments seemed mewhat different from those for the oxidative osphorylation. The photosynthetic phosphorylaon was accelerated markedly by the addition of boflavin monophosphate but not by coenzyme I or , and the system seemed to be more stable at higher H values, at lower temperatures, in the absence of ded fluoride and in the presence of ascorbate. nder these conditions the photosynthetic phoshorylation proceeded approximately linearly with me during the reaction period of sixty minutes ig. 2). Calculated from the data of Fig. 2, the chloroplast fragment fraction, upon illumination, caused disappearance of 13·7 micromoles of inorganic phosphate per hour per 0·5 mgm. of chlorophyll at 10° C., *p*H 7·6, under aerobic conditions. The value for the whole chloroplast fraction was 20·9 micromoles. These values are in fair agreement with that of Arnon *et al.* (16·7 micromoles) for whole chloroplasts under anaerobic conditions.

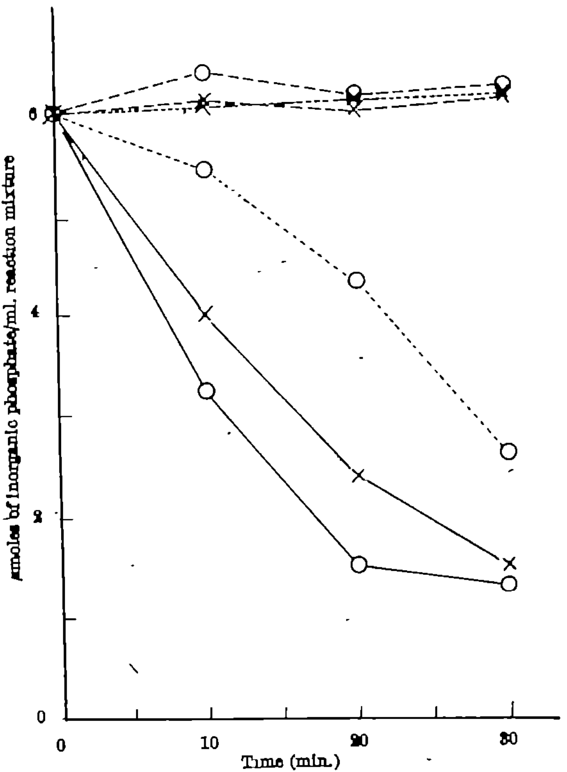

Fig. 1. Phosphorylation in the presence of citrate or in the light. ○,○ Chloroplast fragments containing 0·34 mgm. chlorophyll per ml. of the reaction mixture; ×,×, whole chloroplasts (0·18 mgm. chlorophyll/ml.); solid lines, in the light (c. 2,000 lux) without citrate; broken lines, in the dark without citrate; dotted lines, in the dark with 0·02 *M* citrate.

Spinach leaves were ground in a solution containing the following components in final concentrations: sucrose, 200 m*M*; sorbitol-borate buffer of *p*H 7·2, 50 m*M*; ethylene-diamine tetra-acetic acid, 20 m*M*; and potassium ascorbate, 20 m*M*. The particles were washed with, and suspended in, a solution of similar composition, except that the concentration of ethylene-diamine tetra-acetic acid was 10 m*M*. The reaction mixtures contained the following components in final concentrations: $MgCl_2$, 4 m*M*; $KH_2PO_4$, 6 m*M*; adenosine triphosphate, 1 m*M*; ethylene-diamine tetra-acetic acid, 3·3 m*M*; sucrose, 200 m*M*; glucose, 30 m*M*; sorbitol-borate buffer of *p*H 7·2, 67 m*M*; potassium ascorbate, 15 m*M*; NaF, 8 m*M*; yeast hexokinase, c. 14 units/ml. and crude coenzyme concentrate from pig liver, 0·5 mgm./ml. Erlenmeyer flasks of 50 ml. capacity each containing 3 ml. of the reaction mixture were shaken in the air in a bath of 15° C., and, at intervals, aliquots were withdrawn, deproteinized and inorganic phosphate was determined colorimetrically

Thus, at present, it seems to me that the photosynthetic phosphorylation is the coupling of the Hill reaction with the oxidative phosphorylation. My chloroplast preparations showed such high activities in photosynthetic phosphorylation, as described above even under aerobic conditions, and, in contrast to the finding of Arnon *et al.*, I have, thus far, not obtained results indicating that anaerobiosis was more favourable for obtaining higher activities of the reaction. However, in view of the fact that chloroplast fragments were always more active in photosynthetic phosphorylation than in oxidative phosphorylation, the photo-reduction product of the Hill reaction, that is, the substrate for the subsequent oxidative phosphorylation, may be different from,

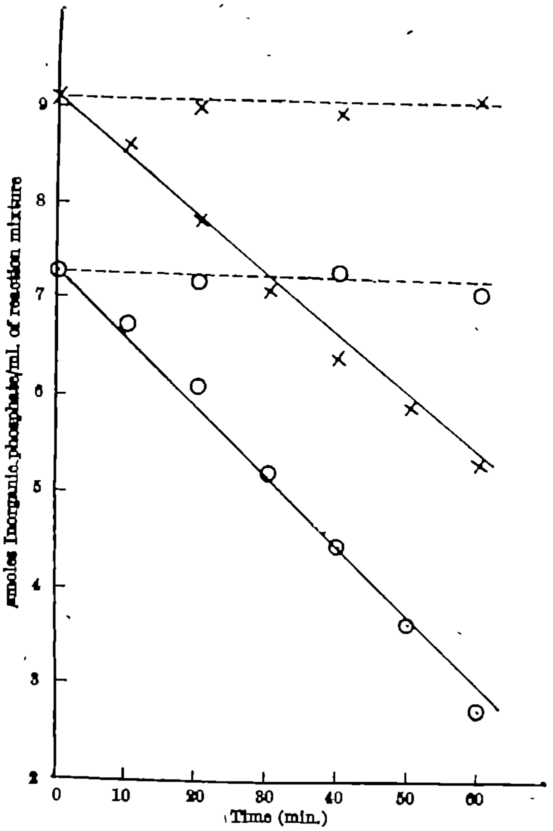

Fig. 2. Time course of the photosynthetic phosphorylation. ○,○, Chloroplast fragments (0·165 mgm. chlorophyll/ml.); ×,×, whole chloroplasts (0·090 mgm. chlorophyll/ml.); solid lines, in the light (*c.* 2,000 lux); broken lines, in the dark. Grinding and washing were carried out in similar solutions, as described in Fig. 1, except that 0·05 *M* *tris*-(hydroxymethyl)-aminomethane (tris) buffer of *p*H 7·6 was used instead of sorbitol-borate buffer of *p*H 7·2. Reaction mixtures contained the following components in final concentrations: $MgCl_2$, 4 m*M*; $KH_2PO_4$, 8 m*M*; adenosine triphosphate, 1 m*M*; ethylene-diamine tetra-acetic acid, 1·5 m*M*; sucrose, 200 m*M*; glucose, 30 m*M*; tris buffer of *p*H 7·6, 67 m*M*; potassium ascorbate, 20 m*M*; yeast hexokinase, *c.* 14 units/ml., and riboflavin monophosphate, 0·1 mgm./ml. Reactions were carried out at 10° C. in the air

and may be a more suitable substrate for the reaction than, the externally added citrate or reduced pyridine nucleotides. The inactivity of the whole chloroplasts in the oxidative phosphorylation may be explained by the impermeability of the added substrate to the site of the reaction.

I thank Prof. S. Funahashi for his advice and interest in this work.

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## Effect of Inhibition of Cholinesterase on the Motility of the Small Intestine

EXPERIMENTS with anticholinesterases have shown that the pseudocholinesterase of rat, dog and man can be inhibited without eliciting any symptoms of acetylcholine accumulation in the intact animal[1]. On the other hand, inhibition of the true cholinesterase by more than 80 per cent leads to acute disturbances indicative of acetylcholine poisoning, while comple inhibition of the true cholinesterase activity is i variably fatal. These results support the origir classification of the cholinesterases according physiological function as proposed by Mendel a Rudney[2], who surmised that the destruction of acet choline in the body, wherever it takes place rapidl is brought about mainly, if not exclusively, by t true cholinesterase.

Later experiments indicated that the contractio of the longitudinal muscle of the small intestine we increased by di*iso*propyl phosphonofluoridate amounts which did not cause more than 20 per ce inhibition of the true cholinesterase while inhibitir the pseudocholinesterase almost completely[3]. The results seemed to indicate that the pseudocholineste ase is concerned with the hydrolysis of acetylcholir in the muscle of the small intestine. Howeve Shelley[4] recently reported results which sugge that the pseudocholinesterase does not play a important part in the destruction of acetylcholir in the isolated longitudinal muscle coat of the rabb intestine *in vitro*. She found that the increase in th tone of the intestinal muscle ran parallel with th percentage inhibition of the true cholinesterase b eserine and by di*iso*propyl phosphonofluoridat regardless of the degree of inhibition of the pseud cholinesterase effected by these compounds. Th increase in tone in the longitudinal muscle fir appeared when less than 20 per cent of the tru cholinesterase was inhibited, and reached a maximu with total inhibition of this enzyme.

The results obtained in our experiments on th motility of the small intestine of the cat under mo physiological conditions have been briefly reporte previously[5] and confirm those obtained *in vitro* b Shelley[4]. For these experiments, a method wa designed by which the contractions of a segment c the small intestine with intact blood supply could b measured *in situ*, and the changes in intestinal motilit and cholinesterase activities were determined afte intravenous injections of three anticholinesterases di*iso*propyl phosphonofluoridate (DFP), tetraethy pyrophosphate (TEPP) and the prostigmine analogu (*Nu* 1250) described by Hawkins and Mendel[6]. Thes investigations also indicated that the pseudocholin esterase is not of primary importance for the hydrolysi of the acetylcholine formed in the small intestine while there is, on the other hand, a fairly clos correlation between the degree of inhibition of th true cholinesterase activity by the various compounds and their effects on the intestinal motility.

In confirmation of Shelley's findings, the motilit of the longitudinal muscle was increased when th true cholinesterase was inhibited by about 20 pe cent. The circular muscle appeared to be somewha less sensitive to all three anticholinesterases an required about 40 per cent inhibition of the tru cholinesterase before its motility was increased. I confirmation of previous observations on intac animals[6], it was found that peristaltic movement appear when the true cholinesterase is more tha 80 per cent inhibited. This difference may be explained by the fact that the normal rhythmic movements of the small intestine are due, to a large extent to acetylcholine of non-nervous origin, whereas th peristaltic movements depend on synaptic transmission in the myenteric plexus[7].

It is conceivable that there is a continuous equilibrium between the release and hydrolysis of acety choline in the muscle of the small intestine whic ffected by a relatively small inhibition of the true linesterase activity. On the other hand, a small ibition of the true cholinesterase appears to have measurable influence on the transient depolariza- produced by the intermittent release of acetyl- line at the synapses in the central nervous system, enteric plexus and ganglia and at the myoneural ctions in the skeletal muscles. As suggested by lley[4], the high acetylcholine content and the rela- ely low cholinesterase concentration in the longi- linal muscle of the small intestine may also be portant factors in determining the high sensitivity this tissue to inhibition of the true cholinesterase.

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## Concentration of *Brucella* Vaccine

Frozen-dried *Brucella* vaccine is in various ntries distributed in multiple-dose containers for nomy of production and convenience in use. The mber of viable, normal organisms per ampoule termines the number of subcutaneous doses one poule contains[1].

The dosage per ampoule may be raised by a simple, expensive and labour-saving technique.

Sodium-carboxy-methyl-cellulose as a substance th protective qualities which does not encourage e growth of micro-organisms had given some omise as preservative in viable liquid *Brucella* ccine[2]. It was also found to be an agglutinant for *ucella* organisms. Combination of these two pro- rties suggested its use for concentrating suspensions organisms before freeze drying.

Carboxy-methyl-cellulose (commercial, high vis- sity, type '70') was added to the *Brucella* vaccine spension in the form of a sterile watery solution d at the rate of 16 gm. per 4,000 ml. containing proximately $6 \times 10^{14}$ viable cells[3]. After agitation a 5-litre flask, this was held at 4·0° C. for 18 hr. allow for sedimentation of the cells. The super- tant was siphoned off and *mist. desicans* was added the sediment. The mixture was pipetted into npoules and freeze-dried on an Edwards Model . 3 apparatus.

Pre-drying counts showed $1,375 \times 10^{9}$ viable ganisms per ml., and a 50 per cent survival-rate was tained when the ampoule was sealed in pure nitro- n after freeze-drying. One half ml. dried in a 1·0 c.c. npoule thus contained $337 \times 10^{9}$ organisms or five ses of vaccine by the conventional standards.

Carboxy-methyl-cellulose is harmless, inert and mmonly taken internally. Parenterally it produced effect in 0·1 per cent solution under the skin. ological reactions of the concentrated vaccine in inea pigs and cattle have given results identical those obtained with vaccine made from agar surface culture. It was tested only in the prescribed density of $12 \times 10^{9}$ organisms per ml.

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## Hæmoglobin *E* in Indonesia

Five abnormal forms of human hæmoglobin, hæmoglobin *S*, *C*, *D*, *E* and *G*, have been described in addition to the normal adult (*A*) and fœtal (*F*) hæmoglobins.

Hæmoglobin *E*, which until recently was thought to be rare, has been found to have a high incidence among the Thais[1]. Its pattern of incidence may be of much anthropological importance. In the present communication I am now reporting the finding of hæmoglobin *E* among the Indonesian peoples.

In a previous communication, cases of Cooley's anæmia in Indonesian children have been described[2]. In order to identify the exact nature of this congenital anæmia, I made an electrophoretic study of the hæmoglobin in the erythrocytes of these individuals. At the same time a survey of pathological hæmoglobins among Indonesians was carried out.

The method employed was a slight modification of that described by Smith and Conley[3] using veronal buffer *p*H 8·6 and ionic strength 0·05. The hæmoglobin solutions were run 8–14 hr. at room temperature.

Five hundred samples of blood taken at random from patients at the Central General Hospital in Djakarta were examined. Most of the patients were from west Java, and the rest were from different parts of Indonesia; 479 were Indonesians, 13 were of mixed Chinese and Indonesian blood, and 8 were Indo-Europeans. Eighteen individuals showed a pathological hæmoglobin in addition to normal adult hæmoglobin. This pathological hæmoglobin has exactly the same electrophoretic mobility as the hæmoglobin *E* we received from Thailand (hæmoglobin *C* is slower and hæmoglobin *S* migrates faster). Its visible and ultra-violet spectra were the same as those of adult hæmoglobin. I therefore diagnosed hæmoglobin *E*.

Of the eighteen individuals carrying hæmoglobin *E* in their blood, sixteen were Indonesians, one was of mixed Chinese and Indonesian blood and one was an Indo-European. The incidence among the 500 individuals examined was therefore 3·6 per cent. No other pathological hæmoglobins were found electrophoretically.

Hæmoglobin solutions prepared from the erythrocytes of cases described as Cooley's anæmia in my earlier paper[2] were also examined. Two of the cases have only adult and fœtal hæmoglobin, which is the pattern expected in Cooley's anæmia. The third case

(case 2 in our publication, whose father was no longer alive for observations) was a case of Mediterranean-hæmoglobin *E* disease. In addition, two other cases of Mediterranean-hæmoglobin *E* disease were discovered.

In those carrying the trait, hæmoglobin *E* formed the minor component, whereas in Mediterranean-hæmoglobin *E* disease the pathological hæmoglobin was the major component (judged from the intensity of the spots on the paper). This fact was also observed by Chernoff *et al.* in their study of hæmoglobin *E* in Thailand. There was no increase in fœtal hæmoglobin (by Singer, Chernoff and Singer's method[4]) in any of the carriers of the trait examined.

Lehman (personal communication) recently found two carriers of the hæmoglobin *E* trait among people from Ceylon.

It is probable that hæmoglobin *E* is prevalent in South-East Asia, and a study of its incidence in different areas of this part of the world is of anthropological interest.

This work is continuing, and a more complete report will be made in the future.

Drs. Itano, Bergren and Sturgeon, who kindly made a comparative study of my pathological hæmoglobin with their own hæmoglobin *E*, found that the former is exactly the same as the original hæmoglobin *E* described by them in 1954. Dr. Itano established the identity by moving-boundary electrophoresis both at pH 6·5 and 8·6.

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## Predation Pressure and Evolution in Lake Nyasa

IN papers dealing with the evolution of fishes in the Great Lakes of East and Central Africa, Worthington[1-3] postulates that a major contributory factor to the great adaptive radiation shown by the family Cichlidae in certain lakes, notably Victoria, Edward and Nyasa, has been the absence from their waters of active predators. The theoretical implications of this suggestion have been accepted by Huxley[4] but have been criticized by Mayr[5].

Worthington's supposition is that large and vigorous predaceous fishes of the genera *Lates* and *Hydrocyon* which are present in several African lakes have played an important part in restricting the adaptive radiation of the non-predaceous species. In Lake Nyasa, where these genera are not represented, he claims that their place is taken by a much less vigorous type of predator in the form of two species of *Barilius*, and as a result large-scale radiation has been permitted to occur.

The results of recent work by us on the ecology and feeding habits of fishes inhabiting both the inshore regions and open waters, together with the results of the 1939 fishery surveys[6] and the work of Lowe[7], indicate that the restrictive effects of predation are not so important as Worthington suggests, as it is now clear that Lake Nyasa harbours a large number of markedly predaceous fishes, each major habitat
having its complement of predators. Although
difference in degree of predation exerted by *Lat*
and *Hydrocyon* and by the Nyasan predators is n
denied, this is probably compensated for by the gre
numerical abundance of some of the Nyasan specie

Predaceous species of the family Cichlidae inclu
the following: *Rhamphochromis* (at least eight specie
the dentition and diet of which are similar to th
occupied by the pikes of Europe and North Americ
*Serranochromis thumbergi* (Castelnau), *Aristochrom*
*christyi* Trewavas, and several species of *Haplochrom*
for example, *H. kiwinge* Ahl, *H. dimidiatus* (Günthe
*H. compressiceps* (Boulenger) and *H. macroston*
Regan. The non-cichlid piscivorous species inclu
*Bagrus meridionalis* Günther, *Barilius microcephal*
Günther, *Barbus rhoadesii* Boulenger, and sever
species of *Clarias*.

Many of these species feed exclusively or almo
exclusively on fishes except, of course, when ve
young. In addition, many other species living
the Lake can be classed as mild predators which ta
fish as part of their diet. Further, it has been observ
that almost any fish in the Lake, be it carnivore
herbivore, will take the eggs or fry of other fish
whenever the opportunity to do so arises.

Fishes in Lake Nyasa, therefore, do not lead liv
which are relatively uninfluenced by predators
Worthington suggests. On the contrary, the percen
age of predators appears to be extremely high, an
as it is improbable that all the predators represe
the most recently evolved species there is no reas
to suppose that, except perhaps in the very ear
stages of colonization, the Lake has ever been witho
its complement of predaceous species.

The fact that we cannot agree with the suggesti
that the great adaptive radiation shown by t
Nyasan fish fauna has taken place largely becau
of the absence of predators does not mean th
we adopt Mayr's view that the phenomenon ca
be explained on the basis of succession of coloniz
tions from a number of different river systems. Thi
while it may have played some part in the initi
stages of the process can certainly be discounted
an important cause of the state of affairs which exis
to-day. The purpose of the present note, however,
not to propose new theories but to indicate that a pr
viously widely circulated view can no longer be hel

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Nkata Bay, Nyasaland.

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## So-called Endosperm Embryos in *Isomeris arborea* Nutt

In 1937 Billings[1] published a paper on th
reproductive cytology of angiosperms, illustrated b
*Isomeris arborea*. His observations may be sum
marized as follows: (1) this plant is a haploid wit
a complement of 17 chromosomes; there is no tr
meiosis or syngamy; (2) the megaspore mother ce

otions directly without producing the usual gaspores ; (3) the mature embryo sac is 3-nucleate, sisting of two synergids and an endosperm nucleus, ue egg being absent ; (4) there is no fertilization ; the endosperm begins as free nuclear, but soon art of it becomes differentiated into multinucleate icles or nodules ; and (6) the embryo arises as a ot outgrowth from one of the endosperm nodules. 'rom time to time, other embryologists have ressed doubt on the accuracy of these reports and ssed the need for a re-investigation of *Isomeris*[1-4]. recent years Maheshwari and Khan[5], and Mahesh- i and Sachar[6] were able to rectify some of the ors made by Billings. Maheshwari and Khan[5] have arly shown that the megaspore mother cell under- s the normal reduction divisions and forms a ad' consisting of an upper dyad cell and two gaspores. The chalazal megaspore gives rise to 8-nucleate embryo sac of the *Polygonum* type. lings had assumed the absence of an egg cell and formation of the embryo from one of endosperm lules located somewhere in the lower part of the bryo sac. We found a perfectly normal egg cell l an embryo in the usual micropylar position.

A few points remained nevertheless to which a clue s been obtained only recently. These are : (*a*) ether fertilization is really absent ; (*b*) what is nature of primary endo- rm nucleus ; (*c*) what is the e origin and function of losperm nodules, and (*d*) at is it that brings the bryo to the basal part of embryo sac cavity ?

Billings stated : "the endo- rm nucleus in *Isomeris orea* is single in origin and haploid with respect to its romosome complement . . .". is is not true, as we have ind two polar nuclei lying e-by-side in the upper part the embryo sac. Actual ion could not be observed ; t the size and appearance of large central nucleus in any embryo sacs leaves no ubt that it represents the ondary nucleus.

Billings saw pollen tubes in ny ovules, but surmised that sperms were never dis- arged. Fig. 1 here clearly ows syngamy as well as triple ion, and it may therefore concluded that the embryo d the endosperm are diploid d triploid respectively, as is oical of most angiosperms. ice Billings never observed uble fertilization, he wrongly erred that the endosperm is ploid.

The zygote, while still at e micropylar position, under- es a series of transverse visions and forms a long iseriate pro-embryo (Figs. 4). Later, all the cells of e suspensor enlarge con- lerably in size and also become multinucleate (Figs. 8, 9). Their hypertrophied nature suggests a haustorial role. Due to the formation of an exceptionally long suspensor the embryo proper is pushed down in the lower part of the embryo sac. A study of whole mounts of embryo sacs dissected out from ovules was very useful and revealed features which had escaped notice in sections. It is now clear that the long suspensor often becomes coiled and twisted (Fig. 10). In microtome sections this organ is cut up into several segments which appear as multinucleate vesicles imbedded in the free nuclear endosperm. Billings, who had missed both the zygote as well as the young pro-embryo, was led to believe that these vesicles or nodules are derived from the free nuclear endosperm ; and as he saw a close connexion between these vesicles and the embryo proper in the middle part of the embryo sac, he postulated an endospermic origin of the embryo (Fig. 11). It is now evident that these vesicles, which were also provisionally accepted by us as endosperm nodules, are in reality the cells of the massive suspensor and have nothing to do with the endosperm (Figs. 5–7).

Briefly then, contrary to what Billings had said, *Isomeris arborea* follows the usual course of development followed in angiosperms, fertilization occurs normally, and the embryo does not arise from an

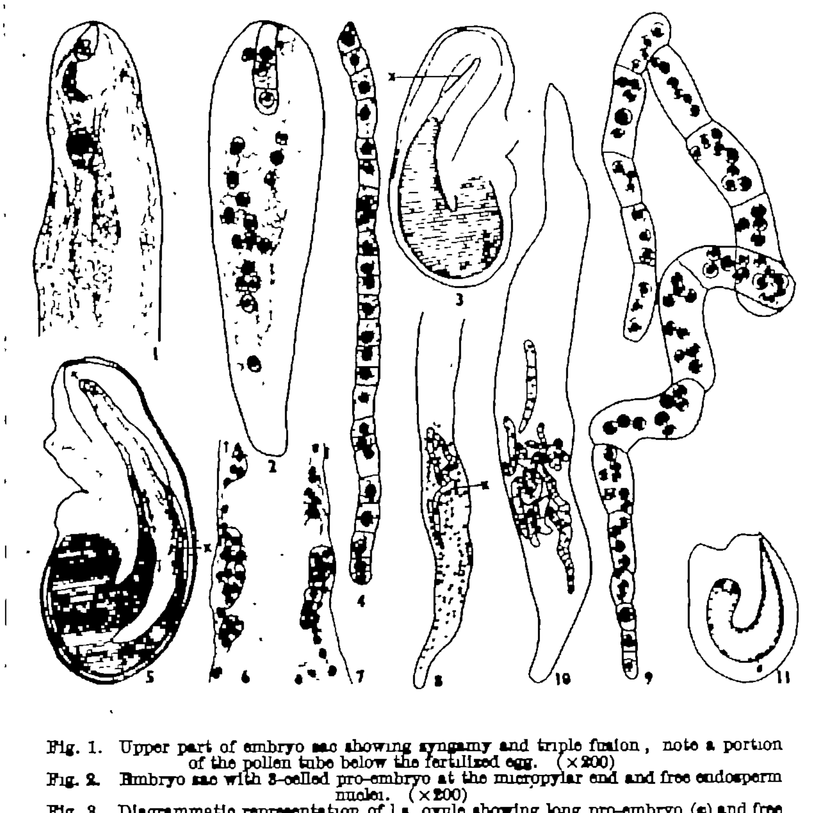

Fig. 1. Upper part of embryo sac showing syngamy and triple fusion, note a portion of the pollen tube below the fertilized egg. (×200)

Fig. 2. Embryo sac with 3-celled pro-embryo at the micropylar end and free endosperm nuclei. (×200)

Fig 3. Diagrammatic representation of l.s. ovule showing long pro-embryo (x) and free nuclear endosperm represented by dots. (× 20)

Fig. 4. Magnified view of the filamentous pro-embryo in Fig. 3. (× 200)

Fig. 5. L.S. ovule showing endosperm nodules in middle region of embryo sac. (× c. 20)

Fig. 6. Part of embryo sac enlarged to show endosperm nodules. (× 150)

Fig. 7. Part of embryo sac enlarged to show embryo marked x in Fig. 5. (× 150)

Fig. 8. Whole mount of lower part of embryo sac showing embryo (x) and free endosperm nuclei. (× 50)

Fig. 9. Magnified view of embryo in Fig. 8 to show the hypertrophied multinucleate cells of the suspensor and three uninucleate terminal cells. (× 218)

Fig. 10. Whole mount of embryo sac showing pro-embryo with massive coiled suspensor (endosperm nuclei not shown). (× 50)

Fig 11. Reproduced from Billings (ref. 1) to show the endosperm nodules along the wall of the embryo sac

endosperm nodule. The really interesting feature in the embryology of *Isomeris arborea* is the formation of a massive suspensor haustorium. This consists of densely cytoplasmic multinucleate cells which were misinterpreted by Billings as endosperm nodules.

Thanks are due to the Indian Council of Agricultural Research for a research grant in connexion with a scheme on "Chemical Stimulation of the Ovule", and to Mr. S. C. Maheshwari for some useful suggestions in the interpretation of the nature of the endosperm and embryo.

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R. C. SACHAR

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July 27.

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## Relationships between the Flying Fox (Genus *Pteropus*) and Arthropod-borne Fevers of North Queensland

DURING field investigations by one of us (L. C. R.) there was observed a fairly close relation in season and place with areas of the city of Townsville, North Queensland, Australia, in which an extensive epidemic of dengue fever occurred during the months of December 1953 to March 1954.

The history of past epidemics in Queensland, so far as can be traced, and also observations made by two of us (L. C. R. and J. L. O'C., unpublished) during the course of the 1953–54 epidemic suggested that members of the flying fox genus (*Pteropus*) might well serve as a reservoir from which the virus could be conveyed to regions closely in association with dwelling-places—because of the habit of these animals of swarming, just after nightfall, from their camps, usually in mangrove swamps, to fruit trees surrounding dwelling places, where they would thus come in close proximity with the known vectors in Townsville (*Aedes* (*Stegomyia*) *aegypti* Linn.).

In investigating this hypothesis a collection was made of various species of *Pteropus* in and around the Townsville area in the months of October–November 1954—about two months prior to the usual time of onset of dengue fever. It should be observed th only a few sporadic cases occurred in the city ov the period December 1954–November 1955.

Table 1

| Serial No. | Species | Deaths in mice* | Presence of antibody |
|---|---|---|---|
| *FF* No. 1 | *gouldi* | 0/6 | positive |
| 2 | ,, | 5/6 | negative |
| 3 | *scapulatus* | 5/6 | ,, |
| 4 | ,, | 2/6 | inconclusive |
| 5 | ,, | 3/6 | ,, |
| 6 | ,, | 4/6 | ,, |
| 7 | ,, | 3/6 | ,, |
| 8 | *gouldi* | 4/6 | ,, |
| 9 | ,, | 6/6 | negative |
| 10 | *scapulatus* | 3/6 | inconclusive |
| 11 | ,, | 6/6 | negative |
| 12 | ,, | 6/6 | ,, |
| 13 | ,, | 5/6 | ,, |
| 14 | *gouldi* | 0/6 | positive |
| 15 | ,, | 0/6 | ,, |
| 16 | ,, | 3/6 | inconclusive |
| 17 | ,, | 1/6 | positive |

* The numerator indicates the number of mice dead at the end of the test; the denominator indicates the number of mice inoculated.

Specimens of two species were obtained: sixte of *P. gouldi* and eighteen of *P. scapulatus*. The brai of these were submitted to histological examinatic and heart blood to serological test for protecti antibodies against the virus of dengue fever Type Mice were inoculated with a mixture of equal volum of inactivated undiluted serum and virus suspensi containing 100 mouse *LD* 50. Mixtures were incubat for two hours at 37° C. prior to injection into mice for each serum specimen.

The results of such protection tests are set out Table 1.

Those tests in which five or six mice survived taken as positive evidence of the presence of protecti antibodies, those in which 0 or 1 mouse survives a interpreted as evidence of the absence of antibod Tests in which 2, 3 or 4 mice survived are regard as inconclusive.

Although the challenge virus used was deng Type I (the Hawaiian strain isolated by Sabin), the results are not interpreted as conclusive of pe infection by that virus.

Current work by us indicate that there is a ve close serological relationship between the virus dengue fever (Type I) and of Murray Vall encephalitis.

J. L. O'CONNOR
L. C. ROWAN
Commonwealth Serum Laboratories,
Melbourne.

J. J. LAWRENCE
School of Public Health and Tropical Medicine,
University of Sydney,
New South Wales.

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## A Variable Dosage Sprayer for Agricultural Experiments

THE present method for testing in the field t toxicity and selectivity of herbicides or other spr chemicals necessitates spraying a number of separa plots with different dosages. Valuable time is wast in making up solutions and emptying the sprayi machine between operations. The time required longer the closer the gradations of dosage which it considered necessary to examine. We have design a machine which makes it possible with one filli to spray continuously decreasing concentratior starting from an arbitrary upper limit. A who spectrum of results is thus made available for exa ination in far less time than is consumed in getti less complete results by the established method.

The dilution principle used is to pump liquid the spray nozzles from an intermediate vessel whi is otherwise closed except for a lead tube from water-supply vessel, is equipped with an efficie agitator and is initially completely filled. As spr liquid is withdrawn it is replaced by water and t concentration falls in an exponential manner. coarsely porous plug in the entrance tube of t mixing vessel prevents adventitious dilution. T nozzles are carefully selected to have equal outp at a given pressure, and are fed by separate narro polythene tubes of equal length from a comm manifold as close as possible to the pump, that the same concentration reaches all nozzl simultaneously.

The pump is directly geared to the tractor on which the machine is mounted, and therefore the concentration taken into the pump is an exponential function of distance along the plot. Since it is necessary for air to be expelled from the spray system before the plot is reached, the simple principle above described is modified by providing also a direct tube from the water tank to a three-branch cock immediately above the pump. The tractor is driven towards the plot spraying water only, pumped through this line. The cock is then quickly thrown over and spraying of chemical commences. Owing to residual water in the pump and manifold, the concentration at the spray nozzles, after clearance of the tubes to the nozzles, rises steeply to a concentration somewhat less than that initially charged, before decreasing along the remaining length of the plot in an approximately exponential manner. The concentration is uniform across the plot. The form of the curve can be worked out theoretically from the volumes; but results are based on experimental calibration. The experimental curve is very accurately constant over the range of speed of a tractor working in one gear. Since the machine is effectively self-washing, repeated sprayings with the same or different chemicals can be made very rapidly.

The machine has enabled the expected advantages of speed and continuity to be obtained, and in addition provides a means of obtaining a rapid estimation of selectivity, and the dosage ratio for limiting crop-damage and limiting weed-kill. Changes in apparent effect with time are also easily observed. By filling throughout with the same spray liquid, the machine can be used for normal spraying. It is also possible to use the machine for examining the effect of admixture of herbicides or of a herbicide and an ancillary (for example, wetting) agent in continuously varying ratio. The exponential form for one concentration or ratio is not, however, the most satisfactory for this application, and a modified machine, using two mixing tanks in series, which gives a sigmoid concentration–distance curve, is to be preferred.

Our thanks are due to Mr. A. Ross for construction of the machine and to the directors of Fisons Pest Control Ltd. for permission to publish this account.

R. Pfeiffer
R. T. Brunskill
G. S. Hartley

Chesterford Park Research Station,
Near Saffron Walden,
Essex. July 14.

## Live Coelacanths

From the discovery of the first Coelacanth at East London in 1938, it was my aim not only to discover their true home, but also I hoped to live to see a living Coelacanth, and for mankind generally to be able to see this living link with the incredibly remote past. When *Malania* was found at the Comores, I planned to catch Coelacanths alive and to keep them alive. It is therefore gratifying that the French are plainly making every endeavour to achieve this. The article by Prof. J. Millot in *Nature* of February 26, 1955, on the experience of the first living Coelacanth at the Comores is of special interest.

The failure of the French to keep their fish alive for more than a few hours is attributed by them to decompression combined with rise in temperature of the water, while a high degree of photophobia on the part of the fish is alleged. While there may be something in this, in my view the cause is probably quite different. Prof. Millot and his collaborators are possibly not aware of the experience that large fishes taken alive after a struggle on a line even with no visible laceration rarely live long after, certainly not in aquaria, and even when liberated many die very shortly. Curiously enough, fishes taken by harpooning, even when extensively gashed, show a greater survival-rate than those taken on hooks. Coelacanths caught by net or trap and kept in a closed vessel will almost certainly have a greater chance of survival even at normal pressure.

It is doubtful whether the view about decompression or small variation in temperature is tenable, since after being hauled to the surface in a trawl-net near East London, the first Coelacanth lived for more than three hours, out of the water, on the deck of a trawler on an unusually warm day.

It is interesting to note that the French used a boat as an improvised aquarium. At a meeting in Nairobi in October 1953 I suggested a decked boat, since it seemed likely that an important factor in survival would be to shield the fish from shocks until such time as it could become accustomed to a new environment. An open whaler, however, was used at Matsumudu, so that the fish had a clear view. We are told that "Throughout the night, which the delighted population of Matsumudu passed in singing and dancing to celebrate the capture, the Coelacanth was watched over with admirable care", by officials, doubtless with constantly flashing torches, and only those who have experienced a night such as is indicated here can have any idea of the noise and lights: the Coelacanth at Matsumudu must have passed the night in a state of high nervous tension.

What the French considered 'photophobia' on the part of the Coelacanth is, in my view, no more than the natural uneasiness that any large and intelligent fish would experience as unfamiliar surroundings and objects become increasingly obvious from dawn.

The 'luminescence' of the eyes of the live Coelacanth is interesting. This phenomenon is, however, quite common in sharks and other large fishes of shallow waters, and on this night there was bright moonlight.

It is a notable feature of the reports that the depth to a metre at which each Coelacanth was caught has been stated. As all these were apparently taken by natives fishing from drifting canoes at night, and the slope of the bottom offshore at the Comores is stated to be at least 50°, it would be of general interest to know how this high order of accuracy is achieved.

In the matter of the first egg-bearing female Coelacanth, it is a strange coincidence that this was captured by one of the crew of Captain Hunt's vessel. only a short distance from where this was anchored. (It was Captain Hunt who took our Coelacanth leaflets to the Comores, which resulted in the discovery of *Malania* there.) The fish was apparently cut open and seen to contain a cluster of eggs at all stages of development "such as is observed in a fowl", or in oviparous sharks. We may therefore expect Coelacanths to have egg-cases like those of Elasmobranchs.

J. L. B. Smith

Rhodes University,
Grahamstown,
Cape Province.
June 17.

# FORTHCOMING EVENT

## Sunday, September 4—Wednesday, September 7

British Association for the Advancement of Science (at Bristol).—Continuation of Annual Meeting.

**Sunday, September 4**

At 11 a.m.—(in Bristol Cathedral)—Religious Service. Preacher: the Rt. Rev. the Lord Bishop of Bristol.

At 8 p.m.—Prof. H. D. F. Kitto: "Scientific and Dramatic Modes of Thought".

**Monday, September 5**

At 10 a.m.—Mr. W. N. Edwards: "Geographical Distribution of Past Floras" (Presidential Address, Section C).

At 10 a.m.—Dr. R. S. Creed: "The Sensory Pathway" (Presidential Address, Section I).

At 8 p.m.—Mr. R. J. C. Atkinson: "Stonehenge in the Light of Recent Research".

**Tuesday, September 6**

At 2.30 p.m.—Mr. B. J. Mason: "Man's Influence on the Weather: Recent Progress and Future Possibilities" (Special Lecture for Young People).

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Physicist (Basic grade) at the Regional Radium Institute, Bradford—The Secretary, Royal Infirmary, Bradford (September 12).

Tutor in Geography—The Registrar, The University, Liverpool (September 12).

Scientific Officer (with an honours degree in chemistry) for scientific control and development at Northern Outfall Works, Beckton, E.6—The Medical Officer of Health (PH/D1), County Hall, London, S.E.1 (September 14).

Lecturer in Pharmacology at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (September 15).

Physicists and Mechanical Engineers (with a first- or second-class honours degree in physics or mechanical engineering, and preferably with some understanding of aerodynamics) at the Royal Aircraft Establishment, Farnborough, Hants, for research and development mainly concerning engineering, instrumentation and problems of parachute development and application, vulnerability of aircraft, refrigeration and air conditioning—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.304/5A (September 17).

Senior Research Officer or Research Officer (with a university honours degree in science or fuel technology) in the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, Australia, to participate in the studies being undertaken to evaluate combustion characteristics of Australian coals—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/154-2 (September 24).

Lecturer or Assistant Lecturer in Metallurgy—The Registrar, The University, Leeds 2 (September 26).

Assistant Lecturer in Dairy Bacteriology—The Registrar, University College of Wales, Aberystwyth (September 30).

Lecturer in Mechanical Engineering—The Registrar, College of Technology, Manchester 1 (September 30).

Junior Research Fellow (with a physics degree) in the Instrument Technology Section of the Physics Department, for photo-electronic research—The Professor of Instrument Technology, Imperial College of Science and Technology, London, S.W.7 (October 1).

Society for Analytical Chemistry Research Fellow (with at least an honours degree or A.R.I.C., and with experience in analytical chemistry) in Analytical Chemistry, for work concerned with the determination of elements by means of radiochemical methods—The Secretary of the Analytical Methods Committee, The Society for Analytical Chemistry, 7–9 Idol Lane, London, E.C.3 (October 1).

Chair of Cultural Anthropology at the University of the Witwatersrand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, October 10).

Lecturer in Philosophy at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 15).

Lecturer in Physics at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 15).

Chair of Engineering at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Tasmania, October 30).

Senior Lecturer in Bacteriology and an Assistant Lecturer in Bacteriology at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, October 31).

Assistant Experimental Officer (with at least G.C.E. (advanced level) or intermediate B.Sc. with mathematics) as Assistant to Statistician, for computational duties and some photographic work—The Director, Anti-Locust Research Centre, c/o British Museum (Natural History), Cromwell Road, London, S.W.7.

British Steel Castings Research Association Fellow (graduate, with some research experience) to work under the direction of Dr. T. P. Hoar in the Department of Metallurgy at Cambridge University, on problems relating to steel castings—Dr. T. P. Hoar, The Department of Metallurgy, Pembroke Street, Cambridge.

Chair of Physiology at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1.

Group Leader (Nuclear Physics Branch) to develop specialized electronic circuits for nuclear physics research in an expanding Branch whose facilities include a 6 MeV. Van de Graaff generator and other accelerators—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. 747/34.

Technical Officer (qualified chemist) to act as Secretary to committees preparing standards in the chemical and related fields—The Establishment Officer, British Standards Institution, 2 Park Street, London, W.1.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Your Weather Service. Prepared by the Meteorological Office and the Central Office of Information. Revised edition. Pp. 52+8 plates. (London: H.M. Stationery Office, 1955.) 1s. 6d. net. [276

The Curtis Museum, Alton, Hampshire, 1855–1955: the First Hundred Years of a Small Museum. By William Hugh Curtis. Pp. vii+55+10 plates. (Alton: Curtis Museum, 1955.) 6s. [276

Plants of the Sea. By Prof. W. E. Isaac. (Inaugural Lecture delivered before the University of Cape Town, April 1955. University of Cape Town Lecture Series—No. 6) Pp. ii+23. (London: Oxford University Press, 1955.) 3s. 6d. [276

Department of Scientific and Industrial Research. Food Investigation Special Report No. 60: Eggs and Egg Products. By Dr. J. Brooks and D. J. Taylor. Pp. vi+106. (London: H.M. Stationery Office, 1955.) 4s. net. [296

Aero Research Technical Notes. Bulletin No. 149: "Redux"—The First Twelve Years. Pp. 6 (Duxford: Aero Research, Ltd., 1955.) [296

A Critical Study of Electrical Stunning and the Jewish Method of Slaughter (Shechita). By Rabbi Solomon David Sassoon. Pp. 40+2 plates. (Letchworth: Rabbi Solomon D. Sassoon, 15 Sollershott East, 1955.) 2s. 6d. [296

## Other Countries

Unified Symbolism for World Understanding in Science, including Bliss Symbols. By Prof. Oliver L. Reiser. (A Paper read in parts at the Annual Meeting of the American Association for the Advancement of Science, Philadelphia, 1951, and at the Conference of the International Society of Significs, Amsterdam, 1953.) Pp. 52. (Sydney: Semantography Publishing Company, 1955.) [276

British Guiana. Report on the Geological Survey Department for the year 1953. Pp. i+111+14 figs. (Georgetown: Geological Survey, 1954.) 2 dollars. [276

Union Observatory, Johannesburg, S. Africa. Annual Report for 1952. Pp. 4. (Johannesburg: Union Observatory, 1954.) [276

Report on Drug Addiction. By the New York Academy of Medicine (Committee on Public Health, Subcommittee on Drug Addiction). Pp. 33. (New York: New York Academy of Medicine, 1955.) [276

Commonwealth Observatory, Canberra. Report of the Commonwealth Astronomer for the year 1954. Pp. 8. (Canberra: Commonwealth Observatory, 1955.) [276

Annual Report of the Queen Victoria Museum and Art Gallery for the year ended 1953–1954. (Ninety-seventh year.) Pp. 7. (Launceston: Queen Victoria Museum and Art Gallery, 1955.) [276

Companhia de Diamantes de Angola. (Diamang.) Serviços Culturas. Dundo—Lunda—Angola. Museu do Dundo. Subsidios para a História, Arqueologia e Etnografia dos povos da Lunda. Campanha Etnográfica ao Tchiboco (Alto-Tchicapa): Notas de Viagem. Por José Redinha. Pp. 172+5 plates. (Lisboa: Companhia de Diamantes de Angola, 1953.) [276

Report on the Scientific Results of the *Michael Sars* North Atlantic Deep-Sea Expedition, 1910. Vol. 4, Part 2, No. 4: Iniomi (Myctophidae exclusive), Lyomeri, Apodes from the *Michael Sars* North Atlantic Deep-Sea Expedition 1910. By Einar Koefoed. With a section of the Serrivomeridae by M.-L. Bauchot-Boutin. Pp. 15+2 plates. (Bergen: University of Bergen, 1955.) [296

Commonwealth Scientific and Industrial Research Organization, Australia. Soil Publication No. 4: The Soils of the Macquarie Region, New South Wales. By R. G. Downes and J. R. Sleeman. Pp. 72+1 map. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1955.) [17

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# EDUCATIONAL POLICY AND MAN-POWER

THE debate on scientific and technical man-power in Great Britain which was initiated by r. Austen Albu in the House of Commons on July 1 added little to the observations on that subject hich have since been published in the report of the dvisory Council for Scientific Policy. The debate as noteworthy, however, for the way in which it elated the man-power situation in Britain to ducational policy as a whole, and it also elicited rom the Minister of Education a statement as to ducational policy, and particularly the policy he nvisages for technical education. Much that Sir avid Eccles said was fundamentally sound, and the ull statement which he promised to make before hristmas will be awaited with great interest. The ery fact, however, that Sir David Eccles confined imself, on this issue of scientific and technical manower, to the expansion of technological and technical ducation, and left the question of university educaion to be dealt with by the Financial Secretary to he Treasury, emphasizes the unhappy division which as been responsible for so much frustration and utility in the past.

Neither Sir David's speech nor that of Mr. Henry rooke gave any indication that this position is to be emedied, and Sir David's rather lame attempt in lefence of his recent acceptance of the recomnendation in the report of the National Advisory ouncil for Education for Industry and Commerce or the institution of a new award for technology lamps hopes of a new and vigorous policy which his peech might otherwise have raised. There is little ndication that the real issues are appreciated, and esources and effort will apparently continue to be listributed too widely or frittered away on nonssentials instead of being concentrated where they vill be most effective. Sir David rightly emphasized hat we should not expect to expand the output of cientists and technologists or technicians cheaply; ut he has equally pointed out the necessity of careful election and timing in order that our limited resources nay be expended to the best advantage. That canot be done without a clearer conception of the elation between technological and technical and niversity education than was shown by the Governnent speakers in this debate. The Minister fully ecognized the human aspect of the problem and hat it is not a matter merely of providing facilities: t is also a matter of persuading more boys and girls o continue their education in particular ways and to adopt particular careers. The creation of a favourble public opinion is a most important factor in ecuring the conditions which will induce boys and irls to adopt the careers which the public interest t any particular time demands, whether it be as cience teachers in the schools, as teachers of techology in the colleges of technology or the univerities, or as technicians and technologists in industry r the public corporations or State departments hemselves.

This is a matter which calls for close co-operation, not merely between industry and the colleges of technology and technical colleges, but also with the secondary schools and the universities and university colleges. The bias against a career in industry or technology is only likely to be removed when the value of technology as an intellectual discipline itself is fully recognized within as well as without the universities. This is an essential factor in inducing a sufficient number of the ablest students to adopt a career in applied science and in attracting to the colleges of technology teachers of outstanding ability. The real objection to the proposed new award is that it does nothing to help the colleges of technology or the technical colleges to gain the status that alone will give the award any value. It ignores the extent to which the professional institutions already provide hallmarks of proficiency, and may well divert effort which could be better expended in creating the teaching conditions and facilities likely to attract teachers of the necessary calibre.

It was clear from Sir David's remarks here that he did not appreciate the importance of academic autonomy as a condition of obtaining staff of the highest qualifications and ability for selected colleges of technology, nor that the number of such men and women is too limited to hold out any real hope of staffing twenty, let alone thirty, colleges of technology on the scale necessary. Sir Hugh Linstead, indeed, questioned the practicability of so staffing more than half a dozen colleges. While, too, there can be no doubt as to the importance of securing the full interest and support of the local authorities, the Minister's view that the colleges of technology selected for development as regional centres cannot therefore be independent of local control is open to challenge. The surrender by the Manchester City Council of its share with the University in the administration of the Manchester College of Technology on the grant of the Royal Charter to the College shows that local authorities may well possess more vision and judgment than the Minister allows. This new charter provides for the setting up of an independent board of governors appointed by interested bodies and, seeing that the Royal Charter has been granted at the request of the Manchester City Council, the University of Manchester and the County Councils of Lancashire and Cheshire, it is inconceivable that academic autonomy will mean any diminution of local interest or pride. Much of the introductory teaching hitherto done at the College will in due course be transferred to other technical colleges in the neighbourhood, leaving the College of Technology as a centre for advanced teaching at degree standard, for training postgraduate students in several branches of technology and for research in these fields. Sir David Eccles himself contemplated this transfer of functions from the regional colleges, and his indifference to academic autonomy and to the views of the professional institutions may well be a direct consequence of the division of responsibility which leaves university education to the Chancellor of the Exchequer, acting through the University Grants Committee. The need for transferring the responsibility for higher technological education fairly and squarely to the University Grants Committee, or alternatively for creating, as Sir Robert Robinson has been the latest to suggest, a technological grants committee, acting in close co-operation with the former body, but independent and with adequate financial appropriations, could not be better demonstrated.

Nor might this change alone suffice. To remove the responsibility for technical education entirely from the Minister of Education might be too disruptive; but the close relation between technical and technological education, and between the latter and university education, makes it imperative that policy in these fields should not be determined without review at a level high enough to take full cognizance of national needs in respect of scientific and technical man-power. In the existing structure, the Lord President of the Council, with his responsibility for the Advisory Council for Scientific Policy and for the various research councils, seems to be the appropriate Minister, particularly in view of the increasing extent to which the Department of Scientific and Industrial Research is concerned with technical education. The importance of the issues, however, are such that not only should the Minister be provided with an appropriate staff, but also the argument for his being a member of the House of Commons is as cogent as that which requires the Chancellor of the Exchequer to be a member of that body. No Government which is content to allow the Lord President to be answerable to the House of Commons at second-hand through a Treasury spokesman can fairly claim to recognize the over-riding importance of science and technology in Britain's economy to-day.

These issues apart, there was much to welcome in Sir David Eccles's speech of July 21. He not only emphasized that the removal of the critical shortage of scientists and technicians is largely a matter of public education rather than administration—of firing the imagination of school children, their parents, teachers and employers, with the adventure of the scientific revolution; he equally insisted on the importance of general education—of giving better education in all subjects and not just in science and mathematics. The first step is to raise the standards of education in the infant schools, primary schools and secondary schools. Teaching men and women how to enjoy wealth is as important as teaching them how to produce it.

Concluding the debate for the Government, Mr. H. Brooke stated that the Chancellor of the Exchequer has sanctioned a further one million pounds for university development schemes in higher technological education next year. This would virtually complete the programme proposed last year by the University Grants Committee and bring the total Government grant for building schemes outside London to about £4,350,000, which would be increased by equipment and other costs to about £6 million and would necessitate an extra £520,000 for maintenance. Major schemes would be starting in the immediate future in Birmingham, Newcastle on Tyne, Sheffield and Cambridge, and a further set of projects, now in the planning stage, constituted the 1956–57 programme to start at Cambridge, Newcastle on Tyne, Sheffield, Southampton and the Manchester College of Technology.

As regards the Imperial College of Science and Technology in London, expenditure on which in 1953–54 exceeded £1 million, of which almost three-quarters came from the University Grants Committee, Mr. Brooke stated that building work to the value of £4 million has already been authorized, and the developments are expected to cost in all £15 million. The academic staff has already increased from 220 in 1952–53 to 304 in 1953–54 and full-time students from 1,653 to 1,870. While the release of the whole of the South Kensington site involves more formidable difficulties than had been originally appreciated and enabling legislation may be required, neither building work nor academic expansion is being impeded.

Mr. Brooke also pointed out that in the academic year just ended the increase in full-time students of technology and science has accounted for almost the whole of the increase in full-time university students, and he estimated that the number of graduate scientists in the working population of Britain has risen from less than 50,000 in 1939 to nearly 80,000 to-day; for technologists the increase is probably from about 50,000 to more than 130,000; and making no allowance for the expansion of facilities at the universities and technical colleges now in hand, these figures should increase by 1965 to more than 110,000 scientists and about 225,000 technologists. Out of 80,000 scientists, about 25,000 are estimated to be employed in teaching and 10,000 in the Civil Service and allied establishments, about half of whom are in the Defence departments and the Atomic Energy Authority. There are also about 3,000 young post-graduate research workers, and apart from some scientists in the Armed Services, the remaining 40,000 are in industry.

Although these figures were given at the end of the debate, they were obviously known to Sir David Eccles when he said the expansion of the universities would still provide too narrow a route to give us the numbers required, both to push forward the frontiers of science and engineering and to apply them to public service. We must therefore shape the education system of Britain, he said, to supply a very large number of trained men and women in support of the scientists, and for these a much broader route is required than that leading to a university degree. To achieve this he suggested that at all stages there should be young people leaving the local technical colleges and advanced technical colleges for industry and young people coming to the colleges from industry. This would involve a very close partnership between the education authorities and industry, particularly in developing the sandwich courses which the Minister regards as so promising. Moreover, he emphasized that it is equally important not to neglect he arts and the humanities; we cannot stop the cientific revolution, but it is equally important that men should learn to behave well. There is also a hortage of artists and humanists and men who put piritual values first, and the educational system must seek to supply these as well as to meet the eed for scientists and technicians.

Although the Minister's speech was criticized for not stressing sufficiently the question of quality in elation to science teaching, either in the schools or he technical colleges, and his proposal to institute new award for technology had a very mixed reception, on the whole his speech was welcomed by the House, which had clearly been deeply impressed by Mr. Albu's remarks on the extent of the actual hortage of scientists and technologists. Mr. Albu had emphasized particularly the implications for the demand for scientific and technical man-power of the development of nuclear energy, the gasification of coal, the modernization of transport, and the needs of the under-developed territories, not only in respect of research, but also, as Sir Ernest Oppenheimer has recently stated, the grave shortages of qualified men in South and Central Africa at all levels and in nearly all industries and Government departments. Mr. Albu's own suggestions, however, notably in egard to the need for ensuring that there is no waste in the use of scientific man-power and that one senior Minister should be made responsible for eviewing the whole problem in the light of changing needs and the present provision for meeting them, met little response in the debate.

One satisfactory feature of the debate is the ndication it gives of the extent to which the House of Commons has been impressed by the seriousness of the situation, and the importance of looking at education at all levels and the problem of trained man-power as a whole. Sir Alexander Todd's remarks o the Parliamentary and Scientific Committee as to he need for eliminating the feeling that science, and till more technology, are socially somewhat inferior pursuits, for seeing that children at school are made more aware of the attractions of a career in science, and for reducing premature specialization at school had obviously convinced the Minister and many members on both sides of the House. There was also upport for his view that no man can to-day claim o be educated if he knows nothing of natural science, and that besides relieving the shortage of science eachers a general university degree in science would be a more effective means than now exists for producing the men and women with an awareness of science who are needed in all walks of life.

Another important feature of the debate was the general recognition that the shortage of science teachers and the expansion of university and of technological education are only particular aspects of education policy as a whole, and that they are closely related to primary and secondary education. There are, in fact, already facilities for technical training, for example in engineering and in textile technology, which are unused because sufficient young people cannot be persuaded to undertake such studies. On the other hand, there are fields where the number of young people who can be trained is limited by the buildings and facilities that are available; and although the climate of opinion is undoubtedly changing towards careers in science and technology, much remains to be done before existing facilities, and still more the expanded facilities corresponding with Britain's real needs, are fully used.

It is at least encouraging to find that the right questions are at last being asked in Parliament, even to the extent of whether we have the right departmental organization for linking the educational needs of the nation with the actual policy being pursued in universities and technical colleges and by local authorities. The importance of quality and of academic autonomy, the impossibility of developing educational institutions at any level 'on the cheap', the necessity for an overall view and for relating educational policy both to available resources and to the age-structure of the population as well as to the changing needs of the Commonwealth, are clearly appreciated far more widely; and to some extent these needs are over-riding preconceived ideas and party prejudices. Perhaps a greater awareness is needed that a technical college, like a university, is an organic entity, and that it needs a tradition of teachers as well as students if it is to function wel and realize the ideals which, very clearly, many of its principals as well as teaching staff already cherish. That ideal of a balanced education, which turns out experts not merely technically competent but also leavened with imagination and human understanding, will not be achieved simply by more generous support for the technical colleges and the universities. Its fulfilment requires also an educational policy which attempts in the schools themselves to feed the colleges and universities with students whose general education is such that it provides an increasingly effective basis for their further education as professional or technical specialists.

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# MECHANISMS OF DEVELOPMENT

## Analysis of Development

Edited by Prof. Benjamin H. Willier, Prof. Paul A. Weiss and Prof. Viktor Hamburger. Pp. xii+735. (Philadelphia and London: W. B. Saunders Company, 1955.) 105*s*.

THIS massive volume is one of the most magnificent contributions which American learning has made to the biological sciences for many years. Its aim is nothing less than "to present a modern synthesis of our knowledge of the principles and mechanisms of development". This is a task which has not been attempted, at least in such a detailed fashion, since Schleip's monumental "Die Determination der Primitiventwicklung" of 1929. More recent authors who have given discussions of comparable thoroughness have confined themselves either to particular aspects of the subject, as Needham, Brachet and Barth have dealt with the biochemical mechanisms, or to certain particular groups such as the echinoderms and amphibia in Lehmann's excellent book. The American authors, however, have covered the whole range of experimental embryology in the broad sense.

"It was evident from the start," the editors write, "that the subject matter had grown in volume and intricacy to the point where it seemed futile for any one individual to attempt to cope with such a task." A short browse through the various chapters will convince even the most self-confident reader that this is true, in the sense that no one man could nowadays possess a critical mastery of all the fields which are included. The battery of experts which has been got together to produce this compilation of knowledge is extremely impressive, and it is seldom one comes across a field which has had to be dealt with by an author who has not made important personal contributions to it. Nevertheless, there are inevitably certain losses to be set against the great advantages which such expertize brings. The editors very disarmingly recognize that "much of the desired unity and integration would be sacrificed, and the present volume bears plainly the stigmata of these imperfections". As a matter of fact, they are too modest. The work is extremely well edited; the individual contributions fit neatly together, with few omissions or overlaps. If the book is to be criticized, it is not for lack of unity or integration at its own level of treatment, but for the absence of a general theoretical scheme which might, as it were, lie behind the details cited in each chapter and provide a framework into which they fitted. Only a single individual author could provide such a scheme, and probably he would have himself to select and arrange the detailed facts which would illuminate it. In spite of the magnitude of the field, there would seem to be, therefore, a place for people bold enough to attempt at least to comprehend, if not to master, the whole of it.

The nearest approach to such a general synthesis is the first chapter, on "Problems, Concepts and their History", by J. M. Oppenheimer. This is a fascinating account of the history of 'embryological philosophy', and one begins to hope that the author will carry on right to the present day, and give us a summary of the ways in which active experimentalists are now picturing to themselves the embryos which they are studying. Alas, she brings her story to a close at about the time of Spemann, and leaves us only with the hint that "the greatest progressive minds of embryology have not searched *for* hypotheses; they have looked *at* embryos". This shirks the crucial issue of to-day, when we are beginning to feel convinced that it is no longer profitable to 'look' at the embryo by anatomical procedures. We seem to be faced with the apparent alternatives of examining it biochemically, or in terms of genetics, or of cell physiology. Which is the more profitable in the immediate future? Or can they be brought together into one broad-fronted line of advance? We are given no direct answer. But the three individual approaches are each separately discussed. F. O. Schmitt and H. Ris contribute extremely stimulating accounts of cell constitution and division. Steinbeck and Moog give a highly schematized description of cell metabolism, the merits of which I am not qualified to judge. O. Stern discusses gene action in a chapter which, to my mind, is somewhat too influenced by the pre-occupation of geneticists with the question of what a single gene does rather than with the embryologist's problem of how the development of an organ or tissue is influenced by its genotype; it thus overlooks what is perhaps the most important contribution of genetics to embryology, namely, the demonstration that even the simplest developmental process is influenced by an extremely large number of factors.

Of the more conventionally embryological chapters, those by Holtfreter and Hamburger on the Amphibia, Weiss on the nervous system, and Burns on the urogenital system are perhaps outstanding; but there is much else which is first class. The only topics the treatment of which seems seriously inadequate are the insects and the whole problem of the formation of pattern and shape; and one might wish for a fuller account of the recent work of the Swedish school on mitochondria and enzymes in echinoderm embryos. A considerable part of the book is devoted to the later stages of development, which have been passed over rather lightly in most texts.

It is unfortunate, but probably inevitable, that the size of the work will put it out of the financial reach of most individual workers. It is an absolutely essential requirement for all libraries which wish to keep up to date in general biology.

C. H. WADDINGTON

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# RESOURCES OF THE SEA

## The Inexhaustible Sea

By Hawthorne Daniel and Francis Minot. Pp. 239 + 25 plates. (London: Macdonald and Co. (Publishers), Ltd., 1955.) 16*s*. net.

IN the search for further supplies of food for the world's growing population, some attention has been directed to the sea as a potential source of these requirements. The authors of "The Inexhaustible Sea" contend that the sea can do much to meet this need, and can in addition be a valuable source of minerals which are becoming progressively more scarce on land.

Much of this book is a straightforward and very readable account of the exploitation of the sea, from the earliest fishing methods to modern trawlers and whaling factory ships. The beginnings of the science of oceanography are described, together with chapters on the chemical and biological constituents of the sea, food relations in the plankton, and modern fishing and whaling methods. A chapter on new instruments for studying the sea perhaps pays too much attention to echo-sounders and their uses, leaving a mere couple of pages to other methods of research, but in general the authors have covered their subject adequately.

Opinions may differ, however, as to the extent to which the oceans can contribute to man's food requirements. It is true that much progress can be made in improving fishing methods, in the farming of enclosed sea areas, and in the preservation and marketing of fish. But how far will these go towards solving our food problems? The greater part of the globe is covered by sea, but at present only certain areas, mainly on the continental shelves, can be fished economically. In the deep oceans, nutrients are lost from the productive surface layers by the sinking of dead and decaying organisms to deeper layers, and it is only in certain areas where there is upwelling of deep water that nutrients are returned to the surface. In tropical waters the very diversity of species, few occurring in the large shoals found in temperate regions, makes productive fishing more difficult. Much could be done to popularize the less common species of fish as food: the authors emphasize that only a very few types of fish are to-day widely exploited by commercial fisheries.

Overfishing, a very real problem in certain areas like the North Sea, is given scant attention in this book; and while it is no doubt true that the total production of fish, if it could be exploited, would more than suffice for man's requirements, much of it is not available either because it is in the deep oceans where existing fishing methods are unsuitable, or it is too remote from centres of human population to be harvested economically. Fisheries research has much to contribute to the problem; the sea may be inexhaustible, but is exploitation of the sea on the scale envisaged worth while? Cultivation of the vast barren and desert areas on land would seem to be a more direct and rewarding answer. This book, originally published in the United States, is attractively produced, and is illustrated by some excellent black-and-white photographs. NORMAN HOLME

# THEORY OF THE SOLID STATE

## Quantum Theory of Solids

By Prof. R. E. Peierls. (International Series of Monographs on Physics.) Pp. viii+229. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 30*s*. net.

ABOUT twenty years ago when the application of wave mechanics to the theory of the solid state had been investigated in some detail, it appeared that basically all relevant problems except superconductivity had been solved. This stage of the theory bears its fruit now in connexion with many important applications. Many aspects of theory itself based on the earlier pioneer work are being developed at present in minute details. Much of this work, unfortunately, does not appreciate that the theory in its present stage is based on a number of assumptions, and that it has not been possible, so far, to justify all these assumptions in a satisfactory way. It is for this reason that recently a renewed interest in the basic side of the theory of solids has arisen. The difficulties which one faces in this connexion are typical for systems of very many degrees of freedom and are similar to some of the difficulties met in other branches of physics.

In these circumstances it is desirable to have a book which describes the present development of the theory in a simple way without going into too great details, but which clearly points to the assumptions on which the present theory is based. R. E. Peierls's recent monograph fulfils these requirements in an excellent way. The book is divided into eleven chapters, the first three of which deal with atomic vibrations and related processes, whereas the remaining eight chapters are devoted to properties of electrons. A number of subjects, in particular those connected with mechanical and electric strength and with crystal structures, have been omitted from the book; but most of the other important questions are treated, though not all in equal detail. This was necessary in order to restrict the size of the book to about two hundred pages, and the choice of the branches which are treated in some detail must naturally depend on the interest the author has taken in their development. Thus, general questions of electrons in perfect lattices, transport (including heat conduction) and magnetic phenomena are presented more thoroughly than questions of cohesive forces or of the interaction of electrons with light. Even so, the author has found space to impress on the reader the importance of certain effects which are often ignored. This holds, for example, of correlation between electrons, the possible significance of which for optical properties is mentioned, though this has never been properly investigated in the literature. A separate chapter deals with the recent attempts to solve the problem of superconductivity on the basis of the interactions of electrons and lattice vibrations. Both the early success and the later difficulties of this theory are well presented. Recent work on so-called plasma oscillations, which one hopes will help in the treatment of the Coulomb interaction between electrons, has not been included in the book.

The book is mainly addressed to theoretical physicists in so far as it assumes knowledge of the basic methods of quantum mechanics. However, the mathematical treatment is very simple in most chapters, so that the book can be read with profit by the experimentalist who wishes to be instructed on the basis of the models which he is accustomed to use. It is hoped that the book will find a wide circulation, and perhaps sometimes will induce research workers to think before embarking on vast calculations. H. FRÖHLICH

# HIGH-SPEED AERODYNAMICS

## General Theory of High Speed Aerodynamics

Edited by W. R. Sears. (High Speed Aerodynamics and Jet Propulsion—Vol. 6.) Pp. xiv+758. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1955.) 100*s*. net.

THE present work is Vol. 6 in an ambitious project published by the Princeton University Press in the United States and by the Oxford University Press in Britain under the general title of "High Speed Aerodynamics and Jet Propulsion". The whole work is to be completed in twelve volumes and is to cover the related fields of gas dynamics, aerodynamics, combustion and jet propulsion. The editorial board which is responsible for the general supervision of this work consists of Theodore von Kármán, Hugh L. Dryden and Hugh S. Taylor. The work has been in progress for some years and, in fact, the formal establishment of the Aeronautics Publication Program took place at Princeton University in the autumn of 1949. In this connexion it may be as well to mention one minor criticism of this great and important work, namely, it is sometimes a little difficult to determine the date on which the different contributions to this volume were completed, and therefore difficult to know exactly how recent is the information which is presented. Another comment which is suggested by the fact that this volume, numbered 6 in the series, is the first to be published, is that the present volume is not self-contained and there are references to work which is to be published in Vol. 3; for example, Crocco's stream function is referred to in the present volume, but the reader is referred to Vol. 3 for a formal definition of this important concept. Questions of priority of publication and discovery are not considered in this treatise, which indeed makes no pretence of being absolutely complete. Considerations of space themselves have set an inevitable limit to the amount of work which is included.

Having made these few critical comments, the reviewer would like at once to pay tribute to the great value and importance of this project. It will provide the aerodynamicist and the aeronautical engineer with what is almost an encyclopædic account of the basic information which has been obtained in the past ten years or so in this most fascinating and vitally important subject; and it will incidentally be of great benefit to the individual research worker, who will be able to throw away some dozens, if not hundreds, of offprints and government reports, now that he has the admirable summaries and critical appreciations which are contained in this volume.

Seven authors have contributed to this volume, which is edited by W. R. Sears. Von Kármán writes on the foundation of high-speed aerodynamics, Friedrichs on mathematical aspects of flow problems of hyperbolic type, Sears on small perturbation theory, Heaslet and Lomax on supersonic and transonic small perturbation theory, Lighthill on higher approximations in both subsonic and supersonic flow; Kuo and Sears have collaborated in a chapter on plane subsonic and transonic potential flows, while Ferri has written two chapters, one on the method of characteristics and one on supersonic flows with shock waves.

The introductory section by von Kármán gives a general account of the linearized theory of aerodynamics, with especial reference to its limitations. This chapter also contains a general introductory sketch of fluid dynamics in the hypersonic range and in the transonic range. The next chapter, by Friedrichs, is almost entirely concerned with problems of the mathematical theory of the differential equations of unsteady one-dimensional flow and of two-dimensional steady flow. Friedrichs gives a careful analysis of what is required in order that these problems should be correctly set, and of the validity of the various idealizations which are contemplated in the mathematical theory.

After traversing the familiar ground of the small perturbation theory due to Prandtl and Glauert, Sears describes the slender-body theory of Munk and Jones and gives a brief review of unsteady flow problems.

These introductory sections cover about 120 pages, and we now come to a long section by Heaslet and Lomax, which occupies about two hundred pages. This chapter opens with a discussion of the wave equation and of some methods of solution. The authors concentrate on the method due to Volterra, although the work of Hadamard is referred to later. They then proceed to discuss standard methods for dealing with problems of two-dimensional steady flow and of three-dimensional steady flow. There is a most useful collection of formulæ and a discussion of the singular integral equations which arise in this part of the subject. In practice, the 'null' transforms which are needed to solve the singular integral equations seem to be obtained by intuition rather than construction. These theories are applied to a number of inverse problems and also to generalized conical flow. The authors then discuss axially symmetric supersonic steady flows and point out the interesting duality between the expressions for the drag of a body of revolution and for a wing of finite span. This is followed by an excellent chapter on slender-airplane theory and by another chapter on the theory of unsteady lift. In this chapter the indicial functions which are fundamental to the topic are quoted but not derived. There is, however, a discussion of the evaluation of the starting lift coefficient which will probably be found more illuminating than in the original paper in which it was first announced. The next chapter deals with reciprocity relations based on Green's reciprocal theorem and on reverse flow theorems. This great section closes with an account of small perturbation theories and transonic and hypersonic flows.

The next section, by Lighthill, covers about 140 pages and deals with the difficult and important problem of obtaining higher approximations to the non-linear equations of fluid dynamics. Although it is invidious to single out for especial mention any one section in this excellent work, it does seem to the reviewer that this is probably the most important section of the whole volume. Lighthill not only gives a very complete and critical account of the older second-order theories of subsonic and supersonic flow, but also gives a stimulating account of the recent work by Whitham himself on the nature of the flow pattern at great distances from an aerofoil or missile. Of all the sections of the book, this one seems to stand out by reason of its continuous appeal to physical concepts and to the new mathematical methods introduced.

In the following section, Kuo and Sears give an account of the hodograph theory due to Chaplygin, together with its simplification by Kármán and Tsien, and to the important, fairly recent developments by Lighthill and Cherry. The ninety-odd pages of this chapter flow with the most valuable summary of formulæ embodying the main properties of the hypergeometric functions which are employed in the solutions of the hodograph equations.

The following chapter, by Ferri, gives a masterly account of the method of characteristics both in two-dimensional potential flow and in axially symmetric flow, while further chapters show how proper allowance can be made for distributed vorticity and for extensions to problems involving three independent variables. Finally, the author discusses the linearized characteristic equations in which one of the velocity components or its variation can be considered small. As a natural sequence, in the concluding chapter Ferri discusses the general theory of shock waves in two-dimensions and in axially symmetric flow; and then passes on to discuss the same problems in transonic flow and in conical flow. These chapters will be most useful to all those who are engaged in the numerical solution of supersonic problems. There is one sentence on p. 587 which reads very strangely, in which Ferri says that "the velocity of sound *a* for the general case depends on the direction of the line along which it is computed". This should be read in conjunction with the careful analysis which Lighthill has given of the physical significance of the fundamental equations, and in particular in connexion with the basic relations, numbered 5 and 6, which Lighthill gives on p. 347.

The publication of this volume is the most important event in the world of aerodynamics since that of the volumes on high-speed flow under the general title of "Modern Developments in Fluid Dynamics" (Clarendon Press, Oxford, 1953). There can be no doubt, too, that this volume, together with its companions, will for some time to come be the standard work of reference; and all students of aerodynamics will be immensely grateful to the editors and contributors who have collaborated to produce this great work. G. Temple

## Oil in the Middle East

Its Discovery and Development. By Stephen Hemsley Longrigg. Pp. xiii + 305. (London: Oxford University Press, 1954. Issued under the auspices of the Royal Institute of International Affairs.) 25s. net.

THIS is essentially not a technical but a historical survey of Middle East oil. Scarcely anything like it has previously been published, at least for this region of oil-producing territories. The author, executive of one of the chief operating companies, has been connected with the Middle East professionally for nearly forty years (twenty-five as resident); he writes with authority and inside knowledge of men and organizations responsible for developing vast petroleum resources of Persia, Iraq, Levant and Arabia, from small beginnings to their present magnitude.

The background to these chronicles is essentially political and economic: sometimes there is peaceful co-existence between them; occasionally decidedly the opposite is portrayed, for example, in his lucid chapter "The Tragedy of Persia", one of the best objectively written accounts of what nationalization of that country's oil really meant to Britain, and still implies. The whole story of fortunes and misfortunes of Middle East oil is vividly unfolded, from early days in the nineteenth century; before, during and after the First World War; between the Wars; and the Second World War and since. The parts played by all-American and international companies (1946–53) are not the least enlightening and valuable sections of the book.

While it deserves a conspicuous position in all libraries of the oil industry, this book will especially appeal to executives and others who have devoted their lives (and to those who still do) to founding, expanding and administering huge international petroleum undertakings, not only in the Middle East but also in other parts of the world where oilfield developments are on a comparable scale. H. B. Milner

## Birds as Animals

1: A History of Birds. By James Fisher. (Biological Sciences.) Pp. 208. (London: Hutchinson's University Library, 1954.) 8s. 6d. net.

THIS work is based on the author's "Birds as Animals", rewritten and enlarged, and is intended as a general introduction to ornithology for university students. Owing to the small size of the book, it has only been able to give a brief survey of the various aspects of the subject; but nevertheless it is a useful summary of what is known. For those who wish to pursue the subject further, there is a voluminous bibliography at the end of the book.

The first three chapters are devoted to an account of the early bird historians and more important writers, based on Newton's "Dictionary" and Cassey Wood's two volumes, which last mention several authors not available to Newton. Systematics and bird specification are dealt with in separate chapters and might well have been combined, and the same may be said of that devoted to bird history, by which the author means the geological history of birds. It is difficult to treat these subjects separately without a good deal of overlapping. In the chapter on geographical distribution we have interesting accounts of some of the birds met with by early visitors to the Americas; but there is rather a dearth of information in regard to the East Indies and Australia. The long account of Audubon and his works might well have been replaced by more information on the birds discovered by Cook. The number of birds is a subject to which the author has paid much attention, and accordingly he devotes a chapter to tell us what he knows. Finally, there are chapters dealing with cycles, changes in numbers and the effect of man on bird populations. N. B. Kinnear

## An Introduction to Plant Physiology

By Dr. W. O. James. Fifth edition. Pp. viii + 303. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 17s. 6d. net.

THIS well-known and highly esteemed little book is now brought up to date by the incorporation of new material on respiration, photosynthesis, mineral nutrition, hormones, and other aspects. The insertions have mostly been woven skilfully into the older text, though a contrary instance is the inclusion of two rather different accounts of axillary bud dormancy. The mechanism of nitrogen fixation is not now so unelucidated as the author suggests.

A few minor weaknesses persist from earlier editions; thus two different formulæ are still given for preparing molar sucrose, without explanation (and it is now implied, erroneously, that the osmotic pressure of a weight-molar sucrose solution is 34·5 atmospheres). The unqualified statements that wheat grains have never been found to survive for more than sixteen years and that the *Calluna* mycorrhiza fixes nitrogen could be questioned.

For much the greater part, however, the text has the stamp of authority, and where finances permit the elementary student of botany to acquire textbooks limited in scope to a single branch of the subject, this one can be strongly recommended. A first reading yielded four misprints only. G. Bond

## Elementary Qualitative Analysis on the Small Scale

By Dr. Peter Woodward. Pp. viii + 92. (London: Oxford University Press, 1955.) 12s. 6d. net.

THIS essentially practical manual for sixth-form pupils and university freshmen deals with the analysis of simple mixtures of salts soluble in acids. The first of the text's five parts contains an advocacy of small-scale methods; the second describes the apparatus required and techniques recommended; the fourth deals with the chemistry of the separations and the fifth with the analysis of more difficult mixtures of anions. Although in general the schemes of analysis (Part 3) are on familiar lines, the book is unusual in its content.

Thus the author has omitted the customary long lists of reactions of the ions concerned; his outstanding contribution is the introduction into school practice of some of the new methods and principles which are revolutionizing qualitative analysis. One example must suffice—the passage of hydrogen sulphide under pressure. Dr. Woodward uses, not the elaborate apparatus described in most books but a small flask attached to an ordinary Kipp's apparatus. The reviewer can testify to the efficacy of this procedure and to the pleasure with which pupils adopt it.

With a touch of genius the author has added appendixes describing: the separation of cobalt and nickel by paper chromatography and the removal of phosphate by exchange adsorption, thus affording exercises for the abler pupils and indicating the way analysis is developing. The methods herein described should come as a boon to teachers and should help to promote a happier presentation of analysis.

G. Fowles

# THE PEACEFUL USES OF ATOMIC ENERGY

## THE GENEVA INTERNATIONAL CONFERENCE

By Sir JOHN COCKCROFT, K.C.B., C.B.E., F.R.S.

THE Geneva Conference on the Peaceful Uses of Atomic Energy organized by the United Nations Organization has been a remarkable experience for those fortunate in participating. It was attended by 1,400 delegates and observers from seventy-three countries. More than a thousand papers were prepared for the Conference, of which 450 were read.

The more general topics such as the future requirements for energy and the role of nuclear power were discussed in three days of plenary sessions. This was followed by nine days of technical discussions going on from 9 a.m. to 5.30 p.m. in three parallel sessions for reactor technology, chemical and metallurgical technology and biology and isotopes. Adequate time was allowed for presentation of the papers, which were simultaneously translated into four languages, and discussion periods of ten minutes or so were fully used.

Besides these, innumerable detailed discussions proceeded in the broad corridors of the Palais des Nations, which is conveniently provided with comfortable seats ideal for such a purpose. Advantage was also taken of the unique gathering of distinguished scientists to arrange many informal seminars. Thus a whole-day seminar on field theory was attended by theoretical physicists from the United States, the United Kingdom and the U.S.S.R. and many other countries, and was the first occasion on which Russian and Western physicists have met for discussion of this subject since 1937. Prof. E. O. Lawrence and Prof. V. I. Veksler attended seminars on high-energy accelerators following the evening lectures which they gave on their own accelerator work. The scientific and technical activities were supplemented by innumerable receptions, lunches and dinners, so that every available minute was occupied from 9 a.m. until midnight, and the Conference was a test of physical fitness unparalleled in our experience.

The main weight of the papers in the sessions on reactor technology and chemical and metallurgical technology came from Britain, the U.S.S.R. and the United States, though there were many valuable contributions from other countries. The Conference led to a lifting of the veil over the atomic energy programme of the U.S.S.R. and coincided with the coming into effect of a revised declassification policy of Britain, Canada and the United States, decided in principle nine months ago.

So we heard a large number of valuable papers on research reactors and power reactors and their associated technology. From the nine hundred or so possible types of power reactors in Dr. A. M. Weinberg's classification, about twelve have been selected for construction in experimental or prototype form by five nations. Thus graphite-moderated reactors using gas, water or liquid sodium for cooling are being built by Britain and France, the U.S.S.R. and the United States, respectively.

Water-moderated reactors using solid fuel are being studied in four types using light or heavy water, and in designs in which the water boils and is transmitted direct to a turbine or in which the water circulates through a heat exchanger to raise steam. Homogeneous thermal reactors were described in at least three forms, while experimental fast reactors are being built by both the United States and the United Kingdom.

Prof. D. V. Blokhintsev, who is head of the Institute of the Academy of Sciences of the U.S.S.R. devoted to reactor development, described the first Russian water-cooled graphite-moderated power station, which has been operating for a year and produces 5,000 kilowatts of electricity. The power reactor was designed on severely practical lines with no regard for neutron economy, since uranium fuel containing 5 per cent of uranium-235 enclosed in stainless steel tubes constitutes the fuel element. So fuel costs are very high, and the regeneration of secondary plutonium fuel is low. The reactor has proved to be very reliable in operation and is providing experience from which a 100-megawatt reactor is now being built. This reactor will also use highly enriched fuel and is expected to produce power at a cost of 10–20 kopecks per unit, as compared with an average price for conventional stations of 10 kopecks. Other types of power reactors are being experimented with, including fast reactors ; but the state of development appears to be behind American and British progress.

The American papers on power reactors and nuclear technology show a very broad development in this field. Very detailed papers were presented on the American pressurized water reactor which is to develop more than 60 megawatts, the sodium-graphite reactor developing 75 megawatts, the boiling heavy-water reactor developing 180 megawatts, the homogeneous aqueous and liquid metal-fuelled reactors and the sodium-cooled 62-megawatt (fast) experimental breeder reactor. These papers were supplemented by most interesting models in the exhibition at the Palais des Nations, together with specimens of the fuel elements to be used.

These reactors form part of the American five-year programme of experimental and demonstration power reactors which will be completed by 1960, so that by then the United States will be generating 700 megawatts of electricity from nuclear stations.

Britain presented papers on the engineering details of the Calder Hall graphite-moderated gas-cooled reactor and the Dounreay fast reactor. Models of these reactors were shown in the exhibition, together with a most interesting colour film on the building of the Calder Hall reactor. Britain also contributed many papers on reactor technology. One of the most interesting described the results obtained with the zero-energy fast reactor—ZEPHYR—which showed that in a plutonium-fuelled zero-energy fast reactor, for each plutonium atom destroyed in the core, two new plutonium atoms are produced in the blanket. Fission of the uranium-235 in the blanket plays an mportant part. The full-sized fast reactor will not realise the full theoretical breeding gain, owing to absorption of neutrons by coolant and other materials. Nevertheless, high-gain factors seem assured, and Dr. W. H. Zinn predicts a breeding gain of 60–70 per cent with the American plutonium – uranium-238 experimental breeding reactor, leading to a time to double the fuel investment of five to six years.

The aqueous homogeneous breeding reactor using the thorium – uranium-233 fuel cycle was predicted to have a breeding gain of 10–15 per cent, together with very high outputs per kilogram of fuel and comparatively low capital costs. The uranium-238 – plutonium fuel cycle does not promise breeding in the thermal region. Since thorium has also favourable properties metallurgically, its use in thermal reactors seems likely to be generally important in the second decade.

Our best view of Russian nuclear technology was in the field of nuclear constants. The nuclear data obtained by the U.S.S.R., Britain, the United States and France have all been plotted on a common basis and show very good agreement, showing that Russian techniques and instruments are as highly developed as those in Britain and the United States.

The papers on the economics of nuclear power showed a general consensus of opinion that capital costs of nuclear power stations will be appreciably higher during the next decade than those of conventional power stations. Typical values were £120 per kilowatt for a 150-megawatt gas-cooled graphite reactor; 250 dollars per kilowatt for a 250-megawatt heavy-water reactor; 200 dollars per kilowatt for a 75-megawatt sodium-graphite reactor. The first figure is based on the construction cost of Calder Hall; the last three on design studies only. Fuel costs were predicted to be lower than for conventional stations; but this depends largely on the 'burn-up' of the uranium-235 which is achieved. Prediction of heat extraction per ton of uranium varied from the equivalent of 10,000 tons of coal to more than three times this figure. But little experimental evidence is yet available.

The figure for the overall cost of nuclear power depends a great deal on the interest rate assumed. The Americans use high capital charges—of the order of 12 per cent—and their forecast overall production costs during the next decade lie between 7 and 10 mills, while the great bulk of their power is generated at about 5 mills. In Britain nuclear power is quasi-competitive.

The forecasts of the proportion of electricity to be generated by nuclear power in 1975 varied, from 40 per cent in Britain to an American figure lying between 1 per cent and 15 per cent, depending on whether costs are 9 mills a unit or 6 mills a unit at that time. The Canadian position seems to be rather similar. Forecasts of the usage in other countries by 1975 varied greatly, depending on the amount of hydroelectricity still to be developed and its capital cost and location. Most Western European countries will not require appreciable amounts of nuclear power before 1965.

Dr. H. J. Bhabha's paper on India's energy requirements showed that 80 per cent of the energy comes from the burning of dung. The energy consumption per head is one-tenth of that of Britain, and electricity consumption one-eightieth. This is planned to increase seven-fold by 1975, so electrical capacity will have to increase from $3\frac{1}{4}$ million kilowatts to 25 million kilowatts. The undeveloped hydroelectric capacity of 35 million kilowatts could provide most of this; but there are some areas far from hydroelectric sources where thermal power stations are at present used, and here nuclear energy will play a part. India is especially interested in the use of thorium.

Papers on the power requirements in other 'under-developed countries' showed a need for power reactors developing about 10 megawatts of electricity. These may also find applications in remote mining areas. Power costs in many of these areas are already much higher than normal costs—up to four times higher. Power from small units will necessarily be higher in cost; but papers presented by the United States suggest that a reactor of the boiling-water type could probably produce power at 15 mills, which is almost competitive with commercial 10-megawatt power stations.

It appears, however, that a much more detailed 'market survey' of the power needs and requirements of these countries is required before we can assess the volume of applications in the next two decades.

The position at the end of the century is easier to assess, since the economists and statisticians agreed in predicting a minimum energy requirement of 7 or 8 billion tons of coal-equivalent by the year 2000, of which half would be required for generating electricity. Hydroelectricity is predicted to supply 1 billion tons equivalent, and it is hoped that nuclear energy would by then be able to do the work of 2–3 billion tons of coal a year. The forecast of British requirements for nuclear energy at that time is about a tenth of this figure.

Papers on the occurrence of uranium and thorium suggest that in the 1960's plenty of fuel will be available at a cost of about 10 dollars a lb. Supplies of at least one million tons were reported to be available and, if by the end of the century breeding is achieved, only a few thousand tons of uranium and thorium a year are required to undertake the predicted task of the economist.

The biological sessions discussed the hazards of radiation to workers in the atomic energy industry and to the general public. The excellent work done by the International Commission on Radiological Protection in determining safe levels of radiation and safe amounts of radioactive materials was described, and it was agreed that these recommendations ought to be incorporated into world-wide codes of practice. The World Health Organization undertook to help countries new to atomic energy development. The genetic problems of radiation were also discussed in brief sessions, and there was agreement about the inadequate experimental data and the need for increasing the scale of experimental work. Besides the United States and Great Britain, several other countries will undertake experimental work. The work is, however, expensive, and may easily cost £100,000 per annum if significant results are to be achieved within ten years.

Numerous papers were presented describing the applications of radioactive isotopes to biology, medicine and industry.

An interesting picture of the state of development of Russian pure nuclear physics was revealed by Prof. Veksler's evening lecture on high-energy particle accelerators. The U.S.S.R. now have the highest-energy synchro-cyclotron in the world—producing 660-million volt protons. They have also nearly completed a 10-billion volt proton synchrotron. This accelerator is of a similar design to the

Berkeley 6-billion volt bevatron. It uses 36,000 tons of steel in a magnet having an air gap of 2 m. × 40 cm.; so for the next three or four years the U.S.S.R. will have more powerful machines than the United States. Britain is now far behind both countries in its equipment and work in this most important field of nuclear physics.

In general, we have gained the impression that the U.S.S.R. have an enormous deployment of scientific effort in the field of atomic energy, and that their output of scientists and technologists from their universities is quite adequate to maintain this without starving other activities.

The Conference has been more successful than we had dared to hope from such a large gathering. It has brought together East and West after a long period of separation in the physical sciences. It has been a meeting ground for innumerable friends from all parts of the world. It has enabled us to discuss how best we can help other countries, and has done a great deal to re-establish the normal pattern of communication in the scientific world.

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# THE CULCHETH LABORATORIES OF THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY INDUSTRIAL GROUP

By DR. A. B. McINTOSH

THE White Paper, "A Programme of Nuclear Power" (Cmd. 9389), has directed attention to the work of the Atomic Energy Authority composed of the Weapons Group (A.W.R.E.), the Research Group (A.E.R.E.) and the Industrial Group. Each is represented by a member of the executive under the chairmanship of Sir Edwin Plowden.

Under Sir Christopher Hinton, its managing director, the Industrial Group is responsible for the design, construction and operation of plants for the production of fissile material and for the prototype nuclear power stations at Calder Hall and Chapel Cross. It is also responsible for advice and guidance to the industrial firms which will undertake the construction of the power stations for the Central Electricity Authority proposed in the White Paper. In collaboration with Harwell, it also pioneers new types of reactors in conformity with the policy laid down in the White Paper.

Within the Industrial Group there are three technical branches: Engineering, Operations, and Research and Development, each under its own director. The design and construction of such projects as the reactors at Calder Hall, Chapel Cross and the large experimental fast reactor at Dounreay are the responsibility of the Engineering Branch. On completion of the plants, the Operations Branch becomes responsible for operation and level of production.

The responsibility of the Research and Development Branch under its director, Mr. L. Rotherham, is: (1) removal of difficulties which may impede the attainment of full production in any part of a production plant and the development of works processes; (2) provision of information to support the design of new plants and prototype reactors; (3) longer-term study of problems which arise from production plants and design studies.

The Branch works in close collaboration with the Research Establishment at Harwell, which undertakes part of the work.

In the Research and Development Branch, the emphasis is always on the technique at a particular date, and all work is planned and progressed in the same way as the engineering construction programmes to which the major part is intimately linked. It is research applied to industrial needs and not pure research, but in all its work there is close co-ordination and collaboration with the Research Group at Harwell. This is especially important in the earliest stages, when the feasibility of future reactor systems is being studied.

There are at present four laboratories in the Research and Development Branch, with a fifth in course of formation for work on the Dounreay site. In each of the laboratories there is a large measure of local autonomy and authority. At the Industrial Group Headquarters at Risley there is a section of the Research and Development Branch working in close collaboration with the design engineers and the headquarters organization of the Operations Branch. Part of the responsibility of this section is that of carrying out theoretical calculations for the four existing laboratories at Capenhurst, Windscale, Springfields and Culcheth.

Except for some specialized fields in which Harwell is responsible, these laboratories, with a scientific and experimental complement of approximately eight hundred, provide a development effort for sanctioned construction projects which are the commitments of the Industrial Group. The Capenhurst Laboratory deals mainly with problems of an engineering nature, such as fluid flow and heat transfer. At Windscale the laboratories are largely devoted to radioactive chemistry, metallurgy and physics, arising from reactor problems at Windscale and Calder and the chemical problems of the plutonium separation process. In Culcheth there is a responsibility for the selection of reactor materials and for work on the extraction of these materials where they may not be commercially available. The small-scale work carried out at Culcheth is then extended to a larger scale at the Springfields Laboratory, which is responsible for the development of fuels and fuel elements.

Culcheth is the only laboratory not on a works site; but it is associated very closely with the Engineering Design Branch at Risley. This gives the laboratories a responsibility for the initiation of work at the feasibility and planning stage of new reactors, especially in the selection of materials for reactor components.

To carry out the commitments of the White Paper, increases in staff in the Research and Development Branch of the Industrial Group are necessary. The Culcheth Laboratories have a present complement of approximately 160 scientific and experimental staff. They are extensively equipped with all the tools required for modern metallurgical research and include laboratories specializing in X-ray diffraction techniques, electron microscopy and ceramics. How-

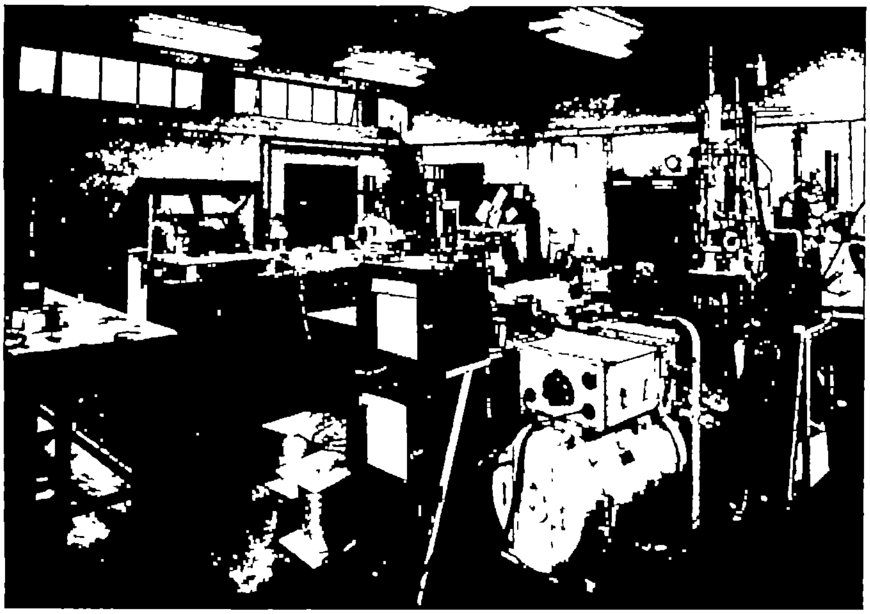

Fig. 1. Metallurgical Laboratory, Culcheth

ever, apart from the large Creep Section and the Materials Inspection Group, both of which have rather special functions, the work of the remainder of the Laboratories is organized to produce results by a planned date for the main programme of engineering construction projects. The objectives of the projects are in all cases the furtherance of the programme of nuclear power development outlined in the White Paper and the development of prototype reactors.

From an overall view, many problems of nuclear power production in the various types of reactor, whether fast fission, thermal or homogeneous, present a common basis. The main questions are of compatibility of materials, the winning of selected metals, the physical metallurgy of chosen alloys and the deformation of metals both in fabrication and under irradiation.

*Fuels.* When uranium is irradiated, it undergoes dimensional changes which, if sufficiently large, impose stresses on the fuel container. Similar changes are produced by thermally cycling the material, particularly if the cycle includes a phase transformation. These changes affect the life of the fuel elements adversely and limit the operating temperature and the rate of operation of the pile. To achieve the enhanced efficiency and lower production costs visualized in the White Paper, work is in hand to limit these two forms of irradiation damage.

Two possible methods of reducing irradiation damage are by alloy additions and by suitable heat treatment. The former necessitates manufacturing techniques which are complicated by the extreme chemical reactivity of uranium. These techniques include vacuum or inert atmosphere arc melting, melting by electron bombardment and powder metallurgy. The latter methods are particularly appropriate for the production of fuels which are permeable to gas, a property which may be desirable. It is worth recording that all melting equipment used at Culcheth was designed and built in the Laboratories and includes two d.c. arc furnaces operated from welding generators. An electron-bombardment furnace of novel design will be operating in the very near future.

Once the alloys have been prepared, physical and mechanical properties such as thermal conductivity, thermal expansion, creep strength and permeability to gas are measured. The behaviour of the material under various thermal cycling treatments is determined. In those cases where the fuel may come into contact with the coolant, suitable corrosion tests assess the compatibility.

*Canning materials.* The economic production of electrical power from nuclear reactions demands the highest efficiency at all stages of operation. These demands are made not only on the reactor fuels, but also in the associated components such as the cans which contain the actual fuel.

In thermal reactors the number of spare neutrons is so small that the paramount requirement for canning materials is that they should have small capture cross-sections for neutrons. If these conditions are to be fulfilled, the most desirable elements for canning include aluminium, beryllium, magnesium and zirconium. These metals do not, however, possess all the other required properties, and work is in progress to assess the improvements which may be achieved by the addition of minor alloying additions to the parent metals.

In fast reactors, the necessity of minimum absorption of neutrons is less important and must be balanced against the need for a metal which can withstand as high a temperature as possible. This focuses attention on the refractory transition metals such as titanium, zirconium, vanadium, niobium, tantalum, molybdenum, tungsten and rhenium. Of these metals, titanium has received considerable attention in recent years as a constructional material, and some of the others have been the subject of research, while most have been used in the form of ferro alloys for additions to steel. At Culcheth, methods have been developed for the extraction of some of these metals in a very pure state, and, for the first time in Britain, vanadium and niobium have been prepared in a ductile form. Techniques have also been devised for the fabrication of these materials, and determinations have been made of their physical and mechanical properties.

It has been found that in some cases a metal or alloy which in other respects possesses highly desirable properties has to be rejected because it reacts with uranium at the appropriate reactor-operating temperature. Methods under investigation to overcome this problem include the deposition of refractory metals from volatile compounds and the use of oxide coatings to separate the fuel from the can.

*Breeder materials.* In order to maintain and improve stocks of fissile material and to take full advantage of the new types of reactor which promise

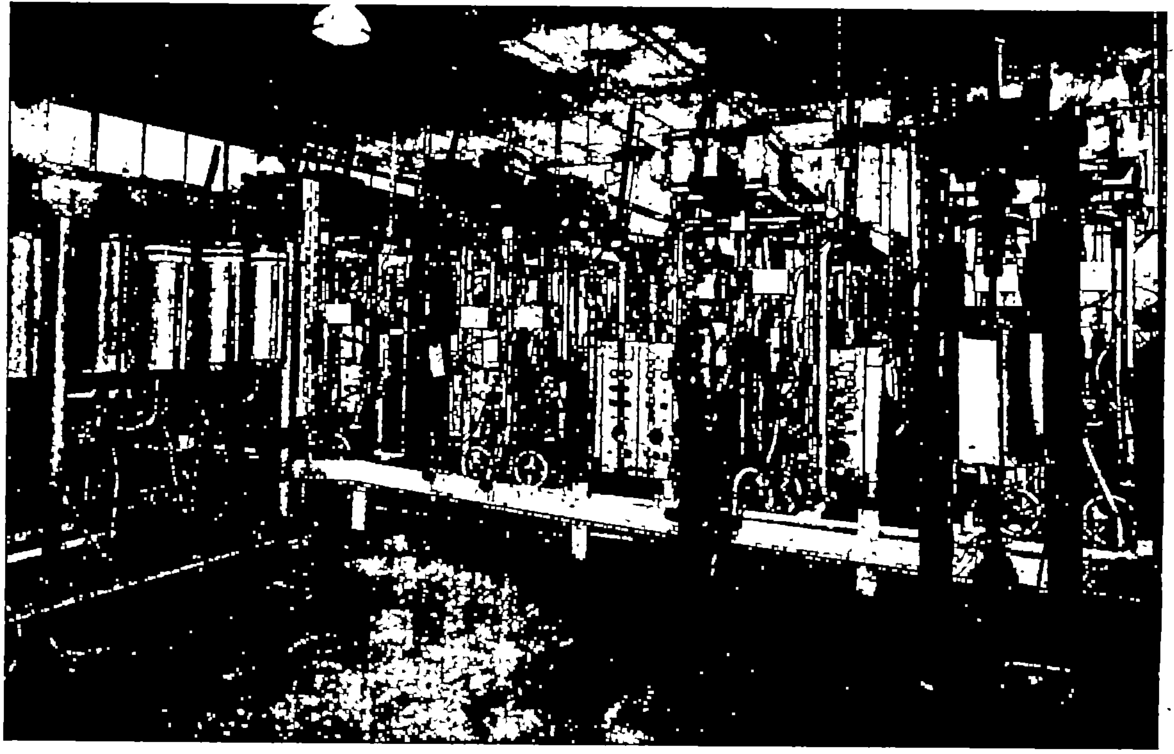

Fig. 2. Creep Laboratory, Culcheth

to be made available as a result of experimental work at Dounreay, it is essential that fresh supplies be obtained by 'breeding' or converting suitable elements. Two such elements are thorium-232 and uranium-238 which, under irradiation, absorb neutrons and then undergo radioactive decay to yield the two fissile materials, uranium-233 and plutonium-239, respectively. The Research and the Industrial Groups have been examining the economic prospects of thorium reactions and, at Culcheth, in view of the success in the preparation of refractory metals by various methods, similar processes are being examined for the extraction of thorium from monazite.

*Coolants.* The coolant is the all-important medium through which the heat developed in the core of the reactor will be removed to generate the required steam pressure in the heat-exchanger. Coolants which may be employed in nuclear reactors include water, gases and liquid metals. Not only must the corrosive behaviour of a coolant be investigated, but also many other of its chemical and physical properties, depending on the particular application. As an example, the Dounreay reactor is likely to employ a liquid-metal coolant in the form of sodium–potassium alloy. For this and other liquid metals considered, precise knowledge of ignition temperatures is essential if an accurate estimate is to be made of any hazard which they may present. This ensures that the safety precautions installed are adequate without being excessive and uneconomical.

*Constructional materials.* The Atomic Energy Authority's products are such that to contain or process them constructional materials must have, in addition to their normal properties, some feature such as resistance to corrosion in conditions where this is more than usually severe, or where loss by pick-up of a valuable process gas must be avoided. Work is constantly in progress at Culcheth on the examination and improvement of plant materials by the development of new alloys or superior manufacturing techniques. This work frequently results in a combination of reduced capital and running costs with an increase in the technical efficiency of a process.

*Materials Inspection Group.* In any large organization, it is essential that routine tests should be made to ensure that all materials employed are of suitable quality. This service to the Inspection Branch is carried out by a section which also acts as a works metallurgical laboratory for some sections of the Industrial Group. Engineering parts which have received particular attention are brass bellows, water-coolers and bearings.

*Creep.* The Culcheth Laboratories possess the only creep-testing facilities in the Atomic Energy Authority, and extensive tests have been carried out in inert atmospheres, on a scale probably larger than any attempted elsewhere in Britain. It is believed that, previously, the usual type of precision mirror extensometer had not been used for routine creep tests of materials requiring protection from atmospheric attack, as an enclosed extensometer requires some device whereby, during the course of the test, the mirrors may be reset without breaking a gas seal. The Laboratories have, however, designed, built and successfully operated enclosed mirror extensometers of this type. Materials tested include specimens of proposed canning metals and of uranium itself. Creep-testing machines have also been used for stress-relaxation tests on specimens of the all-welded steel structure of the pressure shell of the thermal reactor under construction at Calder Hall.

Long-term studies as carried out in the Physical Metallurgy and Creep Laboratories aim at providing the basic information for the development of fuels, canning alloys and materials of construction for advanced types of reactors. Fundamental research in the Creep Laboratories is at present directed towards the hardening properties of solid solutions, based on aluminium–copper alloys. Starting from this simple alloy, additions of elements with different electron configurations and differing atom sizes can be examined. From this it is hoped to deduce the relationship between the size of the atom and the electron structure, the consequent effect upon hardening and ultimately the creep-strength. Results obtained from a simple alloy should be applicable to the development of reactor materials.

In the long chain of development between the concept of a new reactor and its operation, the Laboratories at Culcheth with their specialized interests in chemistry, physical chemistry and deformation of metals provide an important link.

# THE PLANT BREEDING INSTITUTE, CAMBRIDGE

On July 15 the new buildings and experimental grounds of the Plant Breeding Institute, Cambridge, were officially opened by Mr. D. Heathcote Amory, Minister of Agriculture, Fisheries and Food. The guests of the governing body included the Vice-Chancellor of the University of Cambridge, the Mayor of Cambridge, the City Parliamentary member, officials of the City and County and representatives of the Agricultural Research Council, the Ministry of Agriculture, the National Agricultural Advisory Service, research institutes and university departments.

In his opening remarks the chairman of the governing body, Sir Frank Engledow, paid tribute to the classic work on genetics and plant breeding of the late Sir Roland Biffen, the first director, whose early researches not only stimulated the development of genetic science and its application to the improvement of agricultural plants, but also resulted in the foundation of the Institute in 1912 at the University School of Agriculture. Biffen's work was essentially that of a great individualist who was among the first of the few scientists to appreciate the epoch-making significance of Mendel's genetic work. But Biffen's scientific acumen and imagination led him to apply the new knowledge to crop improvement, and he chose wheat on which to experiment and test the validity and value of the new knowledge. This started a new era in plant breeding, and the work at the Institute developed considerably under its two succeeding directors, with the ultimate establishment of the present greatly enlarged research centre.

The Minister, in declaring open the new buildings, said the occasion was significant in marking the fruitful collaboration of agriculture with Cambridge scientists. He welcomed the closer association of scientific research with the task of improving the productivity of British agriculture, and mentioned the great work that had been done in recent years in increasing the output from the farms of Great Britain. He emphasized the great importance that the Government attaches to agricultural research, and stated that although there has been a recent change in the administration of this research through transfer of control to the Agricultural Research Council, this would not mean any lessening of the Government's interest and support; he, himself, would continue to have the closest association with research work through the Privy Council committee dealing with this important matter.

The director of the Institute, Dr. G. D. H. Bell, coupled his thanks to the Minister with acknowledgments to all who had helped in the task of establishing the Institute in its new home, finally separated from the University. He paid especial tribute to Sir Frank Engledow, not only for his important scientific work in the Institute, but also for his valuable help and guidance, together with that of

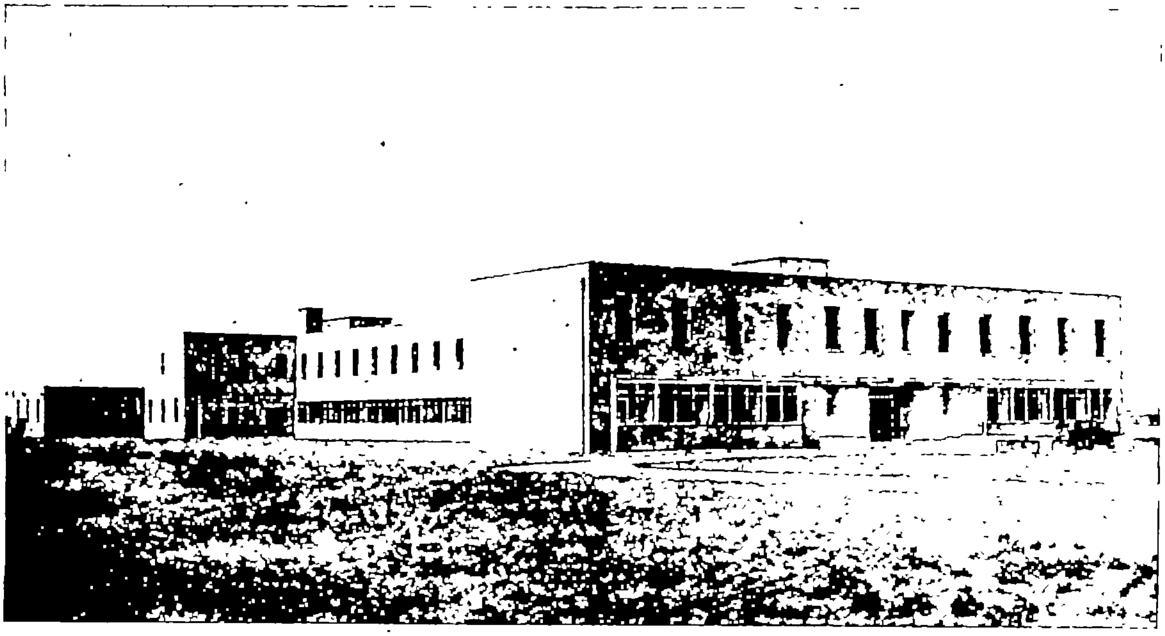

Fig. 1. Plant Breeding Institute, Cambridge, showing the main entrance to the building (right) and the range of laboratories extending from it

members of the governing body. There was much to do, and in developing both fundamental and applied research for the improvement of crops, he saw a satisfying task for his colleagues and himself. There must be the closest integration of science and agriculture, and the facilities which have been provided for the Institute gave the greatest opportunity for those engaged in contributing to scientific knowledge and in breeding improved varieties of crops.

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The new premises of the Institute are situated on Anstey Hall Farm, Trumpington, some 2¼ miles to the south of Cambridge, and adjacent to the headquarters of the Eastern Province of the National Agricultural Advisory Service. The situation is not only appropriate for a research station that is to devote its attention to the arable crops of the drier parts of England, but it also makes possible the continued close liaison with the School of Agriculture of the University, as well as ensuring easy association with other University departments. Consequently the Institute is able to contribute to the teaching in the University, while it also has the inestimable benefit of close association with the research workers in various University departments.

The Trumpington premises have been planned so that the laboratories, offices, glasshouses and all other facilities are situated on the site being used for growing the plant-breeding material. This centralization is of the greatest value in work of this kind. It has the virtue of every worker having his field-material continually under his day-to-day care, with the consequent efficient organization of time and labour. It is no longer a major expedition to visit material growing in the field, the laboratories do not suffer from isolation from the living material, while there is the easiest transition from field-investigations to laboratory work. The unification, and the ensurance of the integration of field- and laboratory-work, are essential for the proper organization of research work devoted to the study of the behaviour of cultivated plants in the field with special reference to their improvement.

The buildings comprise a main and an ancillary block, the former housing the offices, library, main laboratories and other services, and the latter including the implement sheds, soil sterilizing and potting rooms and glasshouses. The two blocks are served by a concrete road and are separated from one another by part of the experimental plots, being situated a quarter of a mile apart. All parts of the premises are consequently of easy access, and there is a minimum of transport of materials involved.

The main building has interesting features from the point of view of the organization of scientific research work devoted to a wide range of problems in a number of different plant species. In the first place, except for the facilities provided in the ancillary buildings, which are largely concerned with the glasshouse work, the whole of the working requirements are provided under the one roof. The building is of two stories, to comply with local planning requirements, although there is a basement laboratory under a portion of the south wing for housing controlled-climate chambers and refrigeration cabinets. The ground floor is, except for a conference and lecture room, devoted entirely to laboratories, a specially constructed fire-resistant seed store, a threshing room and a sugar-beet tare house: the whole layout having as its main objective the centralization of the main servicing departments in connexion with each crop section. This distribution has made it possible to devote the first floor primarily to private rooms, administrative offices and library, but there are also research laboratories for biochemistry, serology and cytology, and a large cereals room.

Although each crop section is provided with its own laboratory, it has been found necessary to provide in addition service laboratories such as cytology, chemistry, pathology and physiology for use by all sections, as well as the common facilities for controlled-climate growth, frost-hardiness testing, and germination tests. This means that there are essentially two kinds of laboratories—crop sectional and common service—to ensure adequate facilities for the different lines of investigation and the various crops included in the programme of the Institute. These developments are necessary to deal with the scientific techniques that must be incorporated in plant-breeding work involving the improvement of the important economic characters of crop plants.

Plant breeding is a slow process compared with some other branches of research work, and it can be very consuming in labour as well as time. Apart from the use of controlled-climate chambers for special purposes, and to increase the number of generations that can be handled in a given period of time, much can be done to economize in time and effort by the use of glasshouses, which are virtually essential for some aspects of plant breeding. The Institute is accordingly provided with standard heated glasshouses for the various crops, and it is possible thereby to continue certain investigations during the winter months. Special light-alloy glasshouses are being erected for the sugar beet programme, which is concerned particularly with the study of artificial polyploidy and other breeding techniques as well as the possibilities of developing beets resistant or tolerant to virus yellows disease. These glasshouses comprise two separate blocks; one is for studying breeding techniques and consists of four banks of air-conditioned compartments which can be used for controlled pollination and seed production of breeding material; the other block includes an insectary for raising aphids, an inoculation chamber, a fumigation chamber, and growing-on houses, the whole being designed to allow work on breeding for tolerance or resistance to virus yellows to continue throughout the year. Extra artificial illumination is provided for winter work, while the houses can be cooled in summer by blinds and water irrigation on the roofs.

The existing facilities provided at the Institute by these buildings and extra land are commensurate with the new responsibilities of the greatly expanded programme of research being undertaken. There is provision for expansion of the staff and of the work to cater for the requirements of plant breeding research on all the important arable crops of Britain.

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# OBITUARIES

## Prof. R. W. Wood, For.Mem.R.S.

With the death on August 11 of Prof. R. W. Wood at the age of eighty-seven, science has lost one of the last links with the great experimental physicists of the past century. Though his principal contributions to science lay in the field of physical optics, Wood was a man of extraordinary versatility. An artist of no mean ability, a musician and, above all, a teller of stories (not all suited to Victorian drawing-rooms), he had a keen sense of humour and an impish wit which made him the best of companions. Wood's "Physical Optics", now in its third edition, and his little satirical book of poems, illustrated by himself, "How to Tell the Birds from the Flowers", have both been best-sellers for many years.

Wood was a great traveller. Sabbatical years seemed to recur at very close intervals, and Wood's visits to Europe became almost an event in the scientific world. He never failed to bring with him something original and ingenious; and, of course, a fund of new stories. Like his great friend, C. V. Boys, Wood was essentially an experimenter who loved to do everything for himself. A craftsman in the laboratory arts and a manipulator of the very highest dexterity, Wood found it difficult to entrust any substantial part of his experimental work to others. When he embarked on an experiment, everything was sacrificed to its consummation in the shortest possible time. All apparatus and equipment, regardless of its normal purpose, was ruthlessly sacrificed to the end in view; and it only took some fifteen seconds to smash a perfectly good electric light bulb and extract the leadglass stem if Wood happened to be in a hurry for a bit of sealing-in glass.

Wood was born in Concord, Mass., in 1868, and was educated at Harvard and the University of Berlin. He became professor of experimental physics at Johns Hopkins University in 1901, where he took charge of Rowland's machines for ruling diffraction gratings and initiated the production of blazed echelette gratings for use in the infra-red. His published papers, which exceed 250 in number, cover a wide field and include experimental work in physical optics, on interference and diffraction and a study of the groove form and intensity distribution in gratings. He made extensive observations of the optical properties of the vapour of sodium at low pressure in which he observed the fluorescence and resonance spectra. Similar observations were made with the vapour of iodine. He studied the use of infra-red and ultra-violet photography of terrestrial objects and also their application to a study of the moon. These are only a few examples, chosen almost at random, of the many fields in physical optics in which he worked with such distinction. He was one of the really great experimenters with an almost uncanny flair for choosing the simplest and best method of attack. He seemed always to know what would work.

Wood received many honours, including Rumford Medals given by the American Academy of Arts and Sciences and the Royal Society, the Ives Medal and the Draper Medal of the U.S. National Academy of Science for his contributions to astrophysics. He was a foreign member of the Royal Society and was awarded honorary degrees by many of the leading universities of Europe. In 1892 he married Gertrude Ames, of San Francisco.

T. R. MERTON

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## Lord Horder, G.C.V.O.

IN his long life of eighty-four years, which came to an end on August 13, Lord Horder witnessed and participated in a revolutionary change in the science of medicine and in the organization of its service to the public. In any age he would have been successful, for he was endowed with that indefinable gift for recognition of disease, great skill in clinical examination and sympathy with human suffering which characterize the ideal physician. To these talents he added scientific knowledge and experience. Up to the present century the diagnostician's tools were limited to a few simple instruments to assist the otherwise unaided senses in the examination of the heart, lungs, eyes and larynx. Horder, trained as a pathologist, was able to add to the examination of the patient's body the examination of the patient's blood, his cerebrospinal fluid, his secretions and excretions. He was one of the first to bring the laboratory to the bedside, to foster and promote clinical pathology. It is little wonder that he soon became the most sought-after physician of his time.

Horder's early research work is recorded in contributions to the annual reports of the Medical Officer of the Local Government Board. In the report for 1906–7, he published a paper "On a Study of the Micro-organisms associated with Rheumatic Fever and Malignant Endocarditis". In the report for 1907–8 he contributed a paper with F. W. Andrewes "On the Behaviour of the Leucocytes in Relation to Infection by and Vaccination against the Pyogenic Cocci", and with M. H. Gordon reported "On an Investigation of Protective Agents in Meningococcus Infections". His chief contribution to clinical medicine was a paper on 150 cases of infective endocarditis in the *Quarterly Journal of Medicine* of April 1909, in which he stated that with care a positive blood-culture of one or other of three types of streptococci could be obtained in 90 per cent of cases. In 1907 he edited Abel's "Laboratory Handbook of Bacteriology"; he wrote on pleurisy in Allbutt and Rolleston's "System of Medicine" in 1909; and in 1910 he published his "Clinical Pathology in General Practice", in which he included an account of vaccine therapy. He edited the second edition of the "British Encyclopædia of Medical Practice", published in 1950, and in 1953 published "Fifty Years of Medicine", an expanded version of his Harben Lectures delivered at the Royal Institute of Public Health and Hygiene in December 1952, which are partly autobiographical.

Horder served on the Minister of Health's Advisory Committee during 1935–39, and during the Second World War rendered conspicuous service as chairman of a committee appointed to inquire into the health conditions of air-raid shelters, and also as medical adviser to Lord Woolton at the Ministry of Food.

He promoted many good causes. For example, physical medicine, industrial hygiene, eugenics, cremation and noise and smoke abatement owe much to his advocacy. In particular, the combating of two scourges of mankind, rheumatism and cancer, concerned him. He was chairman of the Empire Rheumatism Council from its inception in 1936 until 1953. As chairman of the Scientific Advisory Committee of the British Empire Cancer Campaign he rendered great service, and he largely instituted a clinical review and follow-up of all cancer cases in London hospitals. Only last year he attended an international cancer conference at São Paulo, Brazil.

"Those whom the gods love die young." Lord Horder gave a new interpretation of the aphorism, for up to the day of his death his mental powers were unabated, and he was still young in spirit, in enthusiasm, and in love for mankind and for the profession which he adorned.

ARTHUR MACNALTY

# NEWS and VIEWS

### New President of the British Association: Sir Raymond Priestley

At the meeting of the General Committee of the British Association for the Advancement of Science held in Bristol on August 31, Sir Raymond Priestley was elected president of the Association in succession to Sir Robert Robinson. An appreciation of the scientific and educational work of Sir Raymond was published in *Nature* (169, 778; 1952) on the occasion of his resignation from the vice-chancellorship of the University of Birmingham.

### Geology at the Imperial College, London: Prof. H. H. Read, F.R.S.

Prof. H. H. Read retires this year from the chair of geology in the Imperial College of Science and Technology, London, which he has occupied with signal distinction since 1939. After active service in the First World War, he returned to the Geological Survey of Great Britain to spend more than a decade in mapping the complex metamorphic and granitic rocks of the Highlands of Scotland and the Shetland Islands. From this wealth of field experience he drew inspiration for his much-quoted advocacy of the contaminated origin of norites, and for a series of classic contributions to geological literature entitled "Meditations on Granite" and "Commentaries on Plutonism". These and other philosophical writings have won him an international reputation as a leading exponent of metamorphic processes and metasomatic granitization, and election as foreign member of numerous geological societies throughout the world. For nearly twenty-five years he has been an enthusiastic and stimulating teacher, first at the University of Liverpool and later at the Imperial College, where he has built up a large and flourishing research school of geology. He was elected a Fellow of the Royal Society in 1939, and besides serving as president of the Geological Societies of Edinburgh, Liverpool and London and of the Geologists' Association, he was universally acclaimed as president of the International Geological Congress held in London in 1948. Four years later, the Geological Society of London awarded him its premier honour, the Wollaston Medal. Not content to rest on his laurels, Prof. Read is still actively engaged in studying the interplay between tectonics, metamorphism and plutonic phenomena in the Grampian Highlands, and in closely directing a team of research workers in a comprehensive investigation of the metamorphic, migmatitic and granitic rocks of Donegal in a concerted effort to illuminate the vexed problem of the origin of granites. Although he now relinquishes the chair of geology and the pro-rectorship of the Imperial College, it is gratifying to record that, as Senior Research Fellow, he will retain intimate ties with the department that thrived so much under his beneficent and invigorating guidance.

### Oil Technology at the Imperial College, London: Prof. V. C. Illing, F.R.S.

Prof. V. C. Illing, professor of geology (oil technology) in the Imperial College of Science and Technology, London, retires at the end of the 1954–55 session. Prof. Illing is a graduate of Sidney Sussex College, Cambridge, and in 1913 went to the Imperial College to carry out research on the fauna of the Stockingford shales of the Cambrian. Early in 1914 he joined the staff of the Geology Department, and became associated with the newly formed Oil Technology Department, being appointed its first professor in 1936. In 1915 he first visited Trinidad, and so began a long association with oilfield operations in the Caribbean area. 1916 found him supervising work being carried out for the Aeronautical Inspection Department in a new laboratory in the Royal School of Mines. In 1944 he was awarded the Murchison Medal of the Geological Society, and in 1945 was elected a Fellow of the Royal Society. Prof. Illing is widely known for his research work and publications on oil migration and accumulation, and for the emphasis he has placed on the study of stratigraphy and geological history in assessing the oil possibilities of an area. He has also stressed the importance of selecting appropriate techniques in the search for oil fields. For many years he has been recognized as an authority on oil developments in Trinidad and Venezuela. His advice has also been sought on oil-field operations in many other parts of the world, and in 1947 he negotiated, on behalf of British and Dutch interests, a settlement with the Mexican Government in connexion with the expropriated oil-fields.

### Department of Scientific and Industrial Research: Mr. E. Barnard, C.B., C.B.E.

Mr. E. Barnard has recently retired from the post of deputy secretary in the Department of Scientific and Industrial Research. Mr. Barnard, who is sixty-three, had a distinguished career in the Gloucestershire Regiment during the First World War, being awarded the D.S.O., and then in 1919 he joined the Department of Scientific and Industrial Research as an assistant principal. In 1928 he was appointed assistant director of food investigation under Sir William Hardy, the then director, and in 1934 succeeded Sir William. He was director of food investigation until 1943, when he returned to the headquarters office of the Department as principal assistant secretary and deputy to the then head of the Department, Sir Edward Appleton. In 1945 the post of deputy secretary in the Department was created and Mr. Barnard appointed to it. He was made a C.B.E. in 1943 and C.B. in 1951.

### National Coal Board Committee for Research into Human Problems

The National Coal Board has set up a Committee for Research into Human Problems, with the following terms of reference: "To consider and approve, in the form of programmes and budgets, the general lines of the Board's research on human problems, having special regard to the needs of Industrial Relations, Medical and Staff Departments; to receive progress reports and to ensure that work on all the items in the approved programmes is properly and promptly carried out; and that the results of research are adequately disseminated". Research into human problems will be carried out by the research branches of the Departments mentioned (and by outside bodies as well) and the Committee's function will be to supervise, with executive authority, the work of the various research branches. The Committee comprises Mr. J. Bowman (deputy chairman of the Board, in the chair), Sir Andrew Bryan (staff member), Mr. W. H. Sales (industrial relations member), Mr. A. H. A. Wynn (scientific member), Dr. W. Reid (production member) and

Mr. J. Latham (finance member). To provide the means of maintaining contact between all people engaged on this research and formal facilities for the exchange of ideas, an Advisory Committee will be set up, and its terms of reference will include the discussion of progress in research in the medical, human and management fields, the suggestion of the lines on which new research projects might be fruitfully developed, and consideration of the ways in which the information gathered and the research findings might most profitably be disseminated and used.

## British Agricultural Delegation to visit the U.S.S.R.

At the invitation of the Government of the U.S.S.R. a British agricultural delegation is to visit that country; this invitation follows the recent visits to the United Kingdom of two agricultural delegations from the U.S.S.R. The United Kingdom delegation will be led by Mr. G. R. H. Nugent, Joint Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food. The delegation will leave for the U.S.S.R. on September 25 and will return on October 9; its programme will include visits to the Agricultural Exhibition in Moscow, to farms and to agricultural research and experimental stations. In addition to Mr. Nugent, the delegation will include: Prof. H. G. Sanders, chief scientific adviser (agriculture) to the Ministry of Agriculture, Fisheries and Food; Dr. E. E. Cheesman, scientific adviser, Agricultural Research Council; Dr. H. P. Donald, director of the Agricultural Research Council's Animal Breeding Research Organization, Edinburgh; Sir Peter Greenwell, member of the Council of the Royal Agricultural Society of England; Prof. D. S. Hendrie, principal of the West of Scotland Agricultural College; Dr. P. S. Hudson, director of Commonwealth Bureau of Plant Breeding and Genetics, Cambridge; J. Mackie, chairman of the Scottish Committee of the National Institute of Agricultural Engineering; Dr. A. Muir, head of Soil Survey of England and Wales and head of the Pedology Department, Rothamsted Experimental Station; Dr. J. A. B. Smith, director of the Hannah Dairy Research Institute; Dr. A. W. Stableforth, director of Veterinary Laboratories, Ministry of Agriculture, Fisheries and Food; W. C. Tame, under-secretary, Ministry of Agriculture, Fisheries and Food; and representatives of trade unions associated with agriculture. The *News Chronicle*, which was host for one of the recent Russian delegations to Great Britain during part of its stay, has also been invited by the U.S.S.R. to send six representatives; this group will travel with the official delegation, but will probably follow a separate programme.

## The Cleanliness of the British Scene

As the result of a summer of outstanding brightness and delight, in which many in Britain have been prompted to spend the maximum practicable amount of time in the open air, the matter of dreary and blackened buildings, rendered more dismal by the onset of rain, may have been well forgotten for the time. The hour is fast approaching when the issues to be put before Parliament in the Clean Air Bill will arouse the Press, and the attention of the public will be directed to its hoped-for progress through the House. The summer issue, therefore, of a journal that has grown attractive from the efforts of those who have been zealous in the development of smoke abatement is of particular interest at the present time; it is *Smokeless Air* (25, No. 94), the official organ of the Smoke Abatement Society. With the smoke and air pollution that has been the result of the growth of industrial activity in the British Isles, there now looms before us the problem of radioactive pollution associated with the development of atomic energy so necessary to assist our survival as an industrial community. There is a timely reprint in this journal of an address by Sir John Cockcroft, given to the Parliamentary and Scientific Committee on the subject of radioactive pollution (see *Nature*, May 21, p. 873), which is for the time being reassuring. It yet defines a problem which has been very prominent in the news in recent months.

The same issue of *Smokeless Air* also contains a racy contribution from the pen of a Frenchman, Roger Valvert, entitled "A Frenchman looks at Britain's Smoke". A succession of pert reflexions on the Englishman's robustness and toughness in enduring his apparently barbaric forms of heating almost commends the scepticism with which the Beaver Committee report on "Air Pollution" was received last year. We read of "smog, that cocktail of smoke and fog, typical of London and other great industrial centres". Again, "Coal is scarce. One must not waste it. If then this method of heating does not heat, it teaches the English to live in what Continentals would consider cold". Another pleasant gibe runs, "The Englishman to our mind is badly fed and heated, but he has his own flat, or more often house, redecorated every two years, and a well-kept garden. He has a bathroom even if it is arctic. To teach him efficient heating is, therefore, to risk a catastrophe". The author fires his parting shot by suggesting that it would not be a bad thing to observe how the truly sporting spirit helps, that typical characteristic of the Englishman. We shall see when the battle is joined in the coming months. The editor of *Smokeless Air* deftly puts in a final *riposte* by observing that, according to a municipal councillor, the air of Paris will soon be as poisonous as that of London, and he quotes chapter and verse.

## Colour in Foods

The Quartermaster Food and Container Institute in Chicago is an active centre for both fundamental and applied research in food technology. It is responsible for the specifications for foodstuffs supplied to the United States Army, and it maintains close relations with scientific workers in the universities, in industry and in other government departments. This co-operation is fostered through an Advisory Board established by the National Research Council and through various advisory committees, and during recent years a number of specialized conferences have been arranged jointly by the Institute and the Council. Several valuable reports of these meetings have already been published, the latest of these being on "Color in Foods", based on a symposium held in Chicago during November 3–4, 1953 (pp. 186; from the Quartermaster Food and Container Institute, 1819 West Pershing Road, Chicago 9, Ill.; 1954; n.p.). The sixteen contributors discuss a wide range of problems, including the fundamental concepts of colour measurement, the psychological approach to colour preferences, and the nature and reactions of the carotenoids and other food pigments. Several of the papers are concerned directly or indirectly with instrumentation, and they reveal the progress that has been made during recent years in the design of equipment both for research and for routine tests on fruits and vegetables and their products. As a whole, much is included that is of interest to those who are concerned with quality control in food production; the symposium fully discussed the difficulties in correlating colour and quality—in particular, the necessity for considering separately each commodity in terms of its natural colour and of the changes during storage and processing, and also in terms of what is regarded as acceptable and desirable by the consumer. In this connexion, the symposium brings out not only differences in individual and community preferences, but also the effects of external factors such as modern restaurant lighting.

### Archæological and Geological Investigations in South Australia

AUSTRALIAN investigators continue to advance our knowledge of the prehistory of their regions. Long ago it was suggested that little further progress could be made until sites yielding a definite stratigraphy of industries had been discovered and a correlation of cultures with the geological record determined; and further, that in this connexion the fauna associated with the various culture groups must be listed. The problems there are not at all easy to resolve. Prehistory continued until a recent date, and neither the later geology nor the palæontology has been as systematically studied as in Western Europe. A recent number of the *Records of the South Australian Museum* (11, No. 3; 1955) is a useful addition to our knowledge. It contains a long article on the late Tertiary marsupials of South Australia and continues with a study of certain archæological sites at Lake Menindee, a locality near the River Darling in western New South Wales. The Lake is almost always dry except in exceptionally wet periods, such as that, for example, of 1950. In the dune-like area near the northern end of the Lake a stratigraphical sequence of several cultures has been determined, namely, the Tartangan (at the base) and then the Pirrian, with the Mudukian on top. The remains of a fauna and some human bones have been recovered. The industries are made from material foreign to the district, and it would appear that we are dealing with hunting peoples who from time to time occupied the sites either when it was damp or during times of exceptionally heavy rainfall when the Lake had water in it. It would seem clear that at Menindee man was contemporary with extinct marsupials which he hunted for food, and that the dingo only arrived in New South Wales after the time of the first settlement. The age of the earliest levels could be the close of the Pleistocene or the very beginning of the Holocene. The account is well set out; but the illustrations are not adequate in the case of the stone implements. The drawing of stone tools is a specialized art, and more attention could well have been paid to it.

### Scientific Research in India

IN his Thomas Holland Memorial Lecture, given before the Royal Society of Arts on May 19, Sir Alfred Egerton spoke on "Scientific Research in India". After emphasizing that the fruitfulness of science is first and foremost not a matter of money but of outstanding men or women, Sir Alfred said that although much was started before India attained independence, including the Board of Scientific and Industrial Research and, later, the Council of Scientific and Industrial Research to administer the Industrial Research Fund, scientific research only obtained full recognition and encouragement after 1947. This Lecture was essentially an account of the national research laboratories and institutes of India, the work of which was reviewed by a committee with Sir Alfred Egerton as chairman. Sir Alfred thought that the creation of this chain of laboratories in so short a time and the organization it has involved are fine achievements which provide young Indian scientists with the means to show their mettle. He has faith in India's young scientists and technologists and believes that, with initiative and integrity, patience and persistence, they will do work in these institutes which will make them a worthy memorial to India's great public servant, the late Sir Shanti Bhatnagar.

### Scientific Research at South African Universities

A THIRD volume of the "Register of Current Scientific Research at South African Universities" has now been issued, covering research carried out in 1954 (pp. 262. Pretoria: Library and Information Division, Council for Scientific and Industrial Research, 1954). The entries are arranged alphabetically by university departments under their English names; but subject and description are given in the language in which the information was received: in future, it is proposed to supply an English translation of the subject where that is submitted in Afrikaans. There is no index; but a list of contents and a few cross-references afford reasonable safeguards against any particular research being overlooked, and even a comprehensive index could scarcely eliminate the need for a careful examination of the entries in any broad field.

### Plant List of North-West Europe

UNDER the editorship of the Lund Botanical Society, comprehensive lists are being prepared of the plants of north-west Europe, including those of Sweden, Norway, Denmark, East Fennoscandia, Iceland and the Faeroes. In these lists, all species are given point values indicating their rareness within the area of the list, and their occurrence in the different countries is indicated by 'country signs'. Introduced species of diverse kinds are distinguished from the native ones by different types. The main list is completed by lists of synonyms (those most widely used are also given in the main list), of plants protected by law and registers. The present volume on vascular plants has been prepared by Nils Hylander (15 Swedish kroner). A similar list of mosses, algae and lichens (by H. Weimarck, T. Levring and H. Magnusson, respectively) was issued in 1936–37.

### Audio-Frequency Power Measurements

THE eighth in the series of "Notes on Applied Science" prepared by the National Physical Laboratory, Teddington, is a brief pamphlet dealing with "Audio-Frequency Power Measurements" (pp. 16. London: H.M.S.O., 1954; 1s. net). The concept of electrical power and its measurement is introduced by a theoretical consideration of a simple two-terminal load carrying a d.c. current and having negligible leakage between it and its surroundings; and the basic principles of power measurements in an a.c. system free of coupling are outlined before describing in detail the theory of operation of the three modern types of wattmeter. It is stated that on theoretical grounds the electrodynamic type of instrument is the least suitable for the higher audio-frequencies. It is generally superior, however, to the electrostatic or thermal types for speed of response, constancy of calibration, temperature coefficient and other qualities, so that considerable effort has been made by designers to overcome its limitations at the higher frequencies, and the useful frequency-range may yet be extended above 10 kc./s. to 20 kc./s. Many useful practical details of the design and use of the instruments are interspersed with the theory, and the advantages and accuracy of the various types are indicated. Electrostatic and electromagnetic coupling effects are discussed briefly in one section, and the pamphlet concludes with a few remarks about three-phase power measurements.

### *Science Progress*

THE latest number of *Science Progress* (43 ; July 1955) is once more a combination of interesting articles on various aspects of science, shorter descriptions of recent advances in astronomy, physics, meteorology, organic chemistry, geology and botany, some notes on researches and items of interest to scientific workers and the usual comprehensive and valuable list of book reviews. The articles include one on animal communication and the origin of human language by Prof. J. B. S. Haldane, statistical physics and its problems by Prof. C. Domb, aromatic halogenation by Prof. P. W. Robertson, and one by Dr. A. G. Lowndes on the use of the Wolf Rock phonolite as a means of tracing deepwater drift in the English Channel.

### Recent Earthquakes

DURING May–July the greatest earthquake (magnitude 7½) occurred on May 30 in the Volcano Islands (lat. 24¼° N., long. 142¼° E.), and seven other earthquakes caused damage. The most extensive damage was on July 20 at Cotacachi in Northern Ecuador; on July 16 moderate damage was done in the Ægean on Samos and at Soke in Turkey, where about five hundred houses were totally or partially wrecked, four people killed and twenty others injured. Minor damage was done on May 7 in California, May 11 in Ecuador, May 21 in Samoa, May 22 in Austria, and June 5 in Algeria. In Europe, earthquakes were felt in Switzerland (May 2 and 22, and June 16, 17 and 26), Germany (May 12, June 26 and July 2), France (May 12), Norway (June 3) and Spain (June 4). The epicentre of the German earth tremors was in the Onstmettingen–Pfeffingen–Tailfingen triangle, and they were felt with scale 5 (Modified Mercalli) on June 26 and scale 4 on July 2. The epicentre of the Norwegian earth tremor on June 3 was near Sognefjord. Aftershocks of the Orleansville (Algeria) earthquake have continued, and strong earthquakes have been numerous in the Aleutian Islands. On June 28 an earthquake occurred in the north polar region (lat. 86¼° N., long. 70° E.) with magnitude 6. The greatest depth of focus during the three months was 700 km. for an earthquake on May 11 with epicentre at lat. 7° S., long. 123¼° E., in the Banda Sea; and an earthquake with depth of focus 650 km. occurred on June 11 with epicentre at lat. 16¼° S., long. 179° W., near the Fiji Islands.

### Courses in Radiological Physics and Health Physics at the University of Chicago

THE University of Chicago has approved of two new courses leading to the M.S. degree in radiological physics or in health physics, both degrees being awarded by the Department of Radiology. The courses are full-time and last two years, the second of which is spent half on academic work and half in service in the Department at a nominal rate of pay. The work includes physiology, biochemistry, biophysics, anatomy, toxicology and radiological physics. Before they can be accepted, students must have completed the equivalent of the University of Chicago B.S. degree in physics. The courses will commence this autumn. Further information can be obtained from Prof. Lester S. Skaggs, Department of Radiology, University of Chicago, 950 East 59th Street, Chicago 37, Ill.

### Biological Aspects of the Transmission of Disease

A SYMPOSIUM is being arranged by the Institute of Biology on "Biological Aspects of the Transmission of Disease", to be held at the London School of Hygiene and Tropical Medicine during September 29–October 1. Speakers will be drawn from all fields of biology concerned with disease transmission—bacteriology, virology, parasitology and plant pathology. The papers are being arranged in sessions, not by the organism transmitted, but by the method of transmission, that is, passive, direct, or indirect. In order that there can be a useful discussion, preprints will be available before the meeting for those intending to be present. Programmes for the symposium are available from the Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

### Announcements

THE British Society of Rheology is holding a symposium on "Surface Rheology" at the Washington Singer Laboratories, University College, Exeter, during September 22–24. In the evening of September 23 the Society will hold its annual general meeting. Further information can be obtained from the honorary secretary, Dr. P. Feltham, The University, Leeds 2.

THE Industrial Section of the Royal Microscopical Society is organizing a symposium and exhibition under the title "Fibre Microscopy", to be held on November 16 at the rooms of the British Pharmaceutical Society, Bloomsbury Square, London, W.C.1. The papers and exhibits will include work with both the optical and electron microscope, and will be concerned with a large variety of fibres. Further information can be obtained from the Society at Tavistock House South, Tavistock Square, London, W.C.1.

THE eleventh British Commonwealth and Empire Lecture of the Royal Aeronautical Society will be given by Dr. J. J. Green at 6 p.m. on October 6 at the Royal Institution, 21 Albemarle Street, London, W.1. Dr. Green, who is the representative on the Canadian Joint Staff in Washington of the Canadian Defence Board, will speak on "The Growth of Aeronautical Research in Canada during the Post-War Decade". He was the first president of the Canadian Aeronautical Institute, founded in 1954. Further information can be obtained from the Secretary of the Society at 4 Hamilton Place, London, W.1.

WE regret that the obituary notice of Prof. G. F. Shirras in *Nature* of August 27, p. 376, was unsigned; it was written by Dr. John Murray, formerly principal of University College, Exeter.

# THE WORLD HEALTH ORGANIZATION

VIEWED against the background of its basic functions and long-term objectives, the progress made by the World Health Organization in 1954 should be measured less by any particular achievement than by the development of a general attitude which, as a result of six years experience, most of its members seem to be taking towards it (Official Records of the World Health Organization, No. 59).

In all parts of the world there has been a better understanding of the real purposes pursued by the Organization. This evolution is clearly reflected by the nature of the assistance the World Health Organization is asked to provide: there is a definite trend away from requests for supplies and equipment towards requests for technical advice on virtually all aspects of public health. Authorities in many countries now realize that, to be truly effective, the resources of the World Health Organization should be utilized not so much for the temporary alleviation of their problems as for the strengthening of the permanent foundations of their health services.

The most encouraging aspect of the requests received by the Organization in 1954 is the desire shown by many countries to obtain help in working out long-term plans for the progressive and orderly development of their public health services. The growing attachment of Member States of the United Nations to the idea of international co-operation is demonstrated by the great number of inter-country and inter-regional projects. It is also reflected in the continued interest shown by countries in the Organization's efforts to co-ordinate on a regional basis activities carried out on a national level. These methods are being effectively applied in all areas and in practically all aspects of the Organization's work; during 1954, they were used in projects for the development of training facilities, for the exchange of scientific information, and also for the control of communicable diseases and their vectors.

A few examples will indicate the very important part such regional projects played in the total programme of the World Health Organization during 1954.

In the field of education, the Inter-American Centre of Biostatistics in Chile is making a valuable contribution to the improvement of vital and health statistics of all Latin American countries by training technical personnel for the various statistical services. The creation at Alexandria of a regional college of nursing is expected to go a long way towards raising the standards of nursing and nursing education in the countries of the eastern Mediterranean. Countries in Europe took advantage of the advanced training course for waterworks engineers, held in Belgium and the Netherlands, which was attended by engineers from eleven countries.

To exchange scientific information, an important seminar was organized in Wellington (New Zealand), at which thirty-seven participants, from twenty-one countries of the western Pacific, south-east Asia and eastern Mediterranean regions, discussed problems relating to dental health. The conference on African onchocerciasis, convened at Leopoldville and attended by some thirty experts from three regions, yielded valuable information for national and regional campaigns which are to be undertaken in Africa against that disease. The sanitary engineering seminar held in Venezuela proved most effective in promoting inter-American co-operation in the field of sanitation and in integrating public-health engineering activities into the general health programmes of the countries concerned.

An outstanding example of the role being taken by the Organization in the regional co-ordination of national campaigns against specific diseases is the combined effort to be made towards the eradication of malaria from the Americas as a whole. This campaign is to be based on the malaria-control work already being done by individual countries in that region, and on two inter-country programmes assisted by the Organization, one for the Caribbeans and one for Central America.

The second Asian malaria conference, attended by representatives from fifteen countries of south-east Asia and the western Pacific, which took place in the Philippines in November 1954, can be considered as a preliminary step in organizing an inter-regional campaign against this disease. The contacts arranged by the Regional Office for South-East Asia between health authorities of Thailand and of Indonesia are undoubtedly of help to the two countries in their great efforts to bring yaws under control.

There are many examples in the 1954 report of the part the Organization is playing in promoting and especially in co-ordinating essential research work going on in various countries. There is the testing of sorption of non-volatile insecticides by certain types of mud wall, carried out by seven institutes in the Americas, Asia and Europe, and co-ordinated by the Organization. There is also the programme started by the Organization to ensure collaboration among leading experts responsible for field epidemiology studies of trachoma and associated conjunctivitises in different areas of the world. A meeting organized by the Organization in Teheran brought together specialists from Iraq, Syria, Turkey and Iran for a useful exchange of information on the epidemiology of sylvatic plague. Arrangements were also initiated for the exchange of scientific workers between the Nutrition Research Unit in Kampala, the national laboratories of the Indian Council of Medical Research, and the Institute of Nutrition of Central America and Panama.

The overwhelming importance of environmental sanitation for the health programme of the great majority of Member States is emphasized in the report.

In addition to the advisory services in this field given during 1954 to a number of countries, preliminary studies were begun with the view of developing international standards for the quality of drinking-water on the basis of information received from about seventy countries. At the same time, the preparation of material relating to rural water supplies and excreta disposal continued, and it is hoped that this material will contribute to the improvement of sanitary conditions in the rural areas where more than three-quarters of the world's population live.

The scarcity of qualified personnel in the field of sanitation remains acute, and the highest priority is being given to the training of sanitary engineers and related personnel.

Training and education were at the very core of the efforts made by the Organization to assist countries to meet the many health needs of mothers and children, especially in rural areas. International teams, working side-by-side with national counterpart staff in twenty countries during the year, were principally engaged in training activities.

# RESEARCH COUNCIL OF ALBERTA

## REPORT FOR 1954

THE thirty-fifth annual report of the Research Council of Alberta* outlines the work of the Council for 1954, a year in which the geological research programme was enlarged to meet an increasing demand for basic geological information, and increased effort was placed on natural gas research. The construction of the Council's building was commenced; with its completion most of the scientific work will be consolidated under one roof, and more specialized testing and investigational work on behalf of industry will also be possible. The programme of more fundamental research on coal, initiated in 1953 with the object of advancing the knowledge of the constitution and behaviour of coal, was continued; an extended survey of the colloidal structure of typical Alberta coals by means of heat-of-wetting measurements was virtually completed and has confirmed the existence of a catenary type of relation between accessible inner surface and coal rank. More detailed measurements have been made of the sorption of oxygen by coal at − 25° to − 40° C. and considerable progress was made in studies of the effect of an ultrasonic field on the solubility of coal in such solvents as methyl alcohol. Laboratory studies of the low-temperature carbonization of Alberta coals indicate the possibility of modifying profoundly the course of carbonization by means of cracking catalysts, and studies have also been made on the following topics: the constitution of humic acids derived from coal and of the humic acid content of low-grade Alberta coals; techniques for concentrating spores from shales and various kinds of coal with the view of cataloguing plant microfossils of the uppermost Cretaceous and lowermost Tertiary formations of central Alberta; the suppression of surface dust on bituminous coal briquettes; the grindability of sub-bituminous coals.

In the work on petroleum, the study of trace metals (particularly vanadium, nickel and iron) in crude oils was extended to include oils from other oil horizons of the Western plains, and more recently to include magnesium, since the occurrence of magnesium in crude oils appears to be related to the presence of chlorophyll in the living material from which the crude oils are formed. Determinations of sulphur in these crude oils indicate no close relation between the sulphur content of a crude oil and its trace-metals content. A study of the settling characteristics of solid particles in emulsions of water in heavy oils showed that the presence of water retarded appreciably the settling characteristics of solid particles. Certain 'heavy oil' fractions appear to have special merit as a briquette binder and for preparing metallurgical coke, and attempts were also being made to separate the sulphur compounds present in 'heavy oils' from Athabasca oil-sands.

The research programme on natural gas has included the construction of a new furnace for studies on the formation of carbon black, and work on the partial oxidation of *n*-butane continued. A complete section of the McMurray oil-sands formation has been examined for oil saturation, grain-size distribution and heavy minerals analysis, and a Pleistocene research and survey programme initiated in the Coronation district. Mineralogical analyses of a number of clays from south-western and west-central Alberta were completed, and clay research was extended to include the Bearpaw formation.

The Council's part of the Alberta Soil Survey, a joint effort with the Dominion Experimental Farms Service and the University, included a reconnaissance survey of about eight hundred thousand acres, and an exploratory survey of four hundred thousand acres in the Grande Prairie and Beaverlodge areas. Despite exceptionally heavy rainfall, irrigation research in the Youngstown area showed beneficial effects from irrigation in relation to certain soil amendments and cultural practices, while the sub-surface drilling operations initiated during the year are proving of value in soil surveys and irrigation research as well as in geological studies on clays and other non-metallic mineral deposits. Laboratory results in the Highway Research programme indicate that the chrome–lignin gel is as effective in reducing frost heaving as the plain lignosol, and may be more effective provided it is properly dispersed in the soil.

The Biological Cycles project shows that the ten-year cycle is now at what is assumed to be its complete ebb, with signs of recovery in places. In the Department of Animal Science at the University, the Council sponsored investigations of the factors affecting the percentage hatch of turkey eggs and of methods of improving the quality and yield of grass silage. Solar ultra-violet radiation measurements were continued, and an Advisory Committee on Industrial Pollution was constituted to provide technical guidance at an early stage in Alberta's industrial development in the hope of avoiding difficulties now encountered in older industrial regions. The committee appointed to study the fluoridation of public water supplies has now reported. At the end of the Council's report the usual list of publications is appended.

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* Research Council of Alberta. Thirty-fifth Annual Report, 1954. (Report No. 69.) Pp. 47. (Edmonton: Research Council of Alberta, 1955.)

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# THEORY OF ADHESION

IT may be claimed that progress on the practical or empirical side of adhesion and adhesives is more rapid and even spectacular than on the theoretical; but, whether this is so or not, the fact remains that, in the field of production engineering and in other directions, rapid advance has been recorded, especially during the past year or two, some of the most remarkable results being achieved in aircraft design and manufacture. A detailed description of the purely practical application of adhesives to aircraft production is given by Mr. George Epstein, of the Aerophysics Department, North American Aviation, Inc., in his book, "The Adhesive Bonding of Metal" (New York: Reinhold, 1954), and, in lesser detail, in his contribution to the Basic Materials Conference, held in Chicago in May 1954[1].

Several contributions have recently been made to adhesion theory by workers in France, Germany and the U.S.S.R. By way of introduction to these, reference should perhaps be made to the interesting chapter by A. J. Staverman on molecular forces in relation to adhesion which is published in the book by de Bruyne and Houwink on "Adhesion and Adhesives" (1951). This chapter deals at some length with the molecular aspects, to which attention hitherto has been mainly directed, including different kinds of molecular forces and the significance of molecule size, polarity, etc., in connexion with both cohesion and adhesion. It is rightly concluded that much yet remains to be done before we have a complete understanding of the nature of adhesion based on molecular characteristics.

J. Remond[2] includes a discussion of the problem of adhesion (*collage*) and endeavours to elucidate its scientific foundations. In his view, these are to be found entirely in the inter-atomic or inter-molecular forces which account for both the cohesion within matter itself and for its adhesion to another body. These forces have a common origin, are of an electrical kind, and are to-day divided into primary and secondary. It has been realized for some time that the electrical aspects, or in other words, molecular polarity, are of fundamental importance; but as will be seen later in this article when recent Russian ideas on the subject are considered, a new electrical conception of adhesion has been evolved. Meantime, the close similarity between cohesion and adhesion as indicated by Remond is of considerable interest. This has been stated elsewhere in another form: any adhesion theory which attempts to correlate thermodynamic factors, electrical charge factors, or molecular structure factors with the observed strength of an adhesive joint is, in effect, providing a theory of the strength of solids—cohesion—in terms of these factors. In this connexion, of course, one has to remember that the adhesive bond may sometimes be stronger than that of cohesion—for example, where the assembly breaks down, not at the adhesive joint but by fracture within one or other of the parts joined. One has to note, also, at least two kinds of adhesive fracture: where the adhesive film 'tears away' from one or both the joined surfaces, and where the film itself splits into separate laminæ.

Reverting to Remond's division into primary and secondary forces, the former play the leading part in the formation and existence of definite chemical compounds. They are distinguished from the secondary by "their greater importance" and property of saturation and of valency. The special case of carbon is briefly considered by Remond, in the formation of monomeric molecular chains. The secondary forces are those of the polymer, and obviously much weaker. He proceeds to consider some of the fundamental principles of adhesion, including artificial change of polarity, for example, by acid treatment, where this is necessary for effective adhesion, as in the case when rubber (non-polar) is to be joined to wood (polar). An interesting example is cited in the case of the manufacture of a heat exchanger by A. P. V. Co., Ltd.

A great deal of adhesion research is also proceeding in Germany, by such leading firms as Henkel and Cie., Huls, and the BASF (Badische Anilin u. Sodafab.) at Leverkusen. For the latter, Dr. H. Sonne is in charge of developments, and in reporting more particularly on work with dry (or pressure-sensitive) adhesives he has included some interesting notes on molecular structure in relation to adhesion[3]. Here again, cohesion and adhesion are both included in what presumably must be a wide interpretation of the German term *Klebfähigkeit*, or glutability. Undoubtedly, the old-fashioned term 'glue', which in the olden days meant practically only one kind of adhesive, as used by the village carpenter or handyman in his familiar glue-pot, is now applied to a vastly wider and more varied collection now that synthetic resins, and many other materials, have entered the adhesives field; but it is perhaps a little unusual to extend it so far as to include cohesion.

Dr. Sonne deals with high-molecular materials with side-valencies, in which a dispersion effect may be involved, or a disturbance, through chemical bonding, of the original natural frequency of the electron system; also, dipole effects of polar molecules may be involved (that is, an electrical moment). An accumulation of polar groups, as in long-chain molecules, must necessarily increase the total moment, and therefore also the outwardly acting forces. In the normal paraffin ($CH_2$) chain is a non-polar system of high symmetry but of low dispersion effect and relatively small outward force. But the introduction of side-groups or secondary chains causes immediately a non-symmetrical charge distribution which affects inductively the whole molecule; and this becomes more marked with increasing length of chain and number of side-groups, as in high-polymer compounds. Dr. Sonne draws the interesting distinction that "the dispersion forces of the main chain affect chiefly cohesion, while the dipole forces of the side-chains are chiefly related to adhesion". Thus, these side-chains act as innumerable 'fixing points' in the molecule.

In the manufacture of dry (pressure-sensitive) adhesives, compounds of such molecular structure are no doubt to be preferred—for example, those of the poly*iso*butylene (Oppanol *B*) and natural rubber type—as may be deduced from a consideration of their structural formulæ. Others that may be included in this category are the polyacrylates (COO*R*— side-groups), polyvinyl ethers ($OCH_3$—), polyvinyl chloride, polystyrol, Buna products, etc. All these materials have adhesive properties, actual or potential, but the relevant conditions and relations vary considerably, and are somewhat complex. Polymerizates of this kind almost invariably form isomeric mixtures, with chain structures of widely varying length and side-group. It is to be observed that the $CH_3$— side-groups are usually associated with high adhesive power, and it may reasonably be assumed that, with Buna rubbers for example, having lower adhesive powers than natural rubber, mixed polymerizates have been formed that should be of considerable interest in this connexion. Both the natural and synthetic rubber types, as regards the double bonds therein, have unique properties and failings. They are sensitive to the action of oxygen or light, with resulting changes that indicate a lack of stability prejudicial to adhesive power.

More recently, an important further contribution has been made in a symposium on the theory and practice of adhesion at a meeting of the American Chemical Society in Cincinnati (reviewed in *Chem. and Eng. News* of April 18, pp. 1639–40, under the heading, "Why does it stick?"). The symposium included papers on wettability in relation to adhesion, by W. A. Zisman (Naval Research Laboratory); an atomistic approach, by R. M. Gruver (Linden Laboratories), with a note on the electrical forces emanating from surface ions that are not completely surrounded by those of opposite charge; the failure of adhesive bonds involving passage over the free-energy barrier, and the significance of the absolute rate theory in connexion with adhesion, by Marshall R. Hatfield (3M—Minnesota Min. and Mfg. Co.); the measurement of adsorption tendencies in addition to physical test methods, by L. Reed Brantley (Occidental College); cementing various materials to glass, with particular reference to moisture resistance, by F. Moser (Pittsburgh Plate Glass Co.); epoxides and their superiority in this respect, by E. W. McGuiness (General Electric

Co.); new tool for study of structural bond breakdown, with special reference to metal/metal bonds, by S. M. Skinner (Case Institute of Technology); new apparatus for measuring adhesive bond strengths, provisionally called the 'hesiometer', by W. K. Asbeck (Carbide and Carbon Corporation).

An important contribution from the U.S.S.R. to the theory of adhesion, including claims for a new electrical theory, is to be found in a fairly long article by B. V. Deryagin[4], based on his own extensive research and that of other Soviet scientists. He observes that this subject, despite its wide and increasingly varied practical importance, has been neglected on the theoretical side. In the case of protective coatings and adhesive films, it used to be considered fairly obvious that the adhesive forces were of a molecular or chemical nature, in which the surfaces joined took part; but this did not appear consistent with actual measurements of the forces needed to tear away a film under conditions that did not greatly affect the strength of the film itself. These forces might be as much as $10^6$ or even more ergs/cm.$^2$, according to the speed of tear, and this exceeds by many times that required for breaking chemical or molecular bonds. It is necessary here to consider also the number of molecules or chemical bonds per unit surface (one must note, too, many cases of apparent chemical bonding, as in that of rubber to steel by vulcanization).

As an aid to solution, the author thinks secondary phenomena often noted in film removal may be invoked, such as luminescence and crackling, that indicate electrical discharge. On this basis, the Soviet workers claim to have founded their new electrical theory, briefly as follows: on contact of any two bodies, conductors or not, as already known, two electrical layers form at the interface, positive and negative; with some difference of potentials through transfer of charge from one phase to the other, and expenditure of work against electrical forces in the interface, as in a condenser, this difference may be a fraction of a volt to several volts.

If tear-away is sufficiently rapid and does not involve also cohesion (integrity of film itself), there should be separation at identical points of the outer zones of both electrical layers. Differences of potentials between these will depend on distance of separation, and be limited by discharge possibilities. The author here discusses at some length variations in charge according to pressure of ambient gas ($p$), the validity of the laws of gaseous discharge—including Paschen's—and other factors including ionization. If the discharge gap ($h$) or potential ($V$) is known, the following formula gives the work expended ($A$): $A = 2\pi\sigma^2/h = \sigma V/2$, where $\sigma$ is the charge density.

According to Deryagin, under the action of intensive forces of electrical attraction the electrons torn from one surface and dispersing with high energy impinge on the opposite surface, dislodging therefrom positively charged ions and also photons. There is movement towards the surface. Under the impact new secondary electrons are dislodged, and if the number of these exceeds that of the first the electrons multiply, leading to discharge. This may be further complicated in that impacts of positive ions may produce, together with electron emission, a secondary emission of negative ions and also a photo-effect. But the general mechanism and nature of the discharge are obviously not changed as a result of this. It is emphasized that, with a spark-over vacuum, the significance or value of the gap, but not that of the discharge potential, depends on the density of the charges of the double electrical layer.

In regard to the above formula, it has been shown that, choosing a definite value for density of electric charge, and using values of the potential $V$ directly observable in the discharge tube under different gas pressures (including those in which discharge proceeds without participation of the gas itself), one can predict—in determining the work of removing the film ($A$) and in accord with experiment—how this value ought to change with changes in pressure and nature of ambient gas. Thus, by selecting the right value for density of charge of the double layer, agreement with experimental results can be obtained both under ordinary atmospheric conditions and under those of widely varying gas pressures. It is therefore claimed that the new theory, as regards agreement with experiment, has decisive advantages over the conventional theory that takes little account of gas pressures.

The new theory includes also an explanation of the experimentally found values of work done—up to $10^6$ ergs/cm.$^2$ or even more. In such cases, charge densities are obtained corresponding to a potential jump of not more than one volt; and this is only exceeded during the tear-away without discharge, when the voltage may be up to 10 kV. or more at discharge, according to charge density and pressure of ambient gas. Other evidence of the validity of the new electric theory is claimed by Deryagin to have been found in the observation and measurement of speed and energy of electrons emitted during tear-away of films in vacuum from metallic and non-metallic backing. He describes a method of observation, using a photographic film, an absorbent screen of thin foil or mica sheet for maximum speeds, and a magnetic field for determining deflexion. It was found, in agreement with theory, that intensity and energy of emission increased with speed of tear-away, and charges of 10 or more kV. are mentioned. They are of such magnitude that the work expenditure may be attributed mainly to overcoming these electrical forces.

Deryagin acknowledges, however, that this method of measuring electron speeds cannot be said to have a high degree of accuracy. Thus, without necessarily contradicting these measurements, it may be suggested that some part of the work, say 30–40 per cent, may be devoted to something else, such as deformation of the film during removal, with possible evolution of heat. But Deryagin is satisfied that these objections have little or no basic significance, and he produces lengthy arguments in support. He is quite certain that, compared with the electrical component, the molecular component is practically negligible.

It is easy to explain the effect of adsorption of dipole molecules on adhesion, as these form an oriented dipole molecular layer and may considerably modify the value of the potential jump. Some cases of such modification have been studied by A. N. Frumkin. Various considerations lead to the view that the effect is indirect, and may either increase or reduce adhesive power—as appears to be confirmed by experiment. Chemical interaction sometimes doubtless plays an important part, and the example of rubber-to-metal through vulcanization is again cited. But this by no means belittles or invalidates the new electrical theory. As already stated, the work expended on tear-off of film is usually much greater than that needed to break the chemical bonds. Mechanical fracture of the diamond illustrates the absurdity of opposing chemical to mechanical and electrical factors. Reference is made to some Russian work on the electron theory of chemical affinity and of atom adsorption in crystal lattices. Similar reasoning may be applied in passing from surface adsorption to contact of a film with solid bodies, where the film contains mainly a polymer in solution—as is mostly the case with coating or adhesive films. The active atoms or groups in the film may enter into electronochemical union, accompanied by transfer of electrons from one phase to the other, obviously leading to formation of the double electric layer.

A possible objection to the new theory is to be found in the query: Why, in adhesive breakdown (delamification), is the double electric layer split up, though having in many cases the nature of a strong chemical bond, while there is little or no cohesive break along a line, probably of less or even of least resistance? Deryagin's reply is not very clear. He thinks that the principle or rule under which breakdown should occur along a line of least resistance is ambiguous and generally futile until a satisfactory measure of resistance is agreed. This line may vary, for example, with changes in speed of load application. If we consider splitting along a surface, in stages, and the measure of resistance is taken to be the specific work expended in tear-off, the principle of least resistance completely loses validity. This is discussed somewhat vaguely by Deryagin, and at length, including non-adhesive examples. In any event, it appears necessary to develop the theory somewhat further to permit combination of charge density in the double layer with the nature of functional groups in the adhesive, the presence there of active atoms and radicals, and the interaction between these structural elements of the adhesive and the surfaces to be joined.

Another approach to the problem of the origin of the electrical double layer, though possibly more limited, is to be found in studying the contact of a polymer film with metal. This is considered in connexion with electron transfer with the production of electron gas in the metal. In a vacuum such a transfer is only possible at high temperatures, such as those of thermo-emission or photo-effect. The formation and diffusion of the electron cloud and its results are also considered.

Referring to work in the United States by Skinner and colleagues[5], Deryagin considers that their theory of formation of an electrical double layer contains quite a few errors "and is probably only of qualitative interest"; Skinner *et. al* do not cite any of the Soviet work on this electrical theory of adhesion, and he claims that they have ignored the fundamental difference between simultaneous and gradual disturbance or fracture of contact over the whole area. There is no doubt, he continues, that the research already begun on the nature of film adhesion merits wider development, especially if this includes the really practical evaluation of adhesives in different fields of Soviet economy. It is very important to establish closer contact with workers in manufacturing industry directly engaged on new adhesive formulations and uses, and also those particularly interested in building up a sound scientific theory of adhesion.

Of special interest here is the so-called auto-conglomeration or self-adhesion (using terminology suggested by I. I. Zhukov) as observed in bringing into contact two identical strips of polymer, such as rubber. Experiment shows that the work of separating such double-folded strips increases not only with the speed of tear-off, but also with the duration of previous contact and amount of pressure. Such auto-adhesion, of course, is greatly affected by temperature conditions. All these various relations, including that between the structure of the polymer chains and their length, have been studied by different workers—for example, Voyutskii, Krotova, Deryagin and others—who have suggested that the phenomena of self-adhesion to a large extent are determined by intra-molecular thermal movement, forming the basis of polymer elasticity and leading, with contact of two polymer surfaces, to mutual interweaving and diffusion of their chains.

Thus, the surface of separation initially retained on bringing into contact two homogeneous polymers gradually disappears, and instead of two layers of polymer only one exists. Separation or tear now proceeds elsewhere, and the work involved is typical of the cohesion of the material. It is difficult to separate the macroscopic process, of gradual increase of true surface of contact of two materials, from the molecular mechanism of diffusion and interlocking of polymer chains. The initially true area of molecular contact will be considerably less than the apparently nominal. But gradually, owing to flow and relaxation of the polymer, the true area of contact will increase—with a tendency to approach the nominal. Since relaxation and plastic flow in polymers in turn are connected with deformation of macromolecular chains, it is difficult strictly to separate the two mechanisms—molecular coalescence and plastic flow in the contact zones. Further experimental research is necessary, including study of other fields of adhesion phenomena which, in the course of this review, cannot be considered here.

W. G. Cass

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[1] *Adhesives and Resins* (Jan. and March, 1955).

[2] *Rev. Produits Chim.*, 57, 469 (1954); 58, 70 (1955).

[3] *Kunststoffe*, 44 (9), 385 (1954).

[4] *Vestnik. An S.S.S.R.*, 7 (1954). Summarized also in *Research* (Feb., 1955).

[5] *J. App. Phys.* (May, 1953).

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# JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH

## REPORT FOR 1953–54

THE third annual report of the Joint Establishment for Nuclear Energy Research, which has recently been issued*, contains details of the activities of the Establishment during the year ending June 30, 1954. The Establishment, which is located at Kjeller in Norway, is operated jointly by The Netherlands and Norway and is directed by Mr. Gunnar Randers. The experimental equipment includes a 300-kW. heavy-water-moderated, natural-uranium reactor, Joint Establishment Experimental Pile (JEEP), which has been in continuous operation during the year, though four of the uranium rods were found to be defective and had to be replaced. An additional rod, bringing the total up to sixty-five, was required in order to compensate for the heavier load of isotopes. New equipment installed during the year included a pneumatic arrangement for removing isotopes quickly from the reactor and a mechanical master-slave manipulator for remote handling of radioactive material.

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* Joint Establishment for Nuclear Energy Research. Third Annual Report, 1953–54. Pp. iii+28. (Kjeller, near Lillestrøm: Joint Establishment for Nuclear Energy Research, 1955.)

The design of an experimental power reactor in which heavy water and natural uranium are to be used in a pressurized system has continued. The general planning has now reached an advanced stage, and recent work has been concentrated on the design of the natural-uranium fuel elements. The reactor is to be contained within a cylindrical pressurized stainless-steel tank, and the cooling circuit for the fuel elements, which is separated from the moderator, will provide hot heavy-water which will be used for steam production in a boiler connected to a conventional type of turbogenerator.

In November 1953 an extension to the building housing the pile was completed, and the physics, isotope and electronics laboratories and the offices for the Operations and Engineering Department are now housed together in this building. In June 1954 work was started on a new laboratory and workshop building to house the metallurgy and engineering groups and the Reactor Physics Department.

Work in the Chemistry Department has been divided between service tasks for other departments and the study on a laboratory scale of the chemistry of uranium and plutonium, particularly in order to design a pilot plant capable of dissolving up to ten tons of burned uranium rods a year, including the separation of plutonium and the reprocessing of the uranium metal. A 'hot' uranium slug was dissolved in concentrated nitric acid in an all-glass apparatus, the experiment being carried out by remote control behind a 40-cm. thick water wall. The solution obtained contained about 10 mgm. of plutonium. Arrangements have been made for the production of uranium metal by the reduction of uranium tetrafluoride with calcium. The uranium tetrafluoride was produced in accordance with the French method, that is, by reduction and fluorination of uranium tetraoxide, and the report states that uranium of a fair degree of purity has been obtained. Although the metallurgical laboratory is still under construction, some of the metallographic equipment has arrived, and studies of the de-gassing of uranium at elevated temperatures have been undertaken. The stabilization and canning of the uranium and the diffusion of uranium and aluminium at 200° C. and higher temperatures are other problems which have engaged the attention of the metallurgical group.

The production of isotopes has greatly increased, and the number of radioisotope shipments, namely, 335, is more than double that for 1952–53; 65 per cent of these shipments were for export. The different types of isotopes produced and the number of irradiations made in the several departments of the Establishment, together with the number of shipments, their destinations and main fields of application, are listed in the annual report. Stocks of radiocobalt and of radioiridium with fairly high specific activity suitable for industrial radiography have been developed, and many special isotope preparations of medical interest are, or will shortly become, available. No increase in the number of isotopes imported for distribution in Norway is reported. Eighty-four shipments were received from Great Britain, one from the United States and one from Canada. Three examples to illustrate the different technical applications of radioactive isotopes carried out by the Isotope Department during the year are described in some detail in the report. They are concerned with the transport of materials in rotary cement kilns, the loss of catalyst material in the industrial production of nitric acid, and the wear of ball bearings.

The sections of the report devoted to the activities of the Neutron Physics and Reactor Physics Departments are particularly interesting. The fission cross-section of uranium-235, the crystal structure of copper hydride and the magnetic structure of magnetite have been studied by the Neutron Physics Department. The principle of operation of the simple mechanical monochromator for neutrons used at the Establishment, the results of measurements of the rate of fission cross-section of uranium-235 and $(n,\alpha)$ cross-section of boron as a function of neutron energy, and the neutron diffractometer used for crystal structure analysis are some of the topics discussed in the report. The critical factors of various reactor designs were studied by the Reactor Physics Group; other problems considered were shielding properties of concrete, the effect of prompt and delayed $\gamma$-emission on the reactivity of the Pile and the rate of plutonium production in heavy-water reactors.

The report concludes with a list of the Establishment's reports and publications issued during the year, details of the staff of the various departments, and an abstract of the financial accounts for the period under review.

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# THE PHYSICAL SOCIETY

## REPORT FOR 1954

THE report of the Council of the Physical Society for the year ending December 31, 1954, together with the report of the honorary treasurer and the annual accounts and balance sheet, were presented to the annual meeting of the Society held at the Royal Institution, London, on May 11, and adopted. Immediately following the annual meeting, Prof. H. S. W. Massey delivered his presidential address, entitled "Progress and Problems of Physics To-day", in which he described a selection of remarkable achievements in recent research in physics which illustrate the very advanced state of technique to-day, and then dealt with some of the problems, for example, the growing shortage of science teachers in schools and the tendency to extreme specialization, which the great expansion of research in physics has raised. The text of his address will be published in the separate issue of the *Proceedings* of the Society to be called the "Proceedings of the Physical Society Yearbook". The "Yearbook" will also contain the texts of the 1955 Guthrie Lecture and the Thomas Young Oration.

The report states that during the year the student membership of the Society decreased by approximately a quarter to 279, and the total membership fell to 2,046 with a net decrease of eighty-four. There was a small balance of income over expenditure; but the financial position at the end of 1954 was markedly less favourable than at the end of 1953, the deterioration being attributed, in particular, to a decrease in the income from the annual exhibition of scientific instruments and to the absence, in 1954, of a grant-in-aid in respect of the Society's publications. It is true that the cost of the Society's publications, including its commitment in respect of *Science Abstracts*, was almost balanced by the income from sales; but the total cost of the Society's activities continues to rise and gives cause for considerable anxiety.

Five science meetings were held in London during 1954, including the summer meeting on July 7, 9 and 12, which was held in the Royal Institution in connexion with the General Assembly of the International Union of Pure and Applied Physics. Meetings outside London were held in University College, Dublin, during March 30–April 1, and in the University of Birmingham during December 13–14. In addition, a conference on the physics of the ionosphere was held in the Cavendish Laboratory, Cambridge, during September 6–9. The thirty-eighth Guthrie Lecture[1] was delivered by Sir Geoffrey Taylor, who spoke on diffusion and mass transport in tubes, and the seventh Rutherford Lecture by Prof. P. M. S. Blackett. Prof. A. Kastler, of the University of Paris, was the recipient of the ninth Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society; the presentation took place at the Royal Astronomical Society, Burlington House, on May 13, 1954, when Prof. Kastler delivered the Holweck discourse[2] entitled "Les méthodes optiques d'orientation atomique et leurs applications". The thirty-first Duddell Medal was presented to Prof. A. C. B. Lovell, who gave an address on the development and use of large radio telescopes, and the tenth Charles Vernon Boys Prize to Dr. J. S. Courtney-Pratt, who spoke on some new methods of fast photography.

At the request of a number of members, the Society reprinted the first five Rutherford Memorial Lectures, and the pamphlet, entitled "Rutherford, by Those who Knew Him", has been well received. Two special reports, "Defects in Crystalline Solids", representing the proceedings of a conference on this subject held in the University of Bristol during the meeting of the International Union of Pure and Applied Physics, and "The Physics of the Ionosphere", the proceedings of the Cambridge conference on this subject, have recently been issued. Vol. 17 of "Reports on Progress in Physics", containing eight reports, was published during 1954. A new departure was the issue, in addition to the bound volume, of each report as a separate booklet, with paper covers, to be purchased in any required quantity.

The thirty-eighth annual exhibition of scientific instruments and apparatus held at the Imperial College of Science and Technology, London, during April 8–13, 1954, had an attendance of approximately eighteen thousand and was again a great success. The four subject-groups of the Society—the Colour, Optical, Low Temperature, and Acoustics Groups—were all active during the year, and brief details of their membership and meetings are listed in the annual report. The summer meeting of the Low Temperature Group consisted of a visit, led by Dr. K. Mendelssohn and Dr. F. Din, to West Germany; on May 7 the party inspected the oxygen plant of the Messer Company at Hagen-Haspe, and during May 8–9, at Göttingen, a joint session was held with members of the German Physical Society at which scientific papers were read. A list of the numerous bodies and committees on which the Society is represented is also included in the report.

At the annual general meeting the officers and council of the Society for 1955–56 were elected as follows: *President*, Prof. H. S. W. Massey; *Vice-Presidents*, Dr. R. C. Evans, Dr. A. B. Wood, Prof. S. Devons and Prof. F. Llewellyn Jones; *Honorary Secretaries*, Dr. C. G. Wynne and Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Treasurer*, Mr. A. J. Philpot; *Honorary Librarian*, Dr. R. W. B. Pearse; *New Ordinary Members of Council*, Prof. W. E. Burcham, Prof. H. Jones and Mr. D. A. Wright.

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[1] *Proc. Phys. Soc.*, B, **67**, 857 (1954).

[2] *Proc. Phys. Soc.*, A, **67**, 853 (1954).

# NITROGEN NUTRITION, RESPIRATION AND AGEING IN *LEMNA* FRONDS

IN a constant and favourable environment, each frond of *Lemna minor* has a finite length of life and a rate of ageing characteristic of the clone in its particular environment. Ageing, and the progressive diminution in frond-size which accompanies it, are not attributable to the production of daughter fronds, nor to a lack of auxin or adenine. Further, it has been found in surgical experiments that daughter frond area is determined by some substance in the mother frond (not auxin or adenine) which diminishes or is inactivated as the mother frond ages. E. Wangermann and H. J. Lacey (*New Phytol.*, **54**, 2, 182; 1955), in further investigations, have examined the relationship between nitrate nutrition, rate of respiration, and rate of ageing in *Lemna* with the following results.

Maximum length of life and minimum rate of ageing occurred at the lowest nitrogen-levels (less than 0·1 mgm./l.); minimum length of life and maximum rate of ageing occurred at intermediate nitrogen levels (about 0·25 mgm./l.). When rates of respiration of fronds at high and low nitrogen-levels were measured by the Warburg manometric technique, it was found that the rate of respiration of the low-nitrogen fronds (on an area or dry-weight basis) was below that of the high-nitrogen fronds throughout the whole of their life. There was no trend towards reduction in rate of respiration between maturity and death. The length of life was recorded of fronds the respiration of which was periodically inhibited by keeping them in an atmosphere of nitrogen during the dark period. Fronds thus treated lived considerably longer than those the respiration of which was not interfered with. From these results and those of previous experiments, it is tentatively suggested that a causal relationship may exist between rate of respiration and rate of ageing, slow respiration resulting in long life and *vice versa*.

# A NEW FAMILY OF EARLY PRIMATES

THE known primates and primate-like animals from the Palæocene and Eocene of North America and Europe are extraordinarily diverse. All are distinctly pre-anthropoid in structural grade and are considered in a general sense to be Prosimii or, in some cases, primate-like Insectivora. There has been a tendency to compare them either with the tarsiers or lemurs and to place them in the categories Tarsiiformes and Lemuriformes. Most of the supposed early Tarsiiformes have been classified as Anaptomorphidae, and most of the supposed early Lemuriformes have been called Adapidae. A few other families, notably the Plesiadapidae, were also early recognized, although not well defined until more recently.

Over the years it has become evident that the early Cenozoic complex of primates and primate-like insectivores is far more complex than the usual classifications have recognized. It is also increasingly clear that the placing of many or, perhaps, any of them in the essentially Recent categories Tarsiiformes and Lemuriformes is arbitrary and is not a clear expression of their real affinities. A more recent tendency has been to pick out from the mass smaller groups of genera and species which are related among themselves, whatever may be their relationships to their contemporaries or to Recent prosimians, with which most of them seem to have no special relationships.

*Phenacolemur*, a member of this early complex known since 1915 when it was named by Matthew, is a highly distinctive, primate-like animal. It was at first confused with the distinctly different Plesiadapidae and Apatemyidae and recently has been considered simply as a primate, or perhaps insectivore, *incertae sedis*. Knowledge of the genus has increased, and there are now numerous specimens in collections from the late Palæocene and early Eocene Mountain region. Among recent discoveries is a specimen with associated upper and lower jaws and a skull. George Gaylord Simpson now gives a much fuller account of the genus than any in the scattered literature and considers its affinities on a far better basis (*Bull. Amer. Mus. Nat. Hist.*, 105; 1955). A fairly well-defined group, designated as the Phenacolermuridae, emerges as a further contribution to the clarification of the heterogeneous mass of early Cenozoic primate-like mammals.

# STRUCTURE OF POLY-L-PROLINE

By PAULINE M. COWAN and STEWART McGAVIN
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THE configuration of the peptide linkage which involves proline nitrogen is at present unknown. A knowledge of its configuration has an important bearing on the determination of the structure of proteins containing proline, especially that of collagen. Collagen not only contains a high proportion of proline and hydroxyproline, but also recent evidence[1] (and unpublished work by Kroner, Tabroff and McGarr) suggests that the sequence (pro, hypro) occurs as a significant fraction of the total.

Poly-L-proline has recently been synthesized by Berger, Kurtz and Katchalski[2]. They have very kindly supplied us with a sample having an average degree of polymerization of $n = 20$ which had been obtained by polymerization in dioxane. We have examined this material by X-ray diffraction.

The untreated material gave an X-ray powder pattern, all reflexions of which could be indexed on a hexagonal lattice with $a = 6 \cdot 62$ A. and $c = 9 \cdot 36$ A. No reflexions were observed at positions corresponding to indices 0001, 0002, 0004, 0005; but there were no other systematic absences. This indicates a three-fold screw axis parallel to $c$.

These deductions were confirmed by photographs of oriented films obtained from solution in *m*-cresol. The X-ray diffraction patterns first obtained from these films indicated a more complex lattice in which solvent was clearly incorporated. In the course of time, solvent was lost and a fibre diagram was obtained in which the reflexions had spacings the same as those of the original sample (Fig. 1). In the oriented films the $c$-axis was parallel to the direction of shear. Poorly oriented fibres were also obtained in which the $c$-axis was perpendicular to the fibre axis. Photographs of the original powder dispersed from alcohol were taken by Mr. R. E. Burge of this laboratory by means of electron diffraction, and show reflexions on a hexagonal net giving $a = 6 \cdot 57$ A.

The density of the original material was found by flotation in benzene/carbon tetrachloride mixtures to be $1 \cdot 32$ gm.cm.$^{-3}$. This is in reasonable agreement with the value, $1 \cdot 36$ gm.cm.$^{-3}$, calculated for three proline residues in the unit cell. The structure must therefore consist of polypeptide chains situated at trigonal positions, each having three equivalent residues related by an exact threefold screw axis, the 'residue repeat' along the $c$-axis being $3 \cdot 12$ A. These conclusions, and the lack of symmetry in the amide group, limit the space group either to $P3_1$ or $P3_2$.

In crystal structures of simple peptides, the amide group normally has a planar *trans* configuration[3]. It seemed reasonable to suppose that this configuration would also occur in poly-L-proline; but, in view of the unique character of the residue, models were also constructed with planar *cis* groups and

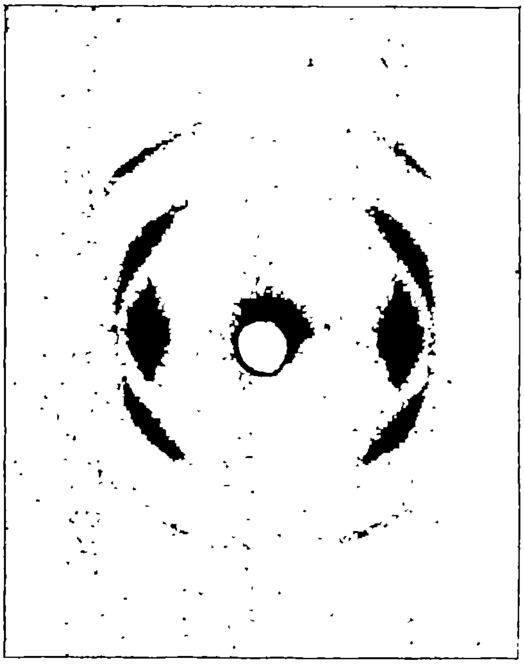

Fig. 1. X-ray diffraction photograph of poly-L-proline sheet oriented from *m*-cresol, slightly tilted, X-ray beam parallel to sheet

with pyramidal nitrogen. The proline ring[4] is puckered, with the γ-carbon atom of the 'side chain' about 0·5 A. from the plane of the other atoms in the ring. Such a ring can readily be attached to an amide group without great distortion of valency angles. In preliminary model building, the ring may be assumed to be planar.

In *cis* amide groups the distance between α-carbon atoms is expected[5] to be about 2·83 A. Considerable distortion of bond angles is necessary for the construction of a chain with repeat of 3·12 A., if composed only of *cis* residues, and such a structure is considered improbable. A model of the required dimensions can be built using pyramidal nitrogen. It seems likely, however, that the proline ring would tend to stabilize a planar form of the amide group. The reported value[3] of the C=O stretching frequency of 1,640 cm.$^{-1}$ tends to confirm this view (the low value being associated with considerable resonance in the amide group). Attention was turned chiefly to the construction of models consisting of the planar *trans* form.

Using, in the first instance, a completely planar residue, with dimensions close to the normal values[5], it was shown that a three-fold helix with repeat 3·12 A. could be constructed if some distortion is allowed at the α-carbon atom. The actual angles depend on the tilt of the plane about the line joining α-carbon atoms. Two models were considered: (1) with $C_2$—α$C_1$—$N_1$ and $C_2$—α$C_1$—β$C_1$ respectively 116° and 103° (both as near tetrahedral as possible); (2) with $C_2$—α$C_1$—$N_1$ and $C_2$—α$C_1$—β$C_1$ 109° and 97° respectively. Both forms are strained. In addition, (1) has two short contacts, $O_2$ to $N_1$, 2·90 A. and $O_2$ to β$C_1$, 2·86 A. In (2) the strain can be relieved by removing β$C_1$ from the plane of the ring by 0·4 A., when $C_2$—β$C_1$ becomes 111°. This arrangement is illustrated in Fig. 2, and co-ordinates for the atoms of a single residue are given in Table 1. In this model, all contacts between non-bonded atoms are normal, with the exception of $O_2$ to $N_1$, 2·72 A. No hydrogen bonding is possible, but substitution on the nitrogen might be expected to increase the polarity of the amide group, since the increased polarizability of the substituted nitrogen facilitates further transfer of negative charge to the oxygen. Attraction between $O_2^{\delta-}$ and $N_1^{\delta+}$ might be expected to favour a *cis* arrangement of the $C_2$—$O_2$ and α$C_1$—$N_1$ bonds, but this is prevented by steric hindrance between $O_2^{\delta-}$ and $O_1^{\delta-}$. The position adopted in the model corresponds to a rotation of nearly 30° from this orientation (that is, close to the alternative configuration suggested by Pauling and Corey, but considered by them to be less favourable, ref. 5, p. 731). It is very similar to that of the carbonyl C—O with respect to the C—$\overset{+}{N}$ ($H_2$) bond in β-glycyl glycine[6] and unlike that preferred by the carboxyl C—O, which is very nearly coplanar with the adjacent C—N in this and almost all other peptides and amino-acids.

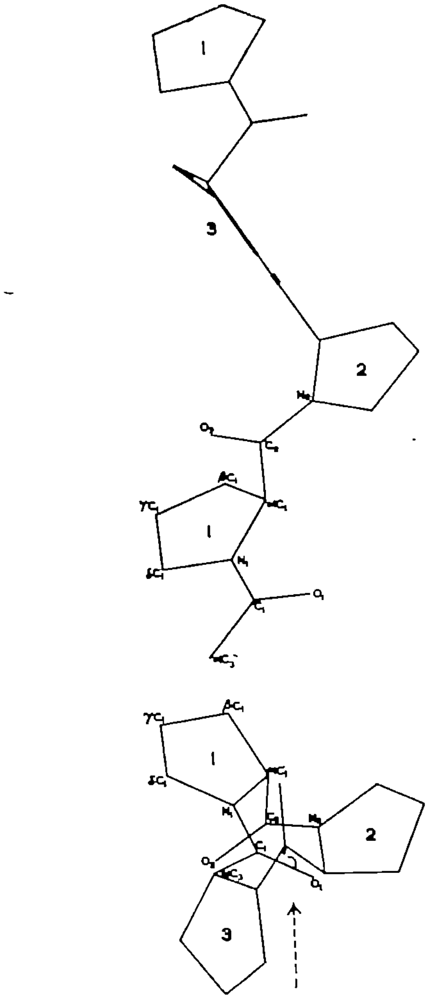

Fig. 2 Single chain of proposed model for poly-L-proline, seen in projection, below, along the threefold screw-axis, and, above, perpendicular to this axis and along the direction indicated by the arrow

Table 1. POLAR CO-ORDINATES FOR A SINGLE RESIDUE OF THE PROPOSED MODEL FOR POLY-L-PROLINE

| Atom | $r$ | $\varphi$ | $z$ |
|---|---|---|---|
| α$C_2$ | 1·30 A. | 0° 00′ | 0·00 A. |
| $C_2$ | 0·32 | − 12° 30′ | 1·14 |
| $O_1$ | 1·14 | − 109° 30′ | 1·28 |
| $N_1$ | 1·01 | 76° 00′ | 1·95 |
| α$C_1$ | 1·30 | 120° 00′ | 3·12 |
| β$C_1$ | 2·68 | 103° 30′ | 3·44 |
| γ$C_1$ | 3·17 | 77° 00′ | 2·86 |
| δ$C_1$ | 2·44 | 63° 00′ | 1·75 |

It is of interest to note that the helix described is left-handed if the absolute configuration of the α-carbon atom is assumed[7]. A right-handed helix of the required dimensions cannot be built with L-residues. The space group is therefore $P3_2$.

The positions of the three-fold axes of the chains are fixed by symmetry. The actual positions of the atoms with respect to the unit cell axes are not fixed, and these will be determined largely by van der Waals interactions between atoms in adjacent chains. For the above model two packing positions appear to be possible, one of which gives better agreement between observed and calculated intensities than the other. This arrangement, however, includes regions of rather low density. A somewhat more even distribution may be achieved by changes in the exact configuration. In the absence of hydrogen bonding, some rotation may be allowed about the C—N bond, as in N,N′-diglycyl cystine[8]. Both γ- and β-carbon atoms may be in a plane other than that of the amide nitrogen. Refinements along these lines are proceeding, together with an attempt to obtain better data with which to test the model. Details will be published elsewhere.

A perpendicular dichroism for the infra-red C=O stretching frequency has been observed in oriented films by Mr. G. R. Wilkinson of this laboratory, to whom we are indebted, and this is in agreement with our model.

From steric considerations the helical configuration is likely to be rather closely maintained in solution, which may account for the high specific lævo-rotation[2]. Again, in collagen, the polypeptide chains may have a similar, although less tightly coiled, configuration. This will be discussed elsewhere.

We thank Prof. E. Katchalski and his co-workers of the Weizmann Institute, Rehovoth, Israel, for making several samples of the polymer available to us and for their comments on our work. We are also grateful to Prof. J. T. Randall for his continued advice and encouragement throughout the course of this work. We should like to acknowledge the helpful discussions we have had with our colleagues of this laboratory, and with Mrs. D. M. Hodgkin of the Chemical Crystallography Laboratory, Oxford. We are both indebted to the Nuffield Foundation for the award of research fellowships, during the tenure of which this work has been carried out. [May 17

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# CHANGES IN ANIMAL TISSUE AFTER HYDROCORTISONE ADMINISTRATION

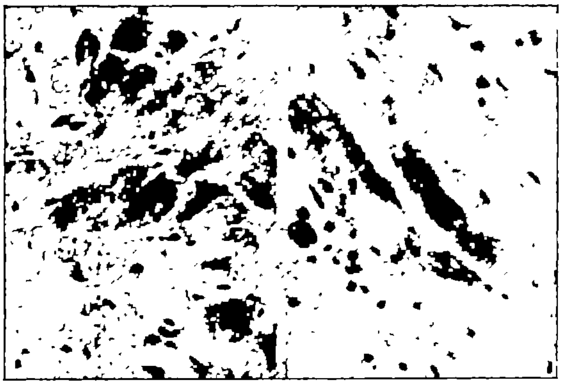
## Production of Dystrophic Calcification of Cardiac Muscle in Mice by Hydrocortisone

In the course of studies on the growth of a transplantable mammary carcinoma in mice as influenced by the administration of adrenal and pituitary hormones, we made the unexpected observation that dystrophic calcification is produced in the myocardium of animals treated with hydrocortisone. So far as we are aware, this type of lesion has not previously been noted as a result of hydrocortisone therapy.

Fifty-four virgin female mice of the $C_3H$ strain, 2–3 months old, were inoculated by trochar with fragments of a transplantable mammary adenocarcinoma in the subcutaneous tissue of the back. Seven days later the animals were apportioned into two groups. One group (twenty-five mice) served as a control, and the remaining animals were injected with hydrocortisone acetate (Merck) according to the following regimen of daily doses: 0·2 mgm. for fourteen days, followed by 1·0 mgm. for twenty-one days, with a final dose of 0·5 mgm. until the end of the experiment. Both groups received a daily dose of 1·0 mgm. of terramycin in addition to the hormone; all injections were administered subcutaneously. The average survival-times of the experimental and control groups were 40 (28–78) and 52 (24–77) days respectively. At the end of the experiment, the average weight of the tumours in the group injected with hydrocortisone was only 0·5 gm., while that of the controls was 13·3 gm. at death. These data confirm the previous observations[1] that hydrocortisone inhibits the growth of transplantable tumours, in addition to shortening the survival-time of the tumour-bearing animals.

Calcific deposits were grossly visible in the heart tissue of those mice which survived treatment with the adrenal hormone for thirty days. The extent of deposition was roughly proportional to the length of survival and hence to the duration of the injection period. Microscopically the hearts showed extensive calcification and degeneration of the muscle fibres (Fig. 1). The nuclei manifested occasional variability with respect to size and shape, some being small and pyknotic. There were granular, basophilic deposits of variable size spread throughout the myocardium of the right and left ventricle and the interventricular septum. The smallest deposits were located within muscle fibres, and were found to stain typically with the alizarin red stain for calcium. In contrast, no such lesions were seen in the myocardium of any animal in the control group.

Additional studies in tumour-bearing $C_3H$ mice have shown that similar myocardial degeneration associated with the deposition of calcium can be produced by high doses of adrenocorticotrophic hormone. Concomitant injections of growth hormone, with either hydrocortisone or adrenocorticotrophic hormone, seemed to potentiate these changes, whereas prolactin prevented their appearance. Non-tumour-bearing female $C_3H$ mice treated for ten days with hydrocortisone and autopsied forty-five days later also manifested similar degenerative changes. In



(*A*) (*B*)

Fig. 1. (*A*), cross-section of cardiac muscle of a tumour-bearing mouse treated with hydrocortisone acetate for a period of 35 days. The various stages of calcification of the fibres should be noted: the earliest stages are represented by granular basophilic material in the fibres and the later stages by more extensive areas of calcium deposition. (Hæmatoxylin and eosin, × 280.) (*B*), longitudinal section of cardiac muscle of a tumour-bearing mouse treated with hydrocortisone acetate for a period of 35 days. Calcification of the muscle fibres and the slight mononuclear cell response should be noted. (Hæmatoxylin and eosin, × 280) another study[2], where analogous observations were made in normal animals treated with hydrocortisone, biochemical investigation of the heart tissue confirmed the histological observation that deposition of calcium is associated with these lesions.

These incidental findings obtained with a potent hormonal agent emphasize that, when one has recourse to a hormone for one specific therapeutic effect, it is essential to bear in mind the tremendously far-reaching effects that may be exercised by that hormone on all tissues of the body.

This investigation was supported in part by grants from the Cancer Board of the University of California, and the Albert and Mary Lasker Foundation.

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## Deposition induced by Hydrocortisone of Calcium in the Heart Tissue of Female $C_3H$ Mice

It is reported in the previous communication that chronic administration of hydrocortisone acetate to tumour-bearing $C_3H$ mice in high dosages produces degeneration of the cardiac muscle fibres. Histological examination of the heart tissue revealed deposition of a mineral material which stains positively with an alizarin dye, suggesting the presence of calcium. These observations have now been confirmed in acute experiments with normal female mice of the $C_3H$, Heston *A* and *B*-albino-*C* strains. Progressively higher values for the calcium content of the heart tissue, as determined by the spectrophotometric method, were noted in hydrocortisone-treated animals as the hormonal dosages were increased, paralleling the degree of mineral deposition observed grossly. These findings invite interesting speculation with regard to the similarity between what is noted here and the pathological changes seen in certain clinical conditions[1,2], although extreme caution must be employed in translating data from one species to another.

Virgin female mice (fifty days of age) of the $C_3H$ strain were given daily subcutaneous injections of either saline or a saline suspension of hydrocortisone acetate (Merck), in a daily dose of 0·25–2·5 mgm. As a prophylactic measure, all animals were also injected intraperitoneally on the first two days with 1 mgm. of terramycin in 1 ml. of a 5 per cent glucose solution; despite this precaution, several of the treated mice succumbed to infection. Only those surviving the entire period of injection have been included in the final analysis.

On the day following the tenth injection, the animals were anæsthetized with nembutal; the heart, adrenals and thymus were removed and weighed. For the calcium determinations, the heart tissue from four or five animals was pooled in a porcelain crucible and ashed in a muffle furnace at 900° F. The ash was taken up in concentrated hydrochloric acid and the calcium was precipitated as the oxalate[3] at approximately $pH$ 4. Following centrifugation, the precipitate was thoroughly washed with 2 per cent ammonium hydroxide, dissolved in 1 *N* hydrochloric acid and made up to a 5 ml. volume with distilled water. The calcium content was then estimated in a flame spectrophotometer at 554 mμ with appropriate standard solutions[4].

Results are summarized in Table 1. As was to be expected, hydrocortisone caused thymic involution and adrenal atrophy; in addition, the hormone produced hypertrophy of the heart tissue. The spectrophotometric analysis of the myocardium afforded both identification of the mineral deposition as a calcium salt, and a means for quantitative estimation of the calcium content, which was shown to be a function of the hormonal dosage. While only small increases were obtained with 0·25 mgm. of the hormone, a ten-fold increase was evident at a dose-level of 1·0 mgm. The microgram quantities listed in the table for calcium should not be thought of in absolute terms, since some variation was found from week to week between appropriate groups given a standard amount of hydrocortisone for the 10-day period. Nevertheless, the comparative increases of calcium observable in the groups receiving progressively higher hormonal dosages were remarkably constant.

Table 1. THE EFFECT OF HYDROCORTISONE ACETATE ON ORGAN WEIGHTS AND CALCIUM DEPOSITION IN $C_3H$ MICE

| Daily dosage (mgm.) | No of mice | Body weight at autopsy (gm.) | Adrenal weight (mgm.) | Thymus weight (mgm.) | Heart | |
|---|---|---|---|---|---|---|
| | | | | | Weight (mgm.) | Calcium content (μgm / 100 mgm.) |
| 0 | 10 | 19·5 | 4·0 ± 0·1* | 41 ± 2·4 | 92 ± 3·6 | 2·2 |
| 0·25 | 7 | 17·0 | 3·0 ± 0·03 | nil | 124 ± 9·1 | 6·4 |
| 0·50 | 10 | 18·5 | 2·9 ± 0·06 | nil | 124 ± 3·9 | 17·2 |
| 1·0 | 5 | 18·0 | 3·1 ± 0·1 | nil | | 25·3 |
| 2·5 | 5 | 17·0 | 2·8 ± 0·4 | nil | | 27·9 |

* Mean ± S.E.

No conclusion can be drawn from the present results with regard to the amount of circulating steroid necessary to induce the observed pathological changes. When the hormone is administered subcutaneously as a saline suspension, considerable quantities of unabsorbed material accumulate beneath the skin. Moreover, doubling the dosage offers no assurance that the total absorption is increased proportionately.

Irrespective of these recognized variables in absorption, these results indicate clearly that the hydrocortisone administered is responsible for the relatively constant occurrence of calcific depositions in the right ventricle of the heart and for their incidental appearance in the liver and other viscera. The mechanism of its action and the influence of other endocrine factors remain to be investigated.

We wish to thank the Albert and Mary Lasker Foundation for research grants which have aided greatly in this investigation.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Palæomagnetism of Sediments from the Colorado Plateau

On the Colorado Plateau of Arizona and Utah there are exposed, as a result of erosion, sedimentary strata substantially undisturbed since deposition, representing almost every period of geological time. In the Grand Canyon of the Colorado River, for example, there are sediments ranging in age from the late Pre-Cambrian or Algonkian to the Permian, and in Zion Canyon and the Painted Desert Mesozoic sediments are found. Thus this part of the southwestern United States is ideal for palæomagnetic work, and I had long wished to make a collection of rocks there for this purpose.

A further advantage of this group of rocks is that throughout the geological column fine-grained red sandstones frequently occur. Experience in palæomagnetic measurements in Great Britain[1] has demonstrated that these sediments are particularly suitable for this work. In any one formation the directions of magnetization of different specimens are reasonably closely grouped together; presumably because quiet conditions during deposition enabled the magnetized iron oxide mineral grains to set with their magnetizations parallel to the geomagnetic field at that time. The magnetizations of such red sandstones can often be shown by certain field-evidence to have remained unchanged in direction, relative to the rock, since deposition; presumably because the high coercive force of the hæmatite, usually the chief ferromagnetic mineral, gives the rock a high magnetic stability.

Last summer, thanks to grants from the Geological Society of America and the Museum of Northern Arizona, I was able to carry out the necessary field-work, the remanent magnetization of the samples obtained being measured early this year with the Cambridge astatic magnetometer. Measurements of the palæomagnetic directions in Tertiary times[2] (1–60 million years ago) had shown that the mean geomagnetic field in this period is very closely that of a geocentric axial dipole along the earth's present axis of rotation. Similar measurements in Great Britain[3] on pre-Tertiary sediments and igneous rocks had shown that the mean palæomagnetic direction changes slowly through geological time, but not appreciably in any one period (about fifty million years on the average). These results have been interpreted[3] in terms of a slow migration of the axis of rotation through the earth carrying with it the mean axis of the geomagnetic field. This is quite a different phenomenon from that of reversals of the magnetization of rocks, which are geologically rapid phenomena and are inferred to be due to reversals in polarity of the geomagnetic field, which regains its axial character when the reversal is completed. The measurements of the Arizona strata provide the opportunity for a test of the polar-wandering hypothesis, and the results are here summarized.

Table 1 compares the positions of the north pole from United States formations of five different periods with the positions calculated from the European formations of the same or similar geological age. These positions are normally computed from the mean direction of magnetization of a number of samples well separated stratigraphically. But in one formation (the Springdale sandstone) the palæomagnetic direction taken is not that of the mean but one which allows approximately for the appreciable magnetic instability of these sandstones, which biases their mean direction towards that of the present geomagnetic field. In the other cases a curve may be described around the pole position which, to a probability of 95 per cent, will contain the true position of the pole for that period. The two semi-axes of this curve are listed in brackets below the respective pole positions in Table 1.

The motion of the pole as deduced from the measurements of British strata consists of a gradual movement from near Hawaii in late Pre-Cambrian times towards the Pacific coast of Asia in Palæozoic times, reaching a high latitude in Triassic times and substantially the present pole position in Cretaceous times. The measurements on the Arizona strata give a similar picture. As is seen from the Devonian pole position given in Table 1, it seems possible that the motion of the pole was not smooth: in fact, it may have been rather like a random walk. It is thus impossible to tell at this stage whether the discrepancies between the pole positions inferred from 'contemporaneous' strata in Great Britain and Arizona are due to systematic errors or to the strata not being truly contemporaneous. The most serious discrepancy is that of the Permian strata; but the British measurements are at present restricted to a

Table 1. Comparison of Pole Positions deduced from Palæomagnetic Measurements in Europe and Arizona

| Era | Period and age | Europe | | Colorado Plateau | |
|---|---|---|---|---|---|
| | | Formation | Position of N. Pole | Formation | Position of N. Pole |
| Tertiary | Miocene (20 million yr.) | Icelandic basalts (J. Hospers's data) | 81° N. 171° E.<br>(18°, 16°) | | |
| Mesozoic | Cretaceous (80 million yr.) | | | Dakota sandstone | 76° N. 127° E.<br>(11°, 9°) |
| | Triassic (150 million yr.) | Keuper marl (Clegg, Almond and Stubbs's data, ref. 4) | 47° N. 122° E.<br>(18°, 7°) | Springdale sandstone (Zion Canyon) | 60° N. 110° E. |
| Palæozoic | Permian (200 million yr.) | Exeter traps (K. M. Creer's data) | 43° N. 162° E. | Supai shales (Grand Canyon) | 23° N. 119° E.<br>(8°, 6°) |
| | Carboniferous (250 million yr.) | Sandstones and siltstones in Derbyshire (J. C. Belshe's data) | 36° N. 137° E. | Naco sandstones | 49° N. 120° E.<br>(4°, 4°) |
| | Devonian (300 million yr.) | Old Red Sandstone (K. M. Creer's data) | 34° N. 156° E.<br>(10°, 5°) | | |
| Pre-Cambrian | Late Pre-Cambrian (about 600 million yr.) | Torridonian (E. Irving's data) | 5° S. 131° W.<br>(8°, 5°) | Hakatai shale (Grand Canyon) | 30° N. 148° W.<br>(10°, 9°) |
| | | Longmyndian (K. M. Creer's data) | 2° N. 118° W.<br>(13°, 7°) | | |

few lavas which may not span a sufficient time to eliminate the effects of the geomagnetic secular variation, which temporarily causes considerable divergences from an axial field.

It may be concluded that strong evidence now exists that considerable polar wandering has occurred throughout geological time. These results appear to dispose of the possibility that since pre-Cambrian times the continents of America have drifted any appreciable distance from the continents of Europe and Africa. Whether any such continental drift has occurred must await refinement of the accuracy of the measurements. I am indebted to Mr. G. Turnbull and Mr. J. C. Belshe for much help in the measurements and computations.

Details of this work will be published in the *Bulletin of the Geological Society of America*.

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## Palæomagnetic Measurements of the Keweenawan

RECENTLY, it has been possible to collect specimens from the Keweenawan system and measure their directions of magnetization. This system is a thick sequence of late Pre-Cambrian volcanics and sediments which outcrop along the margins of the Lake Superior syncline. It is divided into three series, Lower, Middle and Upper Keweenawan. At the type locality on the Keweenawan Peninsula, where most of the specimens were collected, only the Middle and Upper series are represented. Here the Middle Keweenawan consists of 11,000 ft. of basalt and andesite flows known as the Portage Lake Lava Series. There is a total of about three hundred successive flows with occasional interstratified layers of rhyolitic conglomerates and thin beds of sandstone. Succeeding the Portage Lake Lava Series conformably is the Upper Keweenawan, which consists of three divisions. The lowermost is the Copper Harbor Conglomerate, which consists principally of very coarse conglomerates and subordinate amounts of coarse reddish sandstone, but there are also some 500 ft. of interbedded lava flows. The total thickness of the Copper Harbor Formation is 4,500 ft. Lying conformably above the Copper Harbor is the Nonesuch Shale, which in this region consists of 700 ft. of thin bedded sandstones and siltstones. It grades upward into the third of the three divisions of the Upper Keweenawan, the Freda Sandstone. This formation consists of reddish, fine-grained sandstones and siltstones. It is well bedded and consolidated, and usually only shows cross-bedding on a very small scale. One can find ripple marks, mud cracks and raindrop imprints, which clearly indicate a terrestrial deposition. On the Keweenawan Peninsula the Freda Sandstone is approximately 2,500 ft. thick, but in other localities it may reach a thickness of as much as 12,000 ft.

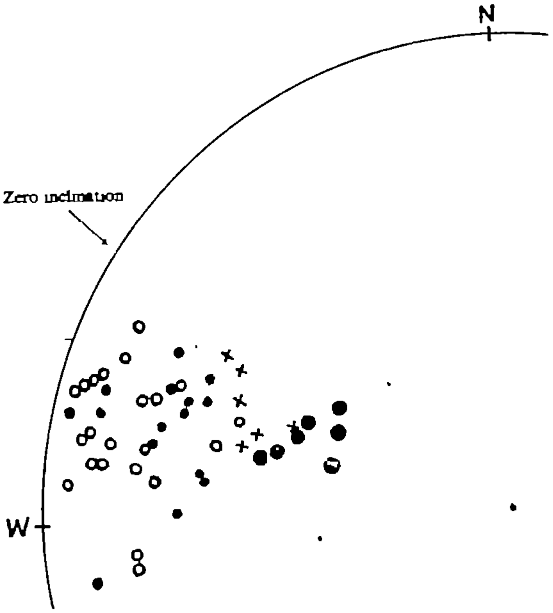

Fig 1. ●, North pole downwards for Freda and Nonesuch; ○, north pole upwards for Freda and Nonesuch; ×, north pole downwards for sandstones in Copper Harbor; ○, north pole downwards for lavas of Copper Harbor and Portage Lake

The structure of the Keweenawan System in this general region is very simple. It is a monocline the eastern boundary of which is marked by the Keweenawan Fault and which disappears under Lake Superior to the west. The strike is north-north-east and the dip ranges from 60° near the fault to 20° close to the shore of the lake. Although the samples were mostly collected from the Keweenawan Peninsula, some specimens were taken near Freda some twenty-five miles to the south-west, where the strata are practically flat-lying. Furthermore, a limited number of samples were collected along the Montreal River, which forms the boundary between Wisconsin and Michigan about a hundred miles to the south-west. Here the strata are steeply tilted with a dip of 70°–80°.

The results of preliminary measurements, corrected for geological dip, are shown in the accompanying portion of a stereogram (Fig. 1). So far, only a small number of specimens have been measured, but one can see that the directions are quite consistent with one another.

The first fact that one notices is that the directions of magnetization are quite different from that of the present earth's field. The second is that the inclinations and, to a much lesser degree, the declinations of the lavas are different from those of the sediments. The first is interpreted as a shift in the geographical pole, in much the same manner as Creer, Irving and Runcorn[1] have interpreted their results obtained from the measurements of pre-Tertiary rocks of Great Britain. For the results from the Nonesuch and Freda formations the pole has been calculated to have been in the Pacific Ocean at long. 165° E., lat. 20° N. Creer[1] has calculated a pole for Lower Cambrian time based on his measurements of the Caerfai Series in Wales, and this pole is located at long. 170° E., lat. 15° N. Thus one can see that there is close agreement between the two, and this agreement suggests the upper part of the Keweenawan is very close to Lower Cambrian in age. This suggestion has often been made by geologists familiar with this region[2].

One would be tempted to attribute the smaller magnetic inclinations of the sediments to the action of sedimentation and compaction. This certainly seems to be the case in the Copper Harbor Conglomerate sandstones, which show an inclination approximately 10° smaller than the lavas above and below them. However, it is difficult to see how these processes could create two almost equal groups of positive and negative dips, which one finds for the formations above the Copper Harbor. Since the mean inclination for the upper sedimentaries is almost 0°, one would expect processes of sediments to have had little or no effect on the value of this mean inclination. Thus it seems that the Copper Harbor sandstones have an inclination smaller than the lavas because sedimentary rocks are unable to reproduce moderate inclinations, but that the mean inclination of the overlying Nonesuch and Freda formations is a true representation of the field at that time. This interpretation means that between Copper Harbor time and Nonesuch time the inclination of the magnetic field changed about 40°, corresponding to a shift of the poles 25° westward. Therefore if the polar wandering was slow and continuous, quite a long period of non-deposition must be represented by the conformable contact of the Nonesuch and Copper Harbor formations. On the other hand, there may have been a sudden and quick change of the pole and continuous deposition.

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U.S. Geological Survey, Monograph LXII.

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# Circular Polarization of Gamma-Rays following Polarized Neutron Capture

An experiment has been carried out in order to verify that the capture of polarized thermal neutrons may result in the emission of circularly polarized γ-rays, as first proposed by O. Halpern[1]. It can be hown that neither linear polarization nor anisotropic distribution of the γ-radiation can result from the reaction[2].

For total neutron polarization, the degree of left circular polarization of the γ-rays emitted in the direction of the neutron spin is[3]:

$$P_r = 2\,(J_c - J_i)\,\frac{L\,(L+1) + J_c(J_c+1) - J_f(J_f+1)}{L\,(L+1)\,(2\,J_i+1)} \quad (1)$$

where $J_i$, $J_c$ and $J_f$ are initial, compound and final pins of the neutron and $L$ is the multipole order of he γ-ray. If $J_i$ and $P_r$ are exactly known, it will, n most cases, be possible to determine $J_c$, $J_f$ and $L$ unambiguously.

The properties of the γ-ray polarization analyser are given by the left circular polarization, $P_\gamma$, of the outgoing beam when the incident beam is unpolarized. The γ-ray intensity measured during the experiment is:

$$I_\gamma = c(1 + P_n P_r P_\gamma) \quad (2)$$

where $P_n$ is the polarization of the neutrons being aptured in the $(n,\gamma)$-target and $c$ is a constant.

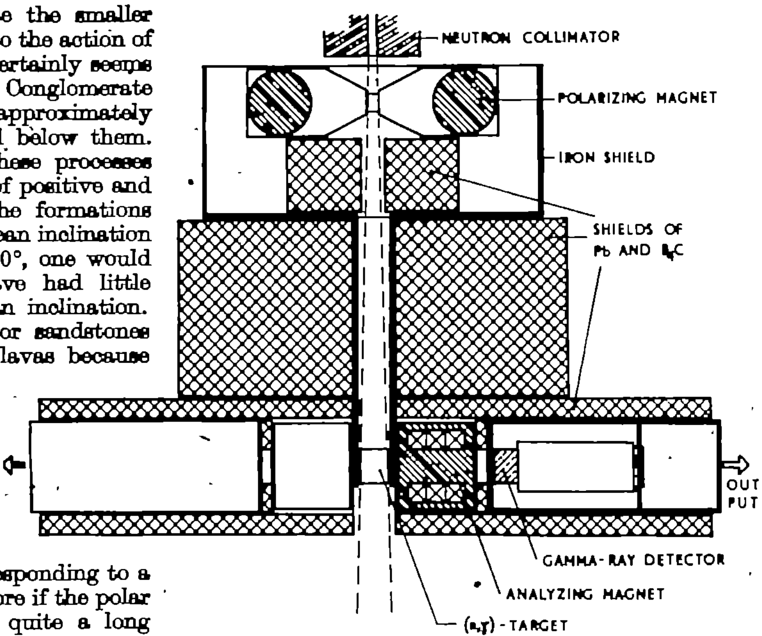

Fig. 1

The experimental arrangement is shown in Fig. 1. Thermal neutrons from JEEP are collimated and partially polarized by transmission through 18 mm. of strongly magnetized iron. The polarized beam falls upon the $(n,\gamma)$-target. γ-Rays are detected by two sodium iodide (thallium) crystals after transmission through pieces of iron 8 cm. long magnetized in the direction of transmission. The total cross-section for magnetized iron is a function slowly varying with γ-energy and dependent upon magnetization direction[4]. At magnetic saturation the cross-section for 8-MeV. circularly polarized γ-rays is:

$$\sigma = \sigma_0\,(1 \pm 0{\cdot}0145) \quad (3)$$

where $\sigma_0$ is the ordinary cross-section and the sign depends upon whether magnetization is parallel or antiparallel to the propagation vector.

During the measurements, $P_n$ was kept constant, and $P_\gamma$ was changed every third minute by reversing the current in the analyser magnets.

Four different γ-rays were studied, all of high intensity compared to the rest of the spectrum and all representing transitions to the ground-state or to a very low-lying state. Therefore, no great difficulties were encountered in selecting them by discrimination. Still, disturbing effects like background and scattering in the target were large. Great care had to be taken in order to make the sensitivity of

Table 1. Data for the Four Gamma-Rays Studied

| Target nucleus | $E_\gamma$ (MeV.) | Known spin values | | | | Observed $\lvert P_n \rvert . P_r$ | Derived |
|---|---|---|---|---|---|---|---|
| | | $J_i$ | $J_c$ | $J_f$ | $L$ | | |
| $^{63}$Cu | 7·91 | 3/2 | | 1 | 1 | 0·061 ± 0·027 | Gamma-ray mainly from $J_c = 2$ |
| $^{56}$Fe | 7·64 | 0 | 1/2 | | 1 | 0·063 ± 0·050 | $J_f = 1/2$ |
| $^{64}$Zn | 7·88 | 0 | 1/2 | | | −0·050 ± 0·042 | $J_f = 5/2$, $L = 2$ or<br>$J_f = 3/2$, $L = 1$ |
| $^{58}$Ni | 9·00 | 0 | 1/2 | 3/2 | 1 | −0·026 ± 0·030 | |

the photomultiplier independent of the polarizing and the analysing magnetic fields. As the polarizing effect is very small, several months of continuous measurements were required to obtain the results quoted in Table 1.

The 'known spin values' are found from nuclear shell theory and from measurements by Kinsey and Bartholomew[5]. No exact measurement of $P_n$ has been made, but it is estimated to be about 8 per cent. The errors given are mainly due to statistical variations. It is clear from these measurements that only the sign of $|P_n| . P_\gamma$ can be quoted with certainty. However, for the simple cases considered, this sign was sufficient for the determination of a few properties by use of equation (1). These are given in the last column of Table 1. The capture in nickel-58 serves as a test for the method.

Work is being carried on in order to improve the experimental arrangement.

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## Hydromagnetic Waves in Ionized Gas

RECENT theoretical studies of hydromagnetic (or magneto-hydrodynamic) disturbances in ionized gas suggest that they may play a major part in the physics of some stellar atmospheres and interstellar *HII* regions. Such disturbances, including shock as well as weak hydromagnetic waves, provide a likely explanation of flares, coronal heating and other solar phenomena; their application to the theory of cosmic ray formation is well known.

Previous studies of hydromagnetic disturbances have, for simplicity, assumed a medium with perfect[1,2] or isotropic[3] conductivity. This assumption hides the nature of the electromagnetic field associated with the mechanical disturbance and so fails to reveal some of the most important properties of the phenomenon. Aström[4] and Ginzburg[5] have made further extensions but at the cost of introducing alternative restrictions.

There is a fundamental equation describing the electromagnetic field in a moving isotropically conducting medium (see, for example, ref. 6, equation 2.6 *et seq.*). It includes, among other special cases, the wireless 'telegraph' equation and leads directly and simply to hydromagnetic waves. A corresponding equation for weak disturbances in anisotropically conducting media has now been derived[7]. When only electron conductivity is important and displacement current is neglected it has the form

$$\nabla^2 \mathbf{H} = 4\pi\sigma_3 \left\{\frac{\partial \mathbf{H}}{\partial t} - \text{curl}\,(\mathbf{v}\times\mathbf{H})\right\} + \frac{\sigma_2}{\sigma_1}\frac{\partial}{\partial z}\,\text{curl}\,\mathbf{H}$$

The steady magnetic field $\mathbf{H}_0$ is parallel to the $z$ axis, and the conductivity components $\sigma_1$ and $\sigma_2$ (Hall conductivity) are perpendicular to $\mathbf{H}_0$ and to one another; $\sigma_3 \equiv \sigma_1 + \sigma_2^2/\sigma_1$ and for the gas concerned $\sigma_3 = \sigma_0$ the conductivity along $\mathbf{H}_0$. When heavy ions contribute to the conductivity (as in ionospheric region *E*) a term in $(1 - \sigma_3/\sigma_0)$ is added. This equation has been used to develop a theory of weak hydromagnetic waves somewhat analogous to the well-known magneto-ionic theory of radio waves.

Three distinct hydromagnetic waves may, in general, be propagated[2]. Two of these, which we call the ordinary (*O*) and extraordinary (*E*) hydromagnetic waves, are identical with the two corresponding radio waves found in the magneto-ionic theory. The latter are limiting cases, when heavy-ion motion becomes unimportant. The third wave resembles a sound wave and is called the *S* wave. The properties of the three waves depend on the relative intensities of the 'magnetic pressure' $H_0^2/8\pi$ and the gas pressure $p$ and are briefly described for the two conditions

$$\frac{H_0^2}{8\pi} \gg p \text{ and } \frac{H_0^2}{8\pi} \ll p$$

A right-handed system of axes has $Oz$ along the steady magnetic field and the wave normal in the $xz$ plane at an angle $\theta$ to $Oz$. The angular frequencies of the wave and the heavy ions (gyrating in the magnetic field) are $\omega$ and $\Omega$ respectively.

(1) $H_0^2/8\pi \gg p$. The velocities and polarizations of the *O*- and *E*-waves are complicated functions of $\theta$ and $\omega/\Omega$. When $\omega/\Omega \ll 1$ the velocities are $V \cos \theta$ and $V$ respectively, where $V^2 = H_0^2/4\pi\rho$ and $\rho$ is the gas density. The waves are then nearly plane polarized along $Oy$ and $O\zeta$ (in the phase plane and perpendicular to $Oy$). They are only circularly polarized[5] for vanishingly small values of $\theta$. The electric polarization is such that $E_z \sim 0$ and $E_x/E_y \sim H_y/H_x$. The Poynting vectors are nearly along $Oz$ and the wave normal. The gas velocity components are $v_z = 0$ and $v_y/v_x = \cos^2\theta' H_y/H_x$, movement being in elliptical orbits.

The third or *S*-wave has velocity $U \cos \theta$, where $U$ is the velocity of sound. The magnetic and electric perturbations are nearly along $O\zeta$ and $Oy$, the Poynting flux along the wave normal and the gas velocity along $Oz$.

(2) $H_0^2/8\pi \ll p$. When $\omega/\Omega \ll 1$ both the *O*- and *E*-waves have velocities $V \cos \theta$ and are circularly polarized. The electric field is given by $E_z \sim 0$ and $E_x/E_y = \pm i \cos \theta$ and the Poynting vectors rotate on a cone touching $Oz$ and the wave normal. The gas velocity vectors lie in the phase planes, rotating with constant amplitude in the same direction and in contraphase with the magnetic vectors.

The *S*-wave has velocity $\sim U$ and magnetic and electric vectors along $O\zeta$ and $Oy$ respectively. The Poynting flux and gas velocity are along the wave normal, the wave being in effect a slightly disturbed sound wave[3]. In all the waves described above the absorption is determined by $\sigma_3$ ($\equiv \sigma_0$) rather than $\sigma_1$ or $\sigma_2$.

The results given above have been extended to strong (or shock) hydromagnetic disturbances, which will be discussed elsewhere.

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## Expansion and Deterioration of Ceramic Bodies

DURING an investigation of local occurrences of expansion of brickwork and deterioration of roofing tiles we have found that:

(1) Kiln-fresh bricks and tiles taken from representative works in Melbourne all expanded irreversibly on exposure to moisture or even to the atmosphere. Bricks expanded linearly on soaking in water from 0·04 to 0·18 per cent, and tiles on autoclaving from 0·08 to 0·57 per cent.

(2) The degree of expansion, which is characteristic of each brick or tile works, apparently depends not so much on the firing temperature (although the rate of expansion is greater in bricks fired at lower temperatures) as on the composition of the raw material. Cream bricks and light-coloured tiles, both richer in kaolin, expanded more than dark ones.

(3) Tiles in use deteriorate predominantly on protected parts, for example under overlaps, which remain moist for long periods. After years of service they contain about 0·7 per cent of water lost above 110° C., which is of the same order as that of the autoclaved tiles.

(4) The small amount of sodium (0·32–0·52 per cent) present in unaffected tiles is largely, if not completely, replaced by calcium in affected parts.

(5) One badly deteriorated tile, about thirty years old, contains a crystalline calcium zeolite.

(6) The type of tile and brick which deteriorates most in use is similar to that which expanded most in our experiments.

That ceramic bodies expand on contact with water is no new observation, for expansion of bricks[1,2], structural tiles[3], sewer pipes[3] and other ceramic bodies[4] has already been reported. Keppeler and Aurich[5] concluded from indirect evidence that the expansion on rehydration of whiteware fired above 950° C. was due to the formation of permutites (amorphous zeolites). Hill[6], when studying the rehydration of fired clay minerals, identified a crystalline zeolite in rehydrated sodium vermiculite. In the X-ray diffraction patterns of some of the other materials he found weak, extra, unidentifiable lines from which he inferred the presence of poorly crystalline zeolites. It is significant that the temperature (1,050° C.) at which Hill found the greatest expansion of kaolinite (after destruction of its lattice) is close to that (approximately 1,060° C.) at which Delimarskii[7] prepared substances from various mixtures of soda, kaolin and quartz, which disintegrated on hydration and formed permutites. These results indicate that glassy material that is found in well-fired ceramic bodies is likely to form permutites on rehydration, particularly when originating from kaolinitic clays containing soda. The glass expands on forming permutite, when water is incorporated in its structure as hydroxyl ions, and this may cause local stresses. These stresses can lead to disintegration, as we have shown by the autoclaving of soda glass which in hydrating (up to 13·8 per cent water) expanded markedly, but disintegrated so badly that the expansion could not be measured.

The presence of permutites, which have a high cation-exchange capacity, would explain the replacement of sodium by calcium in the deteriorated tiles. The introduction of the slightly larger and more highly hydrated calcium ion into the permutite would cause a secondary expansion of the body such as has been found[2] with bricks, which expanded 0·20 per cent in a solution of a calcium salt compared with 0·05 per cent in water.

We conclude that the expansion on rehydration of ceramic bodies burnt above 950° C. is due to the formation of zeolites, mainly of permutites. The ceramic body may deteriorate as a result of expansion in extreme cases, or as a result of frost or salts attacking the already weakened body.

It has been shown that the irreversible expansion can at least be reduced by the addition of lime[2] or magnesite[4] to the raw clay, and it is likely that barium carbonate also would stabilize the fired body. 'Curing' bricks by stacking them in the open for some time should prevent or greatly reduce expansion after laying. These matters are being investigated.

We are grateful to Drs. J. S. Hosking and W. F. Cole and to Mr. R. D. Hill for their valuable discussions.

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## Stillwellite, a New Rare-Earth Mineral from Queensland

THE presence of stillwellite was discovered in 1954[1] during a mineralogical investigation of radioactive ore from the Mary Kathleen Lease, 34 miles east of Mt. Isa in north-western Queensland. At the Lease, stillwellite and allanite occur in quantity, along with garnet and other minerals, as a metasomatic replacement of metamorphosed calcareous sediments. Uraninite is dispersed through both minerals.

Stillwellite is the major constituent of sections of the ore, occurring as crystals up to 5 mm. in diameter. In thin section it is colourless with a birefringence of 0·018–0·020, and is uniaxial positive to biaxial positive with $2V$ up to 6°. Occasional zoning is evident in thin sections and in the variation of the refractive index of the ordinary ray from 1·775 to 1·784 ± 0·003 in sodium light. The stillwellite is thus optically comparable with cerite, from which it differs in having lower refractive indices, and a different X-ray powder pattern.

The preliminary analysis of a concentrate containing 96–98 per cent stillwellite totals 100·30, and gives as major constituents $Ln_2O_3$ 58·4, $B_2O_3$ 11·5, $SiO_2$ 20·1, CaO 3·96, $P_2O_5$ 2·58 per cent. Cerium oxide ($Ce_2O_3$) constitutes 51 per cent of the total lanthanon oxide, which contains not more than 5 per cent of heavy lanthanons.

An X-ray single-crystal study shows that stillwellite is hexagonal, rhombohedral, with space group $C3m$, $C3_22$ or $\bar{C}3m$, a unit cell of dimensions

$a = 6\cdot85$ A, $c = 6\cdot64$ A., and an axial ratio $a:c$ of 1·032. Allowing for the presence of a small amount of a phosphate mineral in the concentrate analysed, this cell contains close to 3(Ln,Ca)BSiO$_5$ for the measured density of 4·57 gm./c.c.

The mineral is named in honour of Dr. Frank Leslie Stillwell, former chief of the C.S.I.R.O. Mineragraphic Investigations, who has contributed so notably to the knowledge of Australian ore deposits and who initiated the study of ore minerals in Australia.

A detailed report will be published elsewhere.

From another source, the discovery of a "boron-bearing variety of cerite" in Mary Kathleen ore was announced in the Adelaide *News* of May 20, 1955.

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## Plasticity of Wool

The marked variations in plasticity among the fibres of a single staple of wool[1] are now known to be associated with the types of follicle from which they are derived, fibres with the lowest plasticity being produced by primary central follicles, which are the first to develop, and fibres with the highest plasticity by the secondary follicles which are the last to develop[2]. It has, however, proved more difficult to identify the chemical and physical causes of the variations in plasticity. With two wools, which were examined in great detail, fibres with the lowest plasticity were found to have the highest sulphur content, and vice versa[1,2], as would be expected if unfolding of the main chains of α-keratin during plastic flow is impeded by cystine cross-linkages; but the simplicity of the relationship appears to be marred in other cases by differences in the mode of distribution of cystine in different fibres.

A rule of more general validity has, however, emerged from studies of the relationship between the plasticity of fibres and the proportion of ordered (crystalline) material they contain. The observation that there is an inverse relationship between plasticity and crystallinity in the case of New Zealand Lincoln wool[3] has now been confirmed with a wide range of New Zealand Romney, Australian merino and South African merino wools. Not only so, but also the physical and chemical causes of variations in plasticity among the fibres of a single staple appear to be linked, as is shown by the following determinations of the plasticity and tyrosine content of fibres from single staples of two New Zealand Romney wools.

Fibres from primary lateral follicles (early curly-tips) and secondary follicles (long histerotrichs) were selected from a single staple in the usual way[2]. Each fibre was allowed to extend about 55 per cent in water at 22·2° C. under a load of 700 kgm./cm.$^2$. On being released, the fibre returned to its original length, and its plasticity ($k$) was calculated from the extension/time curve[1]. The eight early curly-tips with the lowest plasticities and the eight histerotrichs with the highest plasticities were then iodinated with iodine-131 under conditions which are known to convert almost all (96 per cent) of the tyrosine side-chains into 3 : 5-di-iodotyrosine[4]. After the fibres had been freed from loosely combined iodine by treatment with sodium thiosulphate solution and washing, radio-photographs were prepared in the usual way[4]. The tyrosine content of each fibre was then estimated by measuring the optical density of the radiophotograph at intervals along the length and correcting for the variations in cross-sectional area of the fibre. The results are given in Table 1.

Table 1

| Wool No. | Type of fibre | Average diameter ($\mu$) | Average plasticity, ($k \times 10^{-4}$) | Tyrosine content (arbitrary units) |
|---|---|---|---|---|
| 1 | Early curly-tips | 40 7 | 28 7 | 6·4 |
|  | Long histerotrichs | 28·8 | 67·6 | 10·9 |
| 2 | Early curly-tips | 39·0 | 49·7 | 6·1 |
|  | Long histerotrichs | 28 4 | 77·9 | 9·0 |

In both cases the more plastic fibres contain the greater amount of tyrosine, and since the more plastic fibres are also the more amorphous, it seems clear that the bulky side-chains of tyrosine are one cause of main-chain disorder in wool, just as in the case of silk.

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## Theory of Antibiotic Inhibition Zones in Agar Media

Since Cooper and Woodman[1] proposed on theoretical grounds that the formula

$$x^2 = 4\,DT_0\,2\cdot30\,(\log m_0 - \log m')$$

should explain the size of inhibition zones, under specified experimental conditions, evidence on the validity of this proposal has been accumulated by many workers. The variables in the formula have been further analysed, and it is now possible to give an extended explanation of their meaning, which should give a more accurate understanding of the factors influencing the size of inhibition zones.

The original formula was concerned with the diffusion of an antibiotic having a diffusion coefficient $D$, from a solution kept at a constant concentration $m_0$, into an agar culture of an organism (Fig. 1). The time at which the critical concentration $m'$ reached the edge of the zone of inhibition can be

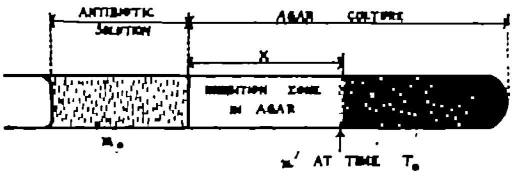

Fig. 1

alculated for all values of $x$ (zones of different sizes) and is given by

$$T = x^2/4\,(D\;2\cdot30 \log m_0/m') \qquad (1)$$

It was shown experimentally that a critical value of $T$ existed in the growth of the bacterial population, when the edge of the zone was formed; for if the organism is incubated for $h$ hr. before adding the diffusing antibiotic, the size of the zone is reduced. This critical value was called $T_0$, because if the time of preincubation of culture $h$ is $T_0$, the zone was reduced to nil. The size of zones for varying values of $h$ was given by putting $T = (T_0 - h)$ in (1), and when $h = 0$, $T = T_0$.

Cooper and Linton[2] examined the factors influencing $T_0$, and showed the importance of temperature control in the early hours of growth. They explained experimental anomalies in the use of plate cultures. Temperature control was much more certain by using the tube method of Mitchison and Spicer[3], and therefore Cooper and Gillespie[4] used this method to investigate its influence on $T_0$, in the case of streptomycin acting on staphylococcus. Over a wide range (22°–42°) the variation in $T_0$ from 2·2 hr. to 9·0 hr. was explicable by:

$$T_0 = L + n'G \qquad (2)$$

where $L$ is the lag period, and $G$ the generation time of the organism in the nutrient medium at the temperature of the experiment; $n'$, the number of generations at time $T_0$, was remarkably constant (3·5–4·4) over the whole temperature range, when a standard inoculum and a standard medium were used.

Cooper[2] pointed out that the slope of the graphs of Mitchison and Spicer[3] with different sizes of inocula were empirically related to the inoculum size ($N_0$). Though the relationship suggested with $\sqrt{N_0}$ was only an approximation without theoretical foundation, it prompted us to examine this more closely. As a result, it is now possible to give a theoretical basis to the meaning of $T_0$ and calculate its value from the growth curve of the organism. The effect of inoculum size observed by Mitchison and Spicer[3], and further investigated by Linton[5], can be even more accurately predicted.

The theory of the early part of the growth curve is well known. Let $N$ be number of organisms at time $T$, $N_0$ their number at zero time, $n$ be the number of generations, $G$ be the generation time. Then $N = N_0\, 2^n$ and $T = L + nG$.

In solid media, the number of organisms per colony is given by $p = N/N_0 = 2^n$, or $n = \log_2 p = \log_2 N/N_0 = 3\cdot32 \log_{10} N/N_0$. Therefore, $T = L + 3\cdot32\, G\,(\log N/N_0)$. When $T = T_0$, let the value of $N$ be $N'$ and the value of $n$ be $n'$. Then

$$T_0 = L + n'\,G = L + 3\cdot32\, G\,(\log N'/N_0) \qquad (3)$$

The first part of this equation is identical with equation (2), which was derived experimentally. It is now evident that $n'$ is the number of generations required to reach a critical density of organisms per ml., and that $T_0$ varies with both temperature and size of inoculum to allow this to be done.

Combining equation (3) from the growth-curve of the organism with equation (1) from the diffusion laws, we have:

$$x^2/4D\,(2\cdot30 \log m_0/m') = T_0 = L + 3\cdot32\, G\,(\log N'/N_0)$$

or

$$x^2 = 4\,D\,(2\cdot30 \log m_0/m')\,(L + 3\cdot32\, G \log N'/N_0)$$

This explains the effects of inoculum density, so long as allowance is made for the possible effect of high values of $N_0$ on lag period and generation time (not detectable in Mitchison and Spicer's results). The values $m'$ and $N'$ depend on the antibiotic and the organism, but the other symbols represent variables all of which can be separately determined and controlled. Even $D$ depends on the viscosity and temperature. It is felt, therefore, that the critical density of organisms $N'$, which represents a limiting factor for inhibition of growth, is just as important as the critical concentration of antibiotic $m'$, which must be reached before $N'$, in order to form a zone. The critical time $T_0$ is the time required by the inoculum $N_0$ to multiply at a rate of $1/G$, in order to reach the population $N'$. The edge of the zone at distance $x$ is decided by the fact that the critical concentration $m'$ must reach there before the bacterial population exceeds $N'$. The amount of bacterial cells is evidently just as important as the amount of antibiotic.

The theory, with appropriate modifications, should be applicable to zones of exhibition in vitamin assay work, as well as zones of inhibition due to antiseptics. An understanding of its principles should enable the detection of other factors influencing results to be made more easily (for example, variations in the sensitivity of the organism; the influence of nutritional and toxic factors in the medium; antagonism and synergism with other substances). In the case of streptomycin and the staphylococcus, the presence of magnesium and iron ions in the agar medium influenced the critical concentration $m'$ and hence the size of the zones (Linton[6]). With constant medium, however, $m'$ and $N'$ have been constant, within the experimental error, for the action of streptomycin on staphylococcus, for all temperatures and all densities of inoculum. With chloramphenicol, temperature affects the action of the antibiotic, giving a change in $m'$—and possibly $N'$ may be slightly affected, though the result is on the borderline of the experimental deviations.

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## Effect of Anti-histamine Substances on Cold Vasodilatation in the Finger

LEWIS[1] described an intermittent vasodilatation in the finger during its immersion in cold water, and suggested that a histamine-like substance was released in the cold tissues.

In order to study the part played by histamine in bringing about this response, the antihistamine substances diphenhydramine hydrochloride ('Benadryl') and promethazine hydrochloride ('Phenergan') were administered to normal, heat-acclimatized, Asian subjects, whose cold vasodilator responses were followed by means of copper-constantan thermocouples strapped to their index fingers. In each case the skin temperature of the finger was plotted against

Table 1

| Treatment | No. of subjects | Area of cutaneous histamine wheal (sq. mm.) | Graphic representation of cold vasodilator response (sq. cm.) | Treatment | No. of subjects | Area of cutaneous histamine wheal (sq. mm.) | Graphic representation of cold vasodilator response (sq. cm.) |
|---|---|---|---|---|---|---|---|
| Dummy by mouth | 4 | 11·4 | 37·5 | 'Benadryl' (50 mgm.) by mouth | 4 | 8·5 | 37·8 |
| Dummy by mouth | 7 | 10·8 | 43·8 | 'Phenergan' (50 mgm.) by mouth | 7 | 3·9 | 25·6 |
| Iontophoresis of 0·9 per cent saline | 3 | — | 46·9 | Iontophoresis of 2·0 per cent 'Phenergan' | 3 | — | 57·5 |

time and the results expressed (1) as the mean area enclosed by this curve[2], and (2) as the latent period of the response[3]. A 1/1,000 solution of histamine acid phosphate was placed on the skin of the forearm of the same subjects and a needle-prick was made through the solution. The mean area of the wheal thus produced was measured immediately before each cold immersion.

The results are given in Table 1. 50 mgm. of diphenhydramine hydrochloride, by mouth, reduced the size of the cutaneous histamine wheal ($t = 2·21$, $p < 0·20 > 0·10$) but had no effect on the cold-vasodilator response. 50 mgm. of promethazine hydrochloride given by mouth caused a highly significant reduction both of the histamine wheal ($t = 11·473$, $p < 0·001$) and of the cold vasodilator response ($t = 3·831$, $p < 0·01 > 0·001$) and it also significantly delayed the onset of the vasodilator response ($t = 3·628$, $p < 0·01 > 0·001$). There was a reflex vasodilator reaction in the index finger of the opposite hand, and this response was also significantly delayed by the oral administration of 50 mgm. of promethazine hydrochloride ($t = 3·357$, $p < 0·02 > 0·01$). When introduced into the finger-tip by iontophoresis, promethazine hydrochloride increased the magnitude of the cold vasodilatation, a result compatible with the local anæsthetic action of promethazine hydrochloride[4,5]. In ten untreated subjects a negative correlation was found between the size of the cutaneous histamine wheal and the magnitude of the cold vasodilatation ($r = 0·705$, $p < 0·05 > 0·02$).

Since systemic administration of promethazine hydrochloride causes central depression[6,7], and since local administration of promethazine hydrochloride did not inhibit the cold vasodilator response, it seems possible that inhibition of the response by the oral administration of 50 mgm. of this drug was due to a central depressant action. These results provide, therefore, no definite evidence for the participation of histamine in the cold vasodilator-response, and this conforms with observations by Duff *et al.*[3].

Experiments are now in progress to investigate the effect of drugs with a central depressant action on the cold vasodilatation in the finger.

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## Effect of Vagal Stimulation on the Sinus Venosus of the Frog's Heart

The effect of vagal stimulation or applied acetylcholine on electrically driven heart auricle fibres ha been studied with intracellular electrodes by severa workers[1]. The purpose of the present experiment was to gain some information about the events durin vagal inhibition in spontaneously active pacemake fibres.

The sinus venosus of a frog's heart was excise together with the two vago-sympathetic nerves, cu open and pinned out. When an electrode was inserte into the region where the beat could be observe to start, a typical pacemaker potential[2] was seen the membrane potential decreases slowly throughou diastole until the threshold for an action potentia is reached. In fibres that showed constant picture for several beats, the most negative value of th membrane potential during the cycle ranged from 45 to 60 mV.

If the vagi are stimulated briefly during the fallin phase of an action potential, the repolarization proceeds to above the most negative point reached i previous cycles, and the next beat is delayed becaus the slope of the pacemaker potential is reduce (Fig. 1*A*, left). With more prolonged stimulatio a slow 'hyperpolarization' suppresses the next pacemaker potential and stops the heart (Fig. 1*A*, right) On removing the vagal stimulus a slow depolarizatio develops again. In the experiment illustrated, thi depolarization was not allowed to reach the threshold instead, a second train of vagal impulses was sen into the preparation, causing a renewed hyperpolarization. After this procedure was repeated onc more, an action potential of shortened duration aros from a now apparently reduced threshold. Th maximum increase of the membrane potential, a measured from the foot of the last pacemake potential, was 8 mV. in this experiment.

In twelve other experiments, the inhibitory hyperpolarization measured 3–13 mV. (mean 8 mV.). O several other sinus fibres, however, vagal stimulatio merely depressed the pacemaker potential (Fig. 1*B*) This suggests that the transition from a typical pacemaker to a typical auricle fibre is gradual. It i noteworthy that the first two action potentials afte the vagal arrest are not only shortened, but als slightly decreased in amplitude. This reduction o the 'overshoot' amplitude was usually observed and was particularly striking on occasions whe impulses reached the inhibited fibre from a accidentally denervated and still beating part o the sinus.

The events underlying the increase in beat frequenc on sympathetic stimulation were studied in a fe atropinized preparations. As might be expected, th pacemaker potential increased in steepness after latent period of several seconds (Fig. 1*C*). Th

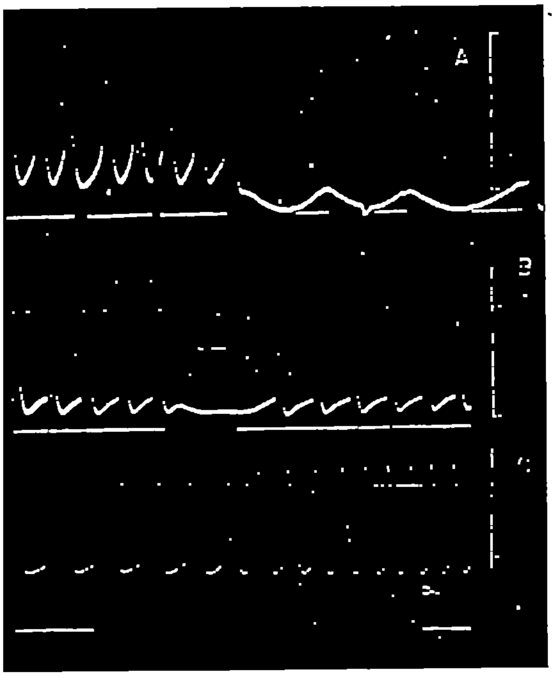

Fig 1 Intracellular records from the sinus venosus of a frog's heart. Vagal stimulation indicated by breaks in the lower beam. (*A*) Vagi stimulated at 10 per sec. during the repolarization of the third action potential. During the eighth action potential, vagal stimulation starts again (see text). Gap after fifth action potential denotes interval of several seconds. (*B*) Depression of pacemaker potential without hyperpolarization This preparation was treated with ergotamine, 1 in 10$^{5}$ (*C*) Effect of vago-sympathetic stimulation in an atropinized preparation.
Voltage calibration in 20 mV steps ; in (*B*) and (*C*) a line is drawn through zero potential, in (*A*) calibration from −10 mV. downwards. Time : 1 sec.

vershoot' was increased from 5·5 mV. to 11 mV. sympathetic stimulation.

These results confirm the results of Gaskell[3], who und that the demarcation potential in turtle auricle as increased during vagal inhibition. They also ll to mind the experiments of Howell and Duke[4], nd of Lehnartz[5], who showed that during vagal rest a heart liberated potassium ions ; for an out-ow of potassium ions could contribute to the hibitory hyperpolarization. An increase in per-eability to potassium, relative to that of sodium, uld also account for a decrease in the 'overshoot' nd for the faster repolarization of the action otential.

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## utritive Value of Heated Vegetable Oils

MUCH of the fat consumed by human beings, articularly in India, has been heated, and the con-itions of heating vary widely and also with the ature of the foodstuff into which the oil or fat is icorporated. It is therefore necessary to have scientific data concerning the nutritive value of heated oils and fat.

Heated oils have been shown to be poorly absorbed[1], to produce cancerous tumours[2] and to cause paralysis resembling that due to vitamin E deficiency[3]. Thermal polymerization was found to develop toxic products responsible for growth depression[4]. Kaunitz[5] stated that oxidized fats destroyed vitamins in the diets and thus caused retardation of growth. Chalmers[6] found that injections of heat-polymerized cotton-seed oil did not lead to the growth of tumours.

In most of the above investigations, the oils were heated in a current of carbon dioxide or nitrogen. In India, oils are heated in open pans for long periods and, further, the residual oil from a day's operations is supplemented with fresh oil and re-heated again. This may accelerate the oxidative and other changes. The work reported in this communication was undertaken to elucidate the nutritive value of some of the commonly used oils when they were fed after heating.

Groundnut, sesame and coconut oils were heated in an open iron pan at 270° C. for 8 hr. They were then incorporated into synthetic diets to give 15 per cent fat, and fed to albino rats. There were six groups of six rats each, five weeks old and weighing 40–50 gm. The two groups of rats allotted to any particular oil (unheated and heated) were litter mates and were distributed with due consideration to weight and sex. The diet employed had the following composition : fat, 15 per cent ; casein, 12 per cent ; sugar, 10 per cent ; salt mixture, 4 per cent ; and starch, 59 per cent ; and the vitamin supplements were : thiamine, 15 ; riboflavin, 60 ; pyridoxine, 10 ; niacin, 10 ; calcium pantothenate, 50 (all in mgm. per kgm. of the diet), and choline, 1 gm. Vitamins A and D were given in the form of two drops of 'Adexoline' twice a week per rat. The rats were housed in independent cages. The vitamin supplements were added to the diet every day, so as to prevent their destruction by the heated oils. Weekly growth records were maintained. At the end of the sixth week, four rats from each group were opened under chloroform, and liver, spleen, stomach and kidney were removed and weighed. The liver fat was also estimated. The observations are presented in Table 1.

Table 1. INFLUENCE OF HEATING THE OIL ON ITS NUTRITIVE VALUE AND FAT DEPOSITION IN THE LIVER

| | Average gain per rat per week (gm.) | Feed efficiency | Liver weight as percentage of body weight | Percentage fat in liver |
|---|---|---|---|---|
| Groundnut oil: | | | | |
| Unheated | 13·0 ± 0·5 | 1·1 | 3·8 ± 0·3 | 3·9 ± 0·3 |
| Heated | 5·0 ± 0·9 | 0·67 | 5·7 ± 0·6 | 7·1 ± 0·4 |
| Sesame oil: | | | | |
| Unheated | 10·0 ± 0·8 | 1·0 | 4·2 ± 0·7 | 4·8 ± 0·3 |
| Heated | 4·3 ± 0·7 | 0·7 | 6·0 ± 0·5 | 7·8 ± 0·3 |
| Coconut oil | | | | |
| Unheated | 11·0 ± 1·1 | 1·1 | 4·3 ± 0·3 | 4·5 ± 0·3 |
| Heated | 4·5 ± 0·7 | 0·7 | 5·8 ± 0·4 | 7·0 ± 0·3 |

The results show clearly that in all three cases the heated oil has adversely affected the gain in weight. The feed efficiency, that is, the increase in weight per gm. of fat consumed, of the heated-oil group of rats is considerably reduced. There were no significant changes in the weights of stomach, kidney and spleen of the two groups of animals. These results are not, therefore, presented here.

It may be seen that the liver weights (fresh) of the heated-oil groups are significantly higher than the controls. The fat content of the livers of the heated-oil group is nearly twice that of the control groups. Heated oil has produced fatty infiltration of the liver. Further, the livers were badly damaged and congested, and were not of the normal colour.

When the heated oil was fed at 30 per cent level, all the rats died within a week, whereas the control rats were quite healthy. In another set of trials, when 15 per cent heated oil (heated at 280° C.) was used in the diet, severe jaundice occurred and four of the six rats died in the sixth week of the experiment. The exact changes brought about by heating the oil and also the other aspects of the problem are being studied.

Our thanks are due to Prof. K. V. Giri for his interest in the investigation.

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## Cessation of Tillering in Young Grass Plants

DURING the early seedling growth of *Lolium perenne* plants in pots, Cooper[1] noted that the number of tillers per plant increased exponentially with time until some date 60–100 days after sowing, when the initial exponential growth was sharply curtailed and tiller production ceased. This phenomenon has been observed in experiments in which the chief concern was with growth as measured by increase in weigh The results obtained in a field experiment where th plants were growing in a sward are summarized i Fig. 1. In this experiment thirty plants of each twenty-two strains representing seventeen gra species were dug up twice a week, washed free of soi the tillers counted and then dried and weighe Each point in the figure is derived from the measure-ment of 660 plants. In the majority of strains till production ceased about the seventieth day aft sowing. No sudden change occurred in the rate increase of the plants (roots plus shoots) or in th rate of increase of the weight of shoot per tille that is, the weight of a tiller. Other details of th experiment have been published elsewhere[2].

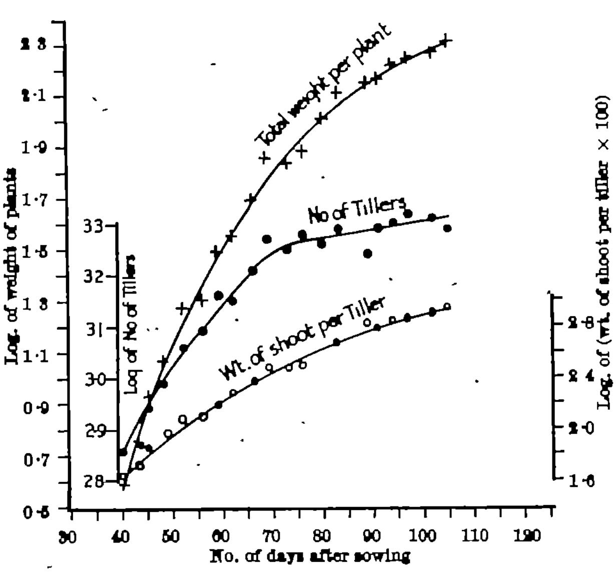

Fig. 1

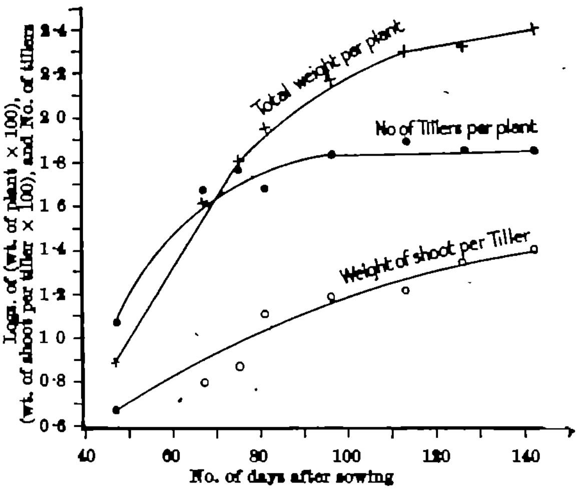

Fig. 2

In another experiment, plants of *Lolium perenne* S.24 were grown in whalehide pots of 6,700 m capacity. An equal number of pots containing on two or three plants were taken at intervals, th plants washed free from soil and then treated as i the other experiment. Usually thirty pots we dealt with on each date. The results are presente in Fig. 2 as the mean of the plants measured on particular date. Tiller production ceased about th hundredth day after sowing. As in the field exper ment, there was no cessation of dry-weight increa comparable to the cessation of tiller productio although a gradual reduction in this rate did occu The weight of shoot per tiller increased at the san rate throughout the period of the experiment.

This state of inanition of tillering would appear affect chiefly the meristematic tissues concerned wi the production of new tillers; the more matu tissues are unaffected and continued to grow, th is, to gain in weight without any sudden change the rate of increase for some considerable time aft the cessation of tiller production. This is in accor ance with Cooper's[3] findings that rate of leaf pr duction on the main tiller was unaffected by cessati of tillering.

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## Temporary Destocking of Pastures to aid Control of the Cattle Tick

The tick *Boophilus microplus* Can., is generally considered to be the most serious single cause of loss to the cattle industry in tropical Australia, contributing to the death of many cattle in dry years. Present control measures are costly, and by placing undue reliance on frequent dipping are thought to have increased the tendency of ticks to become resistant to BHC and arsenic[1]. A method involving only two or three dippings per year can be expected to reduce the difficulties of controlling strains of ticks resistant to these and newer acaricides. The results of the following 'pilot-scale' experiment carried out near Rockhampton, Queensland, emphasize the possibility of reducing the frequency of acaricidal treatment by destocking the pastures for periods which some cattle owners do not find inconveniently long.

Two herds of cattle were kept in adjoining comparable paddocks of approximately seventy-five acres. An equal number (10–14) of animals was present in each of the two herds at any one time. The 'control' herd was allowed access to the whole area of paddock *C* continuously, whereas the experimental herd was alternated between the two halves, *A* and *B*, of the other paddock, which was divided by an electric fence. The periods for which the *A* or *B* paddocks were destocked were based, after mid-November 1953, on observations made in the district on the time taken from the date of drop of a replete female tick to the death of its larval progeny (Wilkinson, unpublished data). Fig. 1 shows infestations of adult ticks, exceeding 0·5 cm. in length, on the two herds, the numbers with arrows indicating occasions on which the animals were sprayed with DDT preparation (1 per cent $p,p'$-isomer). It will be seen that, after the beginning of February 1954, infestations of the cattle moved to previously destocked pastures remained low. A few ticks continued to occur on the cattle, and this was considered a desirable feature, because the cattle would be regularly re-infested with *Babesia* carried by the larvæ and thus retain their immunity to 'redwater' fever[2].

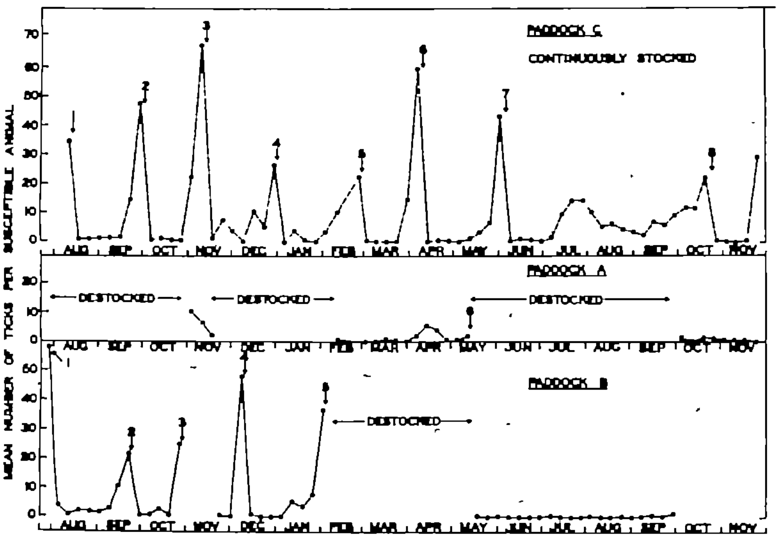

Fig. 1. Comparison of infestations of cattle on a continuously stocked and a pasture spelling paddock. Counts of female ticks, 0·5 cm. and upwards in length, on the right side of the cattle

Destocking of pastures has been practised frequently during tick eradication campaigns, but no experiment on destocking as a control measure has hitherto been described. A fuller account of this work and its application to Queensland conditions will be published elsewhere.

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[1] Hitchcock, L. F., *Aust. J. Agric. Res.*, 4, 360 (1953).

[2] Legg, J., C.S.I.R. Aust. Pamphlet No. 56 (Melbourne, 1935).

## A New Acaricide, 2,4,5,4'-Tetrachlorodiphenylsulphone

Läuger *et al.*[1], Swingle[2] and Browning *et al.*[3] have stated that the insecticidal value of $p,p'$-dichlorodiphenylsulphone is relatively low; Läuger *et al.*[1] state that diphenylsulphone and monochlorodiphenylsulphone are devoid of any insecticidal activity. On the other hand, Eaton[4] found among various diphenyl compounds some substances with a sulphone link active against spider mites and their eggs; optimal acaricidal activity occurred with mono-$p$-chlorodiphenylsulphone[5].

Diphenylsulphone and mono-$p$-chlorodiphenylsulphone are more or less phytocidal at active concentrations. We have now found that 2,4,5-trichlorodiphenylsulphone ('*V* 17') and 2,4,5,4'-tetrachlorodiphenylsulphone ('Tedion *V* 18') possess strong acaricidal properties without phytocidal side-effects. As can be seen from Tables 1 and 2, the latter substance is more active on the eggs than any of the other compounds listed. As is the case with some newer specific acaricides now in use, such as *CPBS* ($p$-chlorophenyl-benzenesulphonate), *CPCBS* ($p$-chlorophenyl-$p$-chlorobenzenesulphonate) and $p$-chlorophenyl-$p$-chlorobenzylsulphide, 'Tedion *V* 18' also shows activity on all stages except adult spider mites.

The various compounds were tested on *Tetranychus urticae* Koch on bean plants (*Phaseolus*). Potted bean plants with or without eggs were dipped in emulsions containing the active material. After the plants without eggs had dried, these were infected with adult females in order to obtain eggs on the dry residue. After two or three days the adults were removed. In order to evaluate the penetration of 'Tedion' into the leaf, leaves were treated on the upper side and infected with mites on the under side. Solutions and emulsions containing 1,000 and 100 p.p.m. of active material caused in these circumstances a total kill of eggs and larvæ.

The phytotoxic properties of 'Tedion *V* 18' were investigated on seedlings of *Tropaeolum majus*, cucumber, tomato, potato, broad bean (*Vicia faba*), French bean (*Phaseolus vulgaris*) and garden pea (*Pisum sativum*). The plants were thoroughly sprayed with 0·3, 1·0 and 3·0 per cent of active material,

Table 1. Action of *CPBS*, *CPCBS* and 'Tedion' on *Tetranychus urticae* Koch

| Compound | Concentration (p.p.m.) | Percentage kill | | | |
|---|---|---|---|---|---|
| | | Eggs dipped | | Eggs layed on residue | |
| | | Direct kill of eggs | Total kill eggs/larvæ | Direct kill of eggs | Total kill eggs/larvæ |
| *CPBS* | 100 | 24 | 100 | 74 | 100 |
| | 30 | 0 | 100 | 14 | 77 |
| | 10 | 0 | 60 | 0 | 0 |
| *CPCBS* | 100 | 25 | 100 | 58 | 99 |
| | 30 | 7 | 100 | 4 | 38 |
| | 10 | 0 | 33 | 8 | 10 |
| 'Tedion' | 100 | 100 | | 100 | |
| | 30 | 100 | | 100 | |
| | 10 | 100 | | 100 | |

Table 2. Action of *p*-Chlorophenyl, *p*-Chlorobenzylsulphide (Chlorparacide) and 'Tedion' on *Tetranychus urticae* Koch

| Compound | Concentration (p.p.m.) | Percentage kill | | | |
|---|---|---|---|---|---|
| | | Eggs dipped | | Eggs layed on residue | |
| | | Direct kill of eggs | Total kill eggs/larvæ | Direct kill of eggs | Total kill eggs/larvæ |
| Chlorparacide | 100 | 81 | 100 | 100 | |
| | 30 | 64 | 99 | 100 | |
| | 10 | 45 | 72 | 87 | 97 |
| | 3 | 10 | 63 | 10 | 42 |
| 'Tedion' | 100 | 100 | | 100 | |
| | 30 | 85 | 100 | 100 | |
| | 10 | 79 | 97 | 100 | |
| | 3 | 87 | 99 | 94 | 98 |

but no deleterious effect could be noted even after ten days.

'Tedion *V* 18' did not show any visible effect on flies, beetles, aphids and other insects when these were exposed to a dry residual film. Bees were not poisoned by contact or by ingestion of contaminated food. The oral median lethal dose for mice of 'Tedion *V* 18' exceeds considerably 5 gm./kgm., for this dosage did not cause death or any visible symptom of intoxication among the test animals. Therefore it appears to be a highly specific compound which is safe for the operator and the consumer of the treated products.

Other mites are also killed by 'Tedion *V* 18'. Field trials on fruit tree red spider (*Metatetranychus ulmi* Koch) have shown that one post-flowering treatment may keep the orchards practically free of red spider up to the autumn. Successful results have been obtained on apples, pears, plums, cucumbers, grapes, carnations, roses and other horticultural crops in the Netherlands, Belgium, Luxemburg and France.

Details of laboratory and field-trials will be published elsewhere.

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Agrobiological Laboratory "Boekesteyn",
's-Graveland. March 22.

---

[1] Läuger, P., Martin, H., and Muller, P., *Helv. Chim. Acta*, 27, 892 (1944).

[2] Swingle, M. C., Phillips, A. M., and Gahan, J. B., "Organic Insecticides for Phytophagous Species". U.S. Dept. Agr. Bull. E-621, Washington (1944).

[3] Browning, H. C., *et al.*, "Toxicity of DDT Analogues: Six Species of Insects", Prog. Rep. 15, C.R., 179 DDT (McGill University, 1946).

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## Control of Yeast Contamination by 'Mycostatin' in Cultures of the Virus of Foot-and-Mouth Disease

Cultures of the virus of foot-and-mouth disease by Frenkel's method[1], in which the epithelial tissue of the cattle tongue is used, is being widely adopted for the provision of virus for vaccine production. The tongue epithelium is grossly contaminated with bacteria and yeasts, and antibiotics must be included in the culture medium for their suppression. The bacterial contamination that we have encountered has been effectively controlled by penicillin and streptomycin; but the problem of inhibiting the growth of yeasts remained. During December 1954–March 1955, fourteen apparently distinct strains of yeasts have been isolated from virus cultures in which the tongue tissue was from cattle slaughtered in London. An attempt is being made to identify these strains using the classification of Lodder and Kreger-van Rij[2]. This has led, so far, to recognition of species from the genera *Endomycopsis*, *Saccharomyces*, *Sporobolomyces*, *Candida*, *Kloeckera*, *Trichosporon* and *Rhodotorula*.

It has now been found possible to control this yeast contamination by the addition to the culture medium of 'Mycostatin'[3], an antifungal substance from a soil actinomycete originally extracted by Hazen and Brown[4]. In *in vitro* tests, 'Mycostatin' inhibited the growth of thirteen of the above fourteen strains in a concentration of 20 units/ml., and the remaining strain was inhibited by 80 units/ml. The addition of 20 units/ml. to the virus cultures has resulted in complete control of yeast contamination. Using fourfold increases in concentration, no decrease in virus multiplication was observed until 320 units/ml. had been exceeded.

We are indebted to Messrs. E. R. Squibb and Sons for supplies of 'Mycostatin'.

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June 4.

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[1] Frenkel, H. S., Bull. Off. int. Epiz., 39, 91 (1953).

[2] Lodder, J., and Kreger-van Rij, N. J. W., "The Yeasts" (North Holland Publishing Co., Amsterdam, 1952).

[3] Squibb and Sons, E. R., London and New York, trade name for 'fungicidin' or 'nystatin' of Hazen and Brown (ref. 4).

[4] Hazen, Elizabeth L., and Brown, Rachel, *Science*, 112, 423 (1950).

## Reproduction in the Cat-fish, *Clarias mossambicus* Peters.

No precise information has been published on the breeding habits of *Clarias mossambicus*. Although previous authors who have studied this species in the field give records of ripe females[1] and breeding fish[2], definite spawning sites have apparently never been determined, nor have the eggs, embryos and larvæ been described.

During recent rains in Uganda an actual spawning site was investigated. Spawning took place in the flooded, low-lying areas adjacent to a shallow drainage stream flowing into Lake Victoria, near Jinja. This stream is separated from the lake by a narrow papyrus swamp which is succeeded on the landward side by a thin belt of the grass *Echinochloa*. When not in spate, the stream is reduced to a series of shallow, disconnected pools without direct surface-water connexion with the lake. Under flood con-

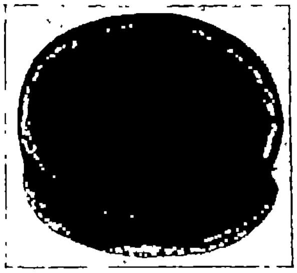

Fig. 1. Fertilized ovum of *Clarias mossambicus*; seen by transmitted light. Magnification c. × 20

ditions the stream overflows its banks, inundating the low-lying *Echinochloa* zone, which becomes a temporary and shallow swamp. Attention was drawn to the presence of adult *C. mossambicus* (normally absent from this stream) by the large number of African fishermen seen spearing these fish. A small sample of speared fish examined showed that females had either ovulated or were likely to ovulate within a short period. All male fish caught were apparently ripe.

Evidence indicating when sexually active fish first ascended the stream is both scanty and equivocal. African fishermen claimed that fish first appeared on April 11; on the other hand, subsequent collections of larvæ demonstrated the presence of young fish at least three weeks older than those known to have been spawned on April 12. More positive evidence is available regarding the time by which adults had returned to the lake. From both fishing activity and personal observation, it seems that few adults remained in the stream four days after fertilized eggs were first found. At this time the extent of the stream and swamp was greatly reduced.

Fertilized eggs were found among the accumulated plant debris lying in pools and side runnels of the main stream. Despite intensive search, very few eggs were found in the main stream or in sites from which the debris had been scoured by the flood. A surprising feature in the spatial distribution of eggs and early larvæ was their dispersion, in small groups of from five to ten individuals, over a considerable area.

The fertilized ovum is small and sub-elliptical in cross-section, having mean greatest and least diameters of 2·0 mm. and 1·5 mm. respectively. The translucent straw-yellow yolk almost fills the vitelline space. A characteristic feature is the large adhesive disk, about 0·5 mm. deep, which entirely surrounds one pole. The outer surface of this disk follows the general contour of the underlying chorion; at its centre there is a well-marked pit-like depression (Fig. 1). Sheets of a glutinous and elastic substance which are extruded from the disk firmly anchor the egg to the substrate.

Since an accurate temporal base-line is known only for laboratory-raised embryos obtained in the first instance by artificial fertilization, the developmental times given below refer to these individuals.

Within an hour of fertilization the fourth blastodermal cleavage has taken place, the blastodermal disk occupying the pole opposite the adhesive disk. After nine hours there is a well-defined embryonic shield lying equatorially. Hatching takes place between twenty-three and twenty-five hours after fertilization. For comparison, it may be noted that *Tilapia esculenta* and *T. leucosticta* raised under similar conditions hatch between five and six days after fertilization. Newly hatched *C. mossambicus* larvæ are 3·5–4·0 mm. long; the first two gill slits are open, and there is a clearly defined opercular fold. The larvæ swim actively, and are not confined to the substrate. A small, but distinct, ventral sucker is developed on the vitelline membrane. The adhesive properties of this sucker are considerably less than those of the chorionic adhesive disk.

Development after hatching is also rapid, especially during the first fifty hours. Perhaps the most outstanding morphological features of this period are the large olfactory sacs, which dominate the anterior cephalic region, and the precociously developed circum-oral barbels.

Between thirty-seven and thirty-nine hours after hatching, an extensive and well-developed vascular network is visible on the expansive branchiostegal membrane. At this stage the operculum is clearly defined, and two cartilaginous branchiostegal rays are present. Preliminary investigation leads me to interpret the branchiostegal vascular net as an extension of the hyoidean vascular arch, without its subdivision into afferent and efferent vessels. Blood flows into this network from the ventral aorta, and after circulating through the net is collected into a single vessel which joins the paired dorsal aortæ behind the eye. It is suggested that the hyoidean vascular net functions as an accessory gill. In larvæ one week old these vessels may still be traced, but thereafter increased pigmentation precludes further direct observations on living material.

The yolk sac is completely resorbed four days after hatching, at which time the larvæ have attained a length of 7–8 mm. and are clearly recognizable as young *Clarias*. The vitelline sucker ceases to be functional at about this period, and is soon lost.

Embryos raised *in vitro* were kept within the temperature-range of 23·0–24·5° C., whereas under natural conditions embryos were subject to a diurnal temperature variation as great as 6 deg. C. (22°–28°). So far as could be determined, development *in vivo* was slower than in the laboratory, there being a time lag of nearly 100 per cent during pre-hatching development, later reduced to 25 per cent by the time that the yolk had been resorbed. Oxygen tension, probably associated with the intensity and turbulence of water flow, is doubtless an important feature in controlling developmental rates. It was noticed, for example, that early development was faster in embryos raised in dishes with a strong current agitating the water than in those supplied with only a slight water flow. Larvæ resulting from artificial fertilization did not survive beyond five days after hatching.

The temporary nature of the spawning area is emphasized by the fact that six days after the discovery of early embryos, the principal spawning site was completely isolated from the main stream. Also at this time, larvæ were first found in the stream; these were at a developmental stage comparable with those still remaining in isolated areas of the swamp. A rapid fall in water-level now occurred, which resulted in many larvæ being concentrated in small isolated pools approximately a foot in diameter and six inches deep. In one such pool the midday surface temperature was 34° C., while six inches below, the temperature of the mud was 25° C. Larval fishes continued to live under these conditions for three days without any marked diminution in their numbers. Finally, on the fourth day the pools dried out completely.

Collections made in the main stream indicated a fairly constant and dense population of young fish over a period of eight days after the first appearance of larvæ in this habitat; however, with the gradual break-up of the stream into disconnected pools, the number of larvæ decreased suddenly and has remained at a low level for some weeks. If these environmental conditions are typical for this period of the 'long' rains, then it would seem probable that larval *O. mossambicus* suffer severe mortality before reaching the lake. On the other hand, rainfall in this area during March and April had been unusually light and irregular.

It has not yet been determined at what stage in the life-history young fishes find their way into the lake.

A full description of embryonic and larval development in *O. mossambicus* will be published elsewhere.

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May 23.

[1] Graham, M., "A Report on the Fishing Survey of Lake Victoria 1927–28" (Crown Agents for the Colonies, London, 1929).

[2] Worthington, E. B., "A Report on the Fishing Survey of Lakes Albert and Kioga" (Crown Agents for the Colonies, London, 1929). "A Report on the Fisheries of Uganda" (Crown Agents for the Colonies, London, 1932). Ricardo Bertram, C. K., Borley, H. J. H., and Trewavas, E., "Report on the Fish and Fisheries of Lake Nyasa" (Crown Agents for the Colonies, London, 1942). Lowe, R. H., "Report on the Tilapia and other Fish and Fisheries of Lake Nyasa, 1945–47" (H.M.S.O., London, 1952).

## Elementary Bodies in Bovine Malignant Catarrh

MALIGNANT catarrh in cattle is widespread, occurring in Africa, America and Europe. Henning[1] has described the clinical syndrome which invariably terminates in death. The etiological agent, although believed to be a virus, has never been described. The disease can be transmitted to cattle by needle passage of spleen/gland emulsions[2]. It has also been adapted to rabbits[3].

The rabbit-adapted strain affords an easier and more economical means of investigation, and, in view of Mettam's[4] remarks that "The virus must be fairly large and only invisible because of some natural peculiarity . . .", it was decided to make a minute examination of smears and sections obtained from various infected rabbit tissues. Using Castaneda, Macchiavello and Giemsa staining, it was observed that elementary and initial type bodies were present in most tissues, but especially spleen, gland, lung and appendix, which resemble those of the psittacosis group of viruses (Fig. 1). These bodies showed the pleomorphism, colour variation and location as described by Bedson and Bland[5].

A check was then made on smears and sections of bovine tissues already prepared, and although the virus is present it is much less numerous and more likely to be confused with cellular debris.

An attempt was also made to establish the disease in fertile hens' eggs using 0·2 c.c. of a 10 per cent spleen emulsion from an infected rabbit, but after only two passages in the yolk sac of eight-day old embryos it was unavoidably necessary to discontinue this work for some months. Smears from yolk sac and chorio-allantoic membrane revealed various forms of the virus, but elementary bodies were undetectable.

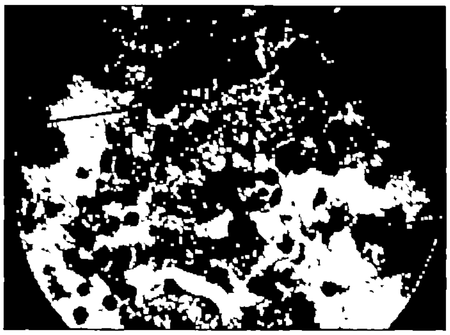

Fig. 1. Rabbit lung stained with Giemsa. Initial bodies, mainly intracellular, are marked by arrows. × 660

In view of the fact that psittacosis virus can be stored for some months by placing infected yolk sacs in deep freeze, and despite the fact that the viru of malignant catarrh will only remain viable for one to two weeks according to all previous investigators it was decided to place one yolk sac in a sterile container in the deep freeze at – 10° C. At the same time the bovine needle passages were also discontinued, but passages in rabbits were maintained. However, after four months from this time (fifty-seventh passage), the rabbits failed to react.

After eight months, when it was possible to resume the work, the frozen yolk sac was emulsified in nutrient broth to make a 10 per cent yolk sac emulsion, and 0·2 c.c. was inoculated into the yolk sac of eight-day old fertile hens' eggs. After a further two passages, 10 c.c. of a 10 per cent whole egg emulsion was inoculated into the prescapular glands of two cattle.

Four weeks later one animal reacted with symptoms associated with malignant catarrh, and this was confirmed by post-mortem findings. A 10 per cent spleen/gland emulsion from this animal was subinoculated into a further two animals by the prescapular gland route, and after three weeks one of the animals reacted, again with typical clinical and post-mortem findings associated with malignant catarrh. Using whole egg emulsion from the fourth egg-passage after storage, a further four cattle were inoculated intratracheally. Three reacted in three to four weeks, again with typical symptoms; but one of these, a young native bull, survived. Thus, a complete cycle, bovine—rabbit—fertile hens' eggs—bovine, has been completed.

Natural infections of malignant catarrh have not been recorded at Kabete.

Papers embodying the results of these studies are being prepared and will be published elsewhere.

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April 15.

[1] Henning, M. W., "Animal Dis. in S.A.", 2nd edit., 791 (1949).

[2] Piercy, S. E., *Brit. Vet. J.*, 108, No. 2, 35 (1952).

[3] Piercy, S. E. (to be published).

[4] Mettam, R. W. M., "Snotsiekte in Cattle", 9th and 10th Rep. D.V.E. and R. S. Afr., 395 (1923).

[5] Bedson, S. P., and Bland, J. O. W., *Brit. J. Exp. Path.*, 13, 461 (1932).

## New Free Amino-Acids in Plant Materials

RECENT research[1] indicates the presence of 5-hydroxypipecolinic acid as well as possibly hydroxylysine, besides pipecolinic acid and baikiain in the non-protein nitrogenous fraction of plant materials.

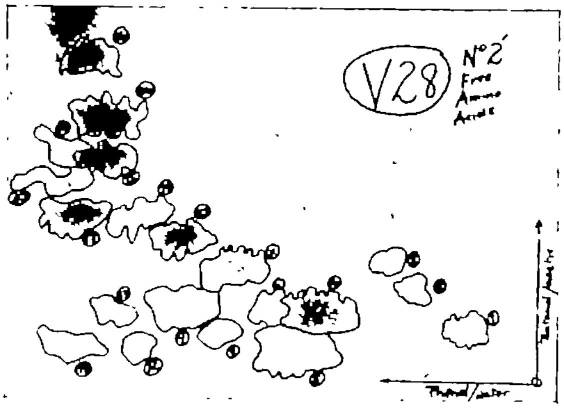

Fig. 1. Ethanolic extract of lucerne hay cut at 14 cm. First phase: phenol–water (4 : 1)/ammonia atmosphere. Second phase: *n*-Butanol/acetic acid/water (4 : 1 : 5, upper layer). Ninhydrin development: 1, Aspartic acid; 2, glutamic acid; 3, 3 . 4 - dihydroxyphenylalanine; 4, serine; 5, asparagine; 6, glycine; 7, threonine; 8, citrulline; 9, glutamine; 10, alanine; 11, β-alanine; 12, histidine; 13, unknown (? ε-aminohydroxycaproic acid or methionine sulphone); 14, valine + methionine; 15, γ-aminobutyric acid; 16, leucines, 17, proline; 18, arginine + lysine; 19, pipecolinic acid; 20, baikiain

Previously unidentified ninhydrin-reactive sub-tances have been found to occur in the hydrolysed[2a] nd unhydrolysed[2b] ethanolic extracts of lucerne hay ut in different stages of growth and in certain marine lgae[3], as well as the extract of fenugreek seeds[2a].

Fig. 1 shows a two-dimensional paper chromatogram of the ethanolic extract of lucerne hay cut at 14 cm. in height (Liběchov). Among the ninhydrin-eactive spots occurring on the chromatogram are hose corresponding to pipecolinic acid (spot 19), aikiain (spot 20) as well as citrulline (spot 8) and ossibly ε-aminohydroxycaproic acid or methionine ulphone (spot 13). The work of Koloušek indicates hat pipecolinic acid is present in mature lucerne hay Tábor) as well as citrulline[4].

An identical picture is given by the ethanolic xtract of lucerne hay cut at 12 cm. in height.

A further unknown ninhydrin-reactive substance occurs sometimes near asparagine (with the same $R_F$ n phenol–water/ammonia as glycine but just below sparagine). This may be ethanolamine phosphate r α-ε-diaminopimelic acid (Work, E., personal ommunication).

5-Hydroxypiperidine-2-carboxylic acid does not eem to occur in these hays, but an unknown inhydrin-reactive substance is found in certain arine algae[3] in the position of this amino-acid on wo-dimensional paper chromatograms (it only gives weak reaction with alloxan and isatin)[2b,3].

A brown ninhydrin colour is given by another nknown substance occurring in the hydrolysates of thanolic extracts of lucerne hay[2a].

Spot 3 is thought to be 3 : 4-dihydroxyphenyl-lanine[2b].

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Grobbelaar, N., Pollard, J. K., and Steward, F. C., *Nature*, 175, 703 (1955).

a) Koloušek, J., and Coulson, C. B., *J. Sci. Food and Agric.* (Pt. IV) (in the press) (*b*) *Chem. Listy*, 46, 186 (1952).

a) Coulson, C. B., *Chem. and Indust.*, 971 (1953); (*b*) Institute of Seaweed Research, Report No 171 (December 1953). (*c*) *J. Sci. Food and Agric.* (Pt. V) (in the press).

Koloušek, J., *Chem. Listy*, 47, 473 (1953); *J. Sci. Food and Agric.*, 6, 380 (1955).

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## Isolation of Ectotrophic Mycorrhizal Mycelia from Rhizomorphs present in Soil

In a recent communication in *Nature*, Warcup[1] described a technique devised for the isolation of fungi directly from hyphæ distributed in soil. By this method he succeeded in isolating a number of fungal species including basidiomycetes generally absent from dilution plates.

During researches on soil fungi carried out at Bedford College, mycelia known to form ectotrophic mycorrhizal associations have been isolated from soil rhizomorphs using the following method: fresh rhizomorphs picked out of the soil were washed for approximately 10 sec. in 0·1 per cent hydrochloric acid, then rinsed in sterilized water and plated on nutrient media commonly used for culturing mycorrhizal fungi. In this way *Boletus bovinus*, *B. scaber* and *Mycelium radicis nigrostrigosum* were isolated from soil brought in from the field and from experimental soil cultures grown in the laboratory.

The accompanying photograph shows a sample of rhizomorphs of *B. bovinus* used for isolation purposes. These hyphal strands, present in a certain heathland soil under investigation, exhibit a pinkish-brown colour. Their average diameter is 60–70μ. Each rhizomorph consists of a central cylinder formed by 1–3 hyphæ 4–5μ wide, enclosed within a sheath of more slender hyphæ each 2–3μ in diameter. Clamp connexions have not been observed in the hyphal filaments forming these rhizomorphs. In the particular soil mentioned above, *B. scaber* and *M. r. nigrostrigosum* were observed to develop hyphal strands structurally not dissimilar from those described for *B. bovinus*.

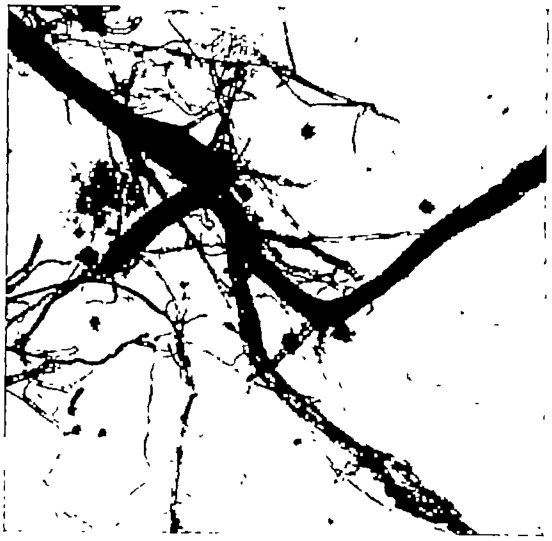

Fig. 1. Soil rhizomorphs of *Boletus bovinus* as used for the purpose of isolation. × 140

The isolation of ectotrophic mycorrhizal mycelia from soil rhizomorphs by means of surface sterilization has proved a convenient method of obtaining pure cultures of these fungi which, so far, have resisted isolation from individual hyphæ.

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Regent's Park, London, N.W.1.
June 3.

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[1] Warcup, J. H., *Nature*, 175, 953 (1955)

## FORTHCOMING EVENTS

### Monday, September 12

Institute of Metal Finishing (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. F. Wild: "Fluoborates in Plating".

### Monday, September 12—Friday, September 16

Imperial College of Science and Technology (at the Royal Institution, Albemarle Street, London, W.1)—Third London Symposium on "Information Theory".

### Tuesday, September 13—Saturday, September 17

Society of Dyers and Colourists (at the Northern Counties Hotel, Portrush, Co. Antrim, N. Ireland)—Symposium on "Bleaching, Dyeing and Finishing To-day".

### Wednesday, September 14—Saturday, September 17

National Physical Laboratory (at Teddington)—Symposium on "Cavitation in Hydrodynamics".

### Friday, September 16

Biochemical Society (in the Department of Biological Chemistry Marischal College, Aberdeen), at 2.15 p.m.—Scientific Papers.

### Saturday, September 17

Nutrition Society, Scottish Group (in the Physiology Lecture Theatre, Marischal College, Aberdeen), at 1.40 p.m.—Symposium on "Cholesterol and Fat Metabolism in Relation to Diet and Disease".

## APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Applied Mathematics—The Registrar, The University, Nottingham (September 19).

Reader in Applied Mathematics at the Imperial College of Science and Technology, London, S.W.7—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 21).

Research Assistants (2) (with a good honours degree in physics or physical chemistry) in the Department of Mining—The Registrar, The University, Leeds 2 (September 23).

Assistant Physicist (with a good honours degree in physics and preferably with experience in electronics and nuclear physics techniques) in the Physics Department of the Sheffield National Centre for Radiotherapy—The Secretary, Sheffield Regional Hospital Board, "Broom Cross", Tree Root Walk, Sheffield 10 (September 24).

Physicist (with a first- or second-class honours degree or equivalent, and preferably with some experience of optics, heat transfer, or radiation problems) at a Ministry of Supply Research Station near Salisbury, Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.312/5A (September 24).

Lecturer in Civil Engineering—The Registrar, The University, Leeds (September 26).

Assistant Lecturer in Physics—The Registrar, University College of North Staffordshire, Keele, Staffs (September 30).

Lecturer in Organic Chemistry—The Secretary, Queen's University, Belfast (September 30).

Lecturer in the Department of Biochemistry—The Secretary of University Court, The University, Glasgow (September 30).

Librarian (with recognized qualifications in librarianship and experience in a special library, and preferably with a knowledge of botany and major foreign languages) of the Royal Botanic Garden, Edinburgh—Chief Librarian, Ministry of Works, Lambeth Bridge House, London, S.E.1 (September 30).

Senior Lecturer in Anthropology at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 30).

Lecturer in Farm Management—The Secretary and Registrar, University College of North Wales, Bangor (October 1).

Lecturer or Assistant Lecturer in Biochemistry—The Registrar, The University, Sheffield (October 1).

Senior Lecturer, Lecturer or Assistant Lecturer in Inorganic Chemistry at the University College of Khartoum, Sudan—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (October 1).

Chief Assistant Chemist and Bacteriologist (Associate or Fellow of the Royal Institute of Chemistry, and preferably with experience of water analysis and treatment)—The Engineer and General Manager, Sunderland and South Shields Water Company, 29 John Street, Sunderland, quoting "Chemist and Bacteriologist" (October 15).

Lecturer in Philosophy at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 15).

Lecturer (proficient in anatomy and cytology and preferably with a good knowledge of cytogenetics) in the University Department of Botany, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Johannesburg, October 15).

Senior Lecturer (with teaching experience at university level and an honours degree and a research degree in zoology) in Zoology at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, October 31).

Agricultural Officers (with a university degree in agriculture or natural science) in the Gold Coast Local Civil Service, to advise the Director of Agriculture on current district agricultural problems, to manage District Agricultural Stations, and to implement agricultural policy in their respective districts—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.63/12/04.

Electronic Physicists and Engineers, Scientific Officer or Experimental Officer class, at Ministry of Supply Experimental Establishments near Farnborough, Hants; Malvern, Worcs; Sevenoaks, Kent; Aberporth, S. Wales; and London H.Q., for research and development on guided weapons; radio, radar and communications; and electronic devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.302/5A.

Hospital Physicist (with an honours degree in physics, and preferably with experience in hospital physics) in the Radiotherapy Department—The Secretary, Romford Group Hospital Management Committee, Romford.

Mechanical and Aeronautical Engineers, Aerodynamicists, Applied Mathematicians, Physicists and Physical Chemists (with a first- or second-class honours degree or equivalent qualification) at the Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.661/5A.

Research Assistant (with an honours degree or equivalent qualification in electronics) in the Department of Physiology for work on auditory physiology—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

Scientific Officer (with a first- or second-class honours degree or equivalent in physics, mechanical or chemical engineering) at the Ministry of Supply Research and Development Establishment, Waltham Abbey, Essex, to assist in research on heat transfer phenomena at high temperatures—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.329/5A.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Department of Scientific and Industrial Research. Report of the Fuel Research Board with the Report of the Director of Fuel Research for the year 1954. Pp. vi+70+2 plates. (London: H.M. Stationery Office, 1955.) 3s. net. [17

The Suppressed Frame System of Telerecording. (B.B.C. Engineering Monograph—No. 1.) Pp. 15. (London: British Broadcasting Corporation, 1955.) 5s. (Annual subscription covering about six issues: 20s.) [17

British Empire Cancer Campaign. Thirty-second Annual Report covering the year 1954. Pp. xxx+531. (London: British Empire Cancer Campaign, 1955.) [17

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1954. South Western Division. By T. A. Jones. Pp. ii+24+3 plates. (London: H.M. Stationery Office, 1955.) 1s. 6d. net. [17

Rothamsted Experimental Station. (Lawes Agricultural Trust.) Report for 1954. Pp 242. (Harpenden: Rothamsted Experimental Station, 1955.) 7s. 6d. [47

Universities Council for Adult Education. Report on the year 1953–1954. Pp. 23. (Bristol: W. H. Salt, The University (Hon. Secretary and Treasurer).) 1955. [47

### Other Countries

Veröffentlichungen des Fraunhofer Instituts Freiburg I.B. Sonnen-Zirkular für die Monate Januar, Februar, März, 1955. Pp. 38. (Freiburg im Breisgau: Fraunhofer Institut, 1955.) [17

Tobacco Research Board of Rhodesia and Nyasaland. Bulletin 4 (June 1955): Frog Eye and Barn Spot. By R. C. Stephen. Pp. 36. (Salisbury: Tobacco Research Board of Rhodesia and Nyasaland, 1955.) [47

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 36, No. 5: Hospitalization of Men at Ages 60 and Over. Pp 12. (New York: Metropolitan Life Insurance Company, 1955.) [47

Annuario Sismologico de Portugal. No. 5—1951. Pp. 7. (Lisboa: Servico Meteorologico Nacional, 1955.) [47

United States Naval Observatory. Circular No. 58: Positions Areas, and Counts of Sunspots, January–February–March, 1955. Pp. 7. (Washington, D.C.: United States Naval Observatory, 1955.) [47

Annual Epidemiological and Vital Statistics, 1952. Part 1: Vital Statistics and Causes of Death. Part 2: Cases of and Deaths from Notifiable Diseases. Pp. 544. (Geneva: World Health Organization; London: H.M. Stationery Office, 1955.) 30 Swiss francs; 50s, 7.50 dollars. [47

Proceedings of the Ninth Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India. (Convened by the Indian Council of Agricultural Research, Izatnagar 11th to 17th March, 1951.) Pp. x+166. (Delhi: Manager of Publications, 1954.) Rs 10/10/–; 17s. [67

United States. Commission on Organization of the Executive Branch of the Government. Subcommittee Report on Research Activities in the Department of Defense and Defense Related Agencies Pp. x+91. (Washington, D.C.: Government Printing Office, 1955. 30 cents. [67

Gold Coast. Annual Report of the Forestry Department for the year ended 1953–54. Pp. iii+46+1 map. (Accra: Government Printer 1955.) 2s. 6d. [6

Ontario Research Foundation. Annual Report, 1954. Pp. 3 (4 plates). (Toronto: Ontario Research Foundation, 1955.) [67

# REASON AND SURVIVAL IN THE MODERN WORLD

NEARLY twenty years ago, in his Conway Memorial Lecture, under the title "The Retreat from Reason", Prof. L. Hogben argued that this 'retreat' was the result of our failure to ensure that, on one hand, the training of the statesman and the man of letters gave them prevision of the technical forces which were shaping the society in which they live, whereas, on the other hand, the education of the scientist and the technician did not make them aware of the social consequences of their own activities. It was accordingly necessary to devise an education which would give us representatives capable of co-operating intelligently with technical experts in constructive social enterprise, and teach us how to choose them. Prof. Hogben then developed his argument for encouraging a wider knowledge of science as a means to action, and outlined a proposal for an institute of social inquiries, and in doing so made numerous comments—for example, that the most expensive products of modern social organization are uneducated men—the truth of which has been amply attested in recent months.

Prof. Hogben's lecture is recalled to mind by the appearance of a special number of *The Political Quarterly* in which, under the general title "The Revolt against Reason", a series of nine articles examines from different angles the evidence for the alleged great reversal during the past forty years of the nineteenth-century climate and movement of ideas, and whether in fact there has been a great revolt against reason, science, and the ideas and ideals of the French Revolution. While, however, the articles indicate that there has indeed been a revolution in scientific thinking and a profound change in the whole climate of our thought, they reveal no convincing evidence of the cataclysmic failure of, or revolt against, reason. The result has been rather a deep confusion, a loss of direction in the political and social mind, both of the expert and specialist and of the ordinary man. The symposium suggests that if we eventually digest the new ideas and adapt ourselves to the new conditions, then we must do it with the aid of reason; but there the affinity with Prof. Hogben's lecture ends. A challenge to thought there may be, but scarcely one to action.

Of the nine articles, those in which Dr. J. Bronowski deals with science, Mr. R. Wollheim with philosophy, and Mr. Noel Annan with the general intellectual revulsion to the right may be of most interest to the man of science. Those of Prof. D. Emmett on religion, of Mr. D. G. MacRae on social science, of Mr. L. Woolf on history, and of Mr. H. R. C. Greaves and Mr. W. Pickles on political thought in Britain and in France, are required, however, to complete the picture of the existing climate of belief, while finally, Mr. R. Bryden analyses the attitude of the younger generation in the universities.

The real situation is well shown by Dr. Bronowski, who proves as stout a champion of reason as any product of the nineteenth century. Discoveries connected with the atom, quantum theory and relativity have made some of the assumptions or conclusions of Newtonian science untenable. The new thought in science is based none the less on new facts, and its predictions have a formidable accuracy, as well as a calculated uncertainty within which we work confidently and methodically. We recognize now that the world is not made in a pattern which can be described by specifying its separate points; but this lends no support to the argument that we can safely abandon the use of reason and substitute the instrument of faith. Nuclear science has released neither scientist nor layman from the duty of using his reason; on the contrary, it has made the scrupulous use of reason even more essential for survival. Similar thoughts were evidently in the mind of Sir Robert Robinson when he spoke in his presidential address to the British Association meeting at Bristol of the need for the freeing of information in this field.

Mr. Wollheim's review of modern philosophy and unreason leads to a like conclusion: that to stand on the side of reason is a matter not of arriving at certain conclusions but of using certain methods. Prof. Emmett, surveying much the same field but more particularly in relation to discussions on religious questions, can find no unequivocal evidence of a revolt against reason but insists rather that there is a problem of communication to be solved. She suggests that there may be signs that a more widespread awareness of problems raised by our uses of language, questions from which not even an exposition of theology can be immune, may lead to a greater readiness on all sides to try to see what it means to be rational in questions which touch ultimate attitudes and beliefs.

It might have been expected that Mr. MacRae, tracing the influence of irrationality and obscuration in the social sciences, would come nearer to Prof. Hogben in his conclusions. While, however, he shows as clearly as Prof. Hogben the obstacles which hinder the development of the social sciences to-day, and agrees with him that only growing rational understanding can give to men control of their natures and of their societies, Mr. MacRae is not concerned with practical problems. He finds no evidence of a genuine retreat from reason and observes that the decision to follow reason is always a moral choice, but in the social sciences in the mid-twentieth century, the task of following reason is a technical one.

Nor do Mr. Annan's or Mr. Greaves's articles warrant pessimism. Mr. Annan's examination of the factors responsible for the intellectual movement to the right leads him to suggest that politically we live again in the age of Bagehot, and that what is needed is a new series of cohesive arguments which will again persuade people that our institutions need changing, not modifying, and that reason is a tool for discovering what changes are necessary and not a means of justifying the present and explaining why it can never improve. Mr. Greaves concedes that the belief in an inevitable progress along predetermined channels of rational, humanitarian, democratic advance has gone, but not that there is real evidence of any failure to relate the stability of institutions in a precarious world to the old principles of rational humanitarianism. There is certainly wider agreement now than at the beginning of the century on basic principles and on objectives, and while that agreement may be less optimistic as to the essential reasonableness of human nature and the inevitability of progress, it is not anti-rational or anti-democratic.

Mr. Bryden's survey of the attitude of the younger generation in the universities ends on a like note. The apparent revolt against rationalism there, in his opinion, amounts not to rejection of the tradition of Bentham and Mill, but to a re-examination of the other tradition, from Coleridge to Green, which in retrospect seems to amount to the philosophy of the other great force which complemented nineteenth-century liberalism. Rationalism, he insists, may have entered the wilderness, but its younger disciples in the universities show themselves determined not to let it die out. Then in two sentences he brings the symposium closer to practical issues than his fellow-contributors seem to do. "If the tradition of rationalistic radicalism does not stir the universities as it once did, surely this is because the universities have lost their sense of community with the rest of the nation." There may have been no deliberate abdication of leadership, but it is scarcely possible for the scientist to be disliked and distrusted by the public in the way that Dr. Bronowski remarks unless the universities have failed to rise to their responsibilities of intellectual leadership. Quantitatively, their post-war expansion should have greatly enhanced their influence on public opinion in Britain, and a failure to seize the wider opportunities may well account in part for difficulties in shaping educational policy to public needs, whether we look, for example, at the expansion of technical and technological education or at the continuing shortage of science teachers. Moreover, the lacuna to which Mr. Bryden directs attention has its dangers for the universities themselves, as Sir Hector Hetherington made abundantly plain in his Anderson Memorial Lecture on "The British University System" delivered in Aberdeen last year*. Academic autonomy depends ultimately on public understanding of what the universities are doing and how best their work is done.

For the second practical issue: if the twentieth century has made anything clear, it is that nations are all too concrete; it may be irrational to adore societies; it seems still more irrational to ignore their existence and their strength. Set those words in the context of some of the platitudes with which distinguished contributors to "The Bomb: Challenge and Answer"† were content to leave the problems with which nuclear energy confronts mankind, and the imperative need for keen, rational thinking which now confronts mankind is plain. Here, at least, and in Dr. Bronowski's essay, a challenge is thrown down in quiet confidence that reason still offers a guide, and the only sure guide, to the right answer to problems of to-day.

The call to action is given less insistently than it was by Prof. Hogben, but it is there none the less. We may be less confident where reason will take us, and we recognize that there are fields of human experience of which science can tell us little or nothing. But that hard thinking and readiness to follow the argument and pursue the inquiry wherever they lead are the essential conditions for solutions to the problems of human survival and existence are as true to-day as ever. For an effective policy, however, we need, as Sir Richard Livingstone reminds us, clear and firm beliefs. Without them we may not only fail to draw the moral lessons we might from history, but also our thinking may lead us not to action but into a miasma of doubt and frustration. Mr. Woolf's contribution to the symposium, at least, displays that danger; but for the rest the symposium has little of the 'ivory tower' about it. Its challenge to hard thought contains more than a hint that such thinking needs to crystallize in action, and indicates at least some of the enterprises of great moment to which our thought should lead.

# SCIENCE AND PETROLEUM

## The Science of Petroleum

A Comprehensive Treatise of the Principles and Practice of the Production, Refining, Transport and Distribution of Mineral Oil. Vol. 5, Part 3: Refinery Products. Edited by Dr. B. T. Brooks and Dr. A. E. Dunstan. Pp. ix+398+23 plates. (London: Oxford University Press, 1955.) 126s. net.

THIS is the most recent addition to the four original volumes published in 1937 and is the fourth supplement to be issued. As it may represent a stage in the successive renewals of an outstanding record of the science and technology of mineral oil, opportunity is taken of referring to the work as a whole. The conception of "The Science of Petroleum" was heroic. It was the thought of A. E. Dunstan more than any other, who sought a means of overcoming the ever-increasing pressure of advancing knowledge required by the man of science and the technologist in an industry of the widest interests, without having immediate recourse to the very many original publications in journals and monographs spread throughout the world's literature. It was not to take the form of a series of abstracts or summaries, nor to be a collection of treatises; but to become an ever-living progression of articles concerned with aspects, achievements and trends written by contemporaries of acknowledged authority. The attempt was successful. "The Science of Petroleum" will continue to live and flourish indefinitely.

The first half of the contents of "Refinery Products" is mainly directed to the characterization of commercial fractions of crude oil as separated at the 'refinery', and ranging from aviation and motor asolines through middle distillates to white oils and raxes. The remainder is mostly concerned with the laboration of test methods. There is therefore little rocess and manufacturing material additional to hat appearing in Vol. 5, Part 2, and what there is eals with relatively minor products and their pplications. It had been hoped that in suitable uise room could have been found for description of he more recent developments in directive catalytic ydroforming and desulphurizing, which are having truly profound influence on refinery practice and roducts. But at the pace new volumes are being repared for the series, one may not have to wait verlong for such disquisitions.

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* The British University System 1914–1954. By Sir Hector Hetherington. (P. J. Anderson Memorial Lecture, 1954. Aberdeen University Studies—No. 33.) Pp. 13. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 1s.

† The Bomb: Challenge and Answer. By Prof. Alexander Haddow, Bertrand Russell, Lord Beveridge and Henry Usborne. Edited by Gilbert McAllister. Pp. 160. (London: B. T. Batsford, Ltd., 1955.) 25s. net.

There are many noteworthy essays in the volume, nd one is forced into generalities of appreciation; ut it is perhaps in the matter of testing that the igh standard of modern petroleum technology is best ortrayed. Both for length and substance (close on ne hundred pages) the contribution of W. G. Lovell n the knocking characteristics of hydrocarbons is a ood example. Here is a subject based on engine esting, many of the data of which are those resulting rom the American Petroleum Institute Research Project 45. It is a subject which will with difficulty each finality because of the friendly competition etween chemist and automobile engineer, each in urn taking the lead in providing or demanding motor uels of higher octane rating. The procedure for ngine-testing appraisement of light fuels has already een standardized between the American Society for Testing Materials and the Institute of Petroleum. The two articles on engine testing of lubricating oils re a reminder of the impetus given also to this important subject by the Co-ordinating Research Council of New York and willingly followed up and developed by British engine manufacturers and oil ompanies.

The last big section of the volume is impressive in its indication of the extent to which modern advances in infra-red spectroscopy, Raman spectroscopy and the use of the mass spectrometer are being applied in hydrocarbon studies and analysis. Imposing, too, are such articles as those of D. Tabor and F. P. Bowden on boundary lubrication, and of J. M. Robertson on X-ray examination of hydrocarbons. But modestly among these more learned contributions, yet of great importance to the subject of international standardization, is one of barely five pages by H. Hyams on volume and specific-gravity corrections for petroleum oils. The chief reference in this article is to the work carried out by the Institute of Petroleum and the American Society for Testing Materials in the preparation, and now the joint publication, of "Tables for Petroleum Measurement". This is the first, and by no means likely to be the last, instance of fully collaborative effort between the petroleum technologists of Great Britain and the United States.

The three impressive volumes which have recently been produced are not merely evidence of this spirit, but fully justify Hyams's claim that they will eliminate buying and selling differences and difficulties throughout the great areas primarily concerned, and will assist in the establishment of world-wide uniformity: this will be a great achievement in the commercial domain of the world's outstanding commodity. The book is a pleasure both to scan and to skim. The Oxford University Press continues its very high standard of production for this great work.

S. J. M. Auld

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# CHEMISTRY OF NAPHTHALENES AND STEROLS

Elsevier's Encyclopædia of Organic Chemistry
Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Volume 12*B*: Naphthalene. (*A*) Compounds containing One Naphthalene Nucleus. Oxo-Derivatives of the Naphthoic Acids; Naphthalenepolycarboxylic Acids. Pp. xliii+4561–4840+34; £10 15*s*. Vol. 14: Supplement. Nor-Steroids. Steroids: Hydrocarbons, Halogen, Nitrogen, and Unsubstituted Monohydroxyl Compounds. Edited by A. Georg, with the assistance of M. Georg-Plant. Pp. xxxix+1347*s*–1868*s*; £18.
(Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1954.)

THE first of these two books is the eighth part of a series and marks the completion of a further stage in the cataloguing of naphthalene derivatives. It is stated that the literature has been consulted up to and including 1944, and the literature concerning the structure of compounds up to the beginning of 1954. The field covered includes derivatives of the naphthoic acids containing carbonyl groups, naphthoic acids containing other carboxyl groups in a side-chain, with their homologues and derivatives (with halogen, nitrogen, hydroxy and carbonyl substituents). Naphthalenepolycarboxylic acids are also covered. In this latter group naphthalic acid is perhaps the most important. As in other parts, corresponding hydronaphthalene derivatives are also treated. Descriptions are given, for example, of formylnaphthoic and benzoylnaphthoic acids and their homologues, tetralone- and decalone-carboxylic acids, and diketo-hydronaphthoic acids. In the diterpene series, a full account is given of the chemistry of agathic acid, the reactions of which are summarized in a typically informative reaction scheme covering two pages. No system of classification is perfect, and it is perhaps a little unfortunate to find such a compound as neolithobilianic acid dealt with in this part, rather than in the volume dealing with bile acids and their derivatives. The list of periodicals occupies eighteen pages, and inevitably covers much the same ground as similar lists in other parts.

The high standard of production with which users of the "Encyclopædia" are familiar is well maintained, with excellent printing, freedom from error and beautifully set formulæ. When Vol. 12*B* is complete, it will be regarded for many years to come as the unique work of reference on naphthalene chemistry.

Vol. 14 of the "Encyclopædia", dealing with carbocyclic compounds containing more than three rings, was the first volume to be published, and it covered the literature up to 1936. It contained 711 pages, 276 pages of which were devoted to the steroid group. In the second of the two books now under review, the range of compounds dealt with in 521 pages of text and 44 pages of index corresponds to 80 pages of the original Vol. 14. This is some measure of the extent of the interest shown in the steroid group in a single decade; for the present work covers the literature up to 1946, with references to the literature concerning the structure of compounds up to 1954.

The book is concerned essentially with the sterols and related hydrocarbons, and derivatives containing halogen, nitrogen and monohydroxy substituents. It seems destined to become *par excellence* the standard work of reference on sterols. A description of cholesterol and its simple derivatives occupies some 120 pages. These include accounts of physical properties, occurrence and formation, reactions and physiology, with descriptions of the addition compounds of cholesterol, its esters and its ethers. The steroid hormones, the bile acids, and the other main groups of steroids are reserved for future parts of the supplementary volume. Brief accounts of sterols of unknown structure may be expected to stimulate further research.

There is a description of the currently used steroid nomenclature, which has been adopted in the text, and the formulæ show configurations so far as these are known. There are fifteen tables summarizing the properties of closely related sets of compounds, the index gives a complete list of naturally occurring compounds considered in the text, and there is a separate formula index. This book is particularly rich in editorial footnotes which correct errors in original papers, direct attention to uncertainties and ambiguities, and in many cases make valuable suggestions as to structures of compounds. One very minor error has been detected in the text—the name "conessine" is mis-spelt on p. 1392*s*. It is no longer true, as stated on p. 1382*s*, that 1 : 2-*cyclo*pentadienophenanthrene has not yet been prepared, and this may have some bearing on the comments on pp. 1389*s* and 1811*s* about the 3′-methyl derivative.

Reaction schemes, which are a characteristic feature of the "Encyclopædia", figure to some extent in the present work, examples being schemes showing the relationships of some of the cholestadienes (p. 1419*s*) and the oxidative degradation of the side-chain and ring *D* of cholesterol (p. 1583*s*). The biosynthesis of cholesterol is briefly discussed; but there is no mention of the use of precursors containing carbon isotopes. In spite of the excellent monographs on steroids which are available, this is a work which no one concerned with the chemistry of sterols can afford to be without.

J. W. Cook

## TEXTILE PROGRESS

### Review of Textile Progress

Vol. 4, 1952; pp. 560; 35*s*. Vol. 5, 1953; pp. 588; 35*s*.
(Manchester: Textile Institute; Bradford: Society of Dyers and Colourists, 1953 and 1954.)

TEXTILE scientists and technologists have come to look forward to this annual "Review of Textile Progress", which usually appears towards the end of the year following that to which the account relates. Vols. 4 (1952) and 5 (1953) follow the same format as previous volumes, and the size of the book, which increased up to Vol. 3, has now become stabilized. The subjects covered include the physics and chemistry of fibrous materials; fibre production; conversion of fibres into finished yarns; fabric production; colouring matters; colouring of textiles; finishing of textile fabrics; analysis, testing, grading and defects; laundering and dry cleaning; building and engineering; and industrial applications of textiles.

Some thirty authors contribute the twenty-six subsections and, resulting from the policy of the joint committee, the authorship has changed considerably so that in Vol. 5 only seven of the sub-sections have the same authors as in Vol. 3 and only three authors of Vol. 1 remain as contributors to Vol. 5. However, the high standard set by Vol. 1 has been maintained. In Vol. 4 the physics and physical testing of fibrous materials was brought under one authorship to avoid overlapping, and in Vol. 5 physical testing has been transferred to its rightful place under the general heading of analysis, testing, grading and defects. Unfortunately, some unnecessary repetition has occurred; for example, references 24, 25, 44, 45, 48 in the section on physical testing duplicate references 72, 73, 77, 76, 90 in the section on physics.

In the period under review there has been a rapid expansion in the production of synthetic fibres, and it is not surprising to find a large number of papers concerned with the difficult problem of their dyeing and with applications in which their characteristic properties can be used with advantage. It should be noted that many of the so-called new fibres being produced are basic types with new trade names. Numerous patents covering fibre-forming polymers have been filed, but fibres from them will not be produced commercially unless they have really outstanding properties. The natural fibres have not been neglected. Thus, the cotton fibre has received much attention, and the resulting modifications such as cyano-ethylated cotton, together with the growth of resin treatment and embossed finishes, promise to open up new applications. Many theoretical papers with a direct bearing on the spinning and preparation processes have appeared and will influence the design of machines to give improved quality and higher productivity per operator. The dyeing of fibres appears to be passing through a period of consolidation of the new ideas published during the past five years. In printing, interesting papers on engraving have overshadowed those on mechanical invention.

There are some three thousand references in each volume to scientific and technical publications and to British and American patents; but this does not mean that the "Reviews" are simply catalogues. The accounts are essentially readable, so that one can start anywhere and become so engrossed that the end of a section is reached all too soon. Extensive author and subject indexes enable the reader to find something he has read about and may wish to read again; they also help when using the "Reviews" as source books of information. All who have taken part in producing these volumes are to be congratulated.

## THE STORY OF THE VITAMINS

### Vitamins in Theory and Practice

By Dr. Leslie J. Harris. Fourth edition. Pp. xxii + 366. (Cambridge: At the University Press, 1955.) 35*s*. net.

AFTER three editions of this book between 1935 and 1938, we have had to wait seventeen years for the fourth edition. It can be said at once that Dr. L. J. Harris has again produced by far the most readable, indeed fascinating, account of the vitamins which has yet appeared.

In simple language and in the clearest style, Dr. Harris tells the story of how the existence of the vitamins was discovered and how each was recognized and defined. The story is enthralling; so often one has read the same facts and been left quite unmoved by a cold recitation of dates and data—perhaps because we are too much concerned about the very latest developments and forget how exciting the earlier story is. Especially we overlook the brilliant work of some of the earlier investigators and how much we can still learn from their approach and their methods. Dr. Harris evokes the same interest in the description of each vitamin—where it occurs, the effects of deficiency in animals and in man, its chemistry and mode of action. By ingenious tables and figures, of which there are more than a hundred of each, essential points are frequently summarized and clarified throughout the book, so that, in spite of its easy readability, the student using it as a text-book will find it admirably suited to his needs. The final section of the book has useful and important things to say on dietetics—the application of nutritional science to the feeding of man. Here are discussed questions of food choice and instinct, the effect of war and rationing, ideal diets and common food faults.

While there is no doubt that this is by far the best book, at a fairly elementary level, which has been produced on the subject of the vitamins, one must reluctantly say that even so it is not the ideal book. One would have liked to see a rather more ruthless pruning of some of the older material and its substitution by newer information. The book abounds in examples of how Dr. Harris, better than so many other writers, could have achieved this. While most of us still remember that the Dutch East Indies are now Indonesia, how many remember which country was once Bosnia ? Is it not now accepted that "a scaly follicular eruption" of the skin is by no means a "fairly clear symptom of vitamin A deficiency" ? Anti-vitamin K has not merely a *possible* use in medicine—it is, in fact, used extensively. It is misleading to say that riboflavin deficiency is "uncommon in most regions of the globe". It is a pity, too, that reference has not been made to the Bataan experiment, where beriberi has been almost completely eradicated by the enrichment of rice, nor to the claims—mostly unfounded, it is true—of the therapeutic uses of vitamin E. Apparatus described for measuring dark adaptation has long been recognized as unsatisfactory.

However, let it be said once again that these small criticisms still leave this book easily the best to recommend, not only for students of nutrition but also for anyone who is interested in a subject about which there is so much misinformation. It is well produced, a pleasure to handle and a joy to read. JOHN YUDKIN

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# LIBERTY IN THE MODERN WORLD

The Spirit of Liberty

Papers and Addresses of Learned Hand. Collected, and with an Introduction and Notes, by Irving Dilliard. Pp. xxx+285. (London: Hamish Hamilton, Ltd., 1954.) 21s. net.

THE papers and addresses collected in this book range for the most part over fields with which the man of science is concerned rather as citizen than as scientist. Even here, they could help to correct the immaturity and lack of education, to the dangers of which Conway Zirkle directed attention in a forceful address last December to the American Association for the Advancement of Science. The book takes its title from the brief address which Judge Learned Hand gave in May 1944, and the main interest of the book to the scientist lies in the interpretation of liberty and its significance in the world to-day, given by a cultured legal mind. In addresses on sources of tolerance, on liberty, on the contribution of an independent judiciary and on the debt of the world to Greece, and in the plea for the open mind and free discussion which he made as recently as October 1952, there is clear appreciation of the conditions of scientific advance or any other form of intellectual activity, of the responsibilities which the creative worker must recognize and penetrating analysis of what is involved in living together in an ordered society. Here are displayed no ready-made solutions but the ripe wisdom of a cultured mind, rich in inspiration, and confident of its exposure of humbug and pretence.

"Liberty," the author writes, "is an essence so volatile that it will escape any vial however corked. It rests in the hearts of men, in the belief that knowledge is hard to get, that man must break through again and again the thin crust on which he walks, that the certainties of to-day may become the superstitions of to-morrow; that we have no warrant of assurance save by everlasting readiness to test and test again." Elsewhere in the book he writes of the function of the scholar in a democratic State and the influence of his detachment in assuaging the faction which, admitting no mediation and demanding the extinction of all opposition, would convert the State into an autocracy "except in so far as the state is made up of those, to some degree practised in the habit of suspended judgment, and possessing a spirit capable of disinterested scrutiny". Nor does he incite the scholar or scientist to rash political action. "You cannot raise the standard against oppression, or leap into the breach to relieve injustice, and still keep an open mind to every disconcerting fact, or an open mind to the cold voice of doubt." The scholar must be content to be himself, confident that, if faithful in that, his light will shine, steady and far. Judge Hand believes in the spirit of moderation and toleration, that the scholar, whether scientist or other, brings his contribution by pursuing his inquiry where it leads him, by just 'monkeying around', by continually thinking out afresh the concepts of 'liberty' and 'independence' and the like in the context of to-day, and refusing to accept false values in their place, by maintaining wide horizons and a suspended judgment in the times of stress when men are most prone to reject them.

Supremely the book testifies to the truth of Judge Hand's contention that there is no substitute for an open mind enriched by reading and the arts, and that the scientific worker who would influence the thought and action of his time must have some acquaintance, the wider the better, with what others have thought and felt in circumstances as near as possible to those of the groups in question. Here is the fundamental reason why an education which includes the humanities is essential to correct the political immaturity of the scientist. "Just as in science we cannot advance except as we take over what we inherit, so in statecraft, no generation can safely start at scratch. . . . The imagination can be purged and the judgment ripened only by an awareness of the slow, hesitant, wayward course of human life, its failures, its successes, but its indomitable will to endure." The plea for the open mind and free discussion in which these words occur is much more than championship of dissent and a direct rebuke to the excesses of McCarthyism and secrecy and security procedures: it is an outstanding statement of the case for general education as the basis of a free society. R. BRIGHTMAN

## Atomphysik

Von Dr. Karl Bechert und Dr. Christian Gerthsen. Band 1: Allgemeine Grundlagen, Teil 1. Von Dr. Gerthsen. (Sammlung Göschen Band 1009.) Pp. 124. 2.40 D. marks. Band 2: Allgemeine Grundlagen, Teil 2. Von Dr. Christian Gerthsen. (Sammlung Göschen Band 1033.) Pp. 112. 2.40 D. marks. (Berlin: Walter de Gruyter and Co., 1955.)

THE "Sammlung Göschen" used, in the past, to provide the intelligent amateur, the teacher and the young student with short tracts on general or restricted fields of science, technology, history and philosophy and language, etc., attractively written, well printed and generally comprehensive. Since they were cheap, they allowed one to build up a valuable library which contained a great deal of information without the expenditure of a lot of money.

The "Sammlung Göschen" continues to be issued by Walter de Gruyter and Co. in succession to G. J. Goschen'sche Verlagshandlung. The two volumes under review, each of about a hundred and twenty pages, form Part 1 and Part 2 of a four-volume account of atomic physics. It is noteworthy that the joint authors, Karl Bechert and Christian Gerthsen, are both full professors at universities. The text sets out with great clarity the basic experimental facts upon which the large structure of present-day atomic physics is based, with little theory attached to it and not many formulæ. Both volumes are written with great lucidity, and the skill with which the different aspects are explained shows that the authors have considerable teaching practice. The figures and the reproduction of photographs are remarkably good for a volume of this small size (4 in. × 6 in.). I am sure these little booklets will contribute considerably to stimulating the interest of the younger generation in the physical sciences, and in view of their cheapness may well have some influence on the supply of young physicists.

In the past, Göschen used to offer its volumes cloth bound. It is regrettable that the present issue looks rather fragile and would, presumably, soon come to pieces.

E. Bretscher

## Copper

The Science and Technology of the Metal, Its Alloys and Compounds. Prepared under the Editorial Supervision of Allison Butts. (American Chemical Society Monograph Series—No. 122.) Pp. xii+936. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1954.) 160*s.* net.

TO anyone interested in copper the value of this book is inestimable. It seems to cover every aspect of production, technology and physical and chemical properties, as well as the diverse applications of the metal and its compounds. The foregoing simply does not do justice to the extent of the subject-matter, consisting as it does of forty-six chapters each on a separate topic. However, to mention a few less obvious topics—namely, isotopes of copper, its analytical chemistry, metallography of copper and its alloys, application in organic chemistry and agriculture, and biological considerations—perhaps will help to indicate better the tremendous scope of this book.

The fifty-three specialist contributors are mainly from American organizations, although there is some British and Canadian representation. Considerable latitude has been allowed to the writers in the presentation of their subjects, and the results are distinctly agreeable with respect to balance and style. The subject-matter is thoroughly up to date and is well illustrated. The printing and the paper are pleasing. The editor and publishers are to be congratulated on the production of a first-class reference book.

A. R. Bailey

## Michael Tswett's First Paper on Chromatography

By Gerhard Hesse and Herbert Weil. Pp. 35+2 plates. (Eschwege: M. Woelm, 1954.) n.p.

THE booklet is published in English and contains Tswett's preliminary communication entitled "On a New Category of Adsorption Phenomena and their Application to Biochemical Analysis", which was read in 1903 to the Warsaw Society of Natural Sciences. Although not as well known as his famous paper of 1906 on chromatographic adsorption analysis, it is clearly the forerunner of that paper. In the 1903 communication, Tswett systematically tested more than a hundred substances as adsorbents for leaf pigments and described how stepwise removal of the components from solution could be achieved by adding small quantities at a time of certain adsorbents. He also described separations of pigments on simple column-chromatograms and was able by similar means to separate the colourless substance, lecithin, from impurities, by elution through an inulin column. One is struck by the elegance of Tswett's work and how, from a few simple observations and understanding of the principles involved, he devised a technique which was destined to have such a profound influence. Following the paper, there is a section consisting of editorial notes on the paper and finally a biographical section which includes some interesting, recently discovered details of Tswett's life.

R. Consden

## A Handbook of the Palace of Minos at Knossos, with its Dependencies

By J. D. S. Pendlebury. Pp. 76+14 plates. (London: Max Parrish and Co., Ltd., 1954.) 12*s.* 6*d.* net.

JOHN PENDLEBURY was one of the more brilliant younger Ægean archæologists between the two World Wars. He was the curator at Knossos during 1929–34. In 1939 he published a major work, "The Archæology of Crete", which is a model for a book of its kind. He also did a considerable amount of work in Egypt at Tell El-Amarna. In Crete in 1941 he was wounded, captured and then shot by the Germans.

The ruins at Knossos are very extensive and complicated; they are also frequently visited both by serious students of Near Eastern archæology and by tourists. Many years ago Pendlebury set himself the task of producing a guide to the ruins which would at the same time be scientific, intelligible and readable. This handbook has long been out of print and has now been re-issued in a new edition with an introduction by the late Sir John Myres and Sir John Forsdyke. Very little previous knowledge is assumed, and the reader at once realizes the sequence of happenings at Knossos during the nine periods into which the story of prehistoric Crete is divided. There follows an itinerary through the buildings, both of the main palace and of the dependencies outside. There are a number of excellent illustrations.

The new handbook, like its forerunner, meets a real need and will be welcomed by serious students and intelligent tourists alike.

M. C. B.

# UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

## NEW SCIENCE BUILDINGS

By Prof. P. W. RICHARDS

THE new building for the Botany and Forestry Departments and the extensions to the Departments of Chemistry, Physics and Zoology of the University College of North Wales, Bangor, were opened on May 20 by Sir Keith Murray, chairman of the University Grants Committee. At the ceremony in the Powis Hall before the formal opening, many representatives of universities and other guests were present, including several representatives of the French Forest Service, which has on a number of occasions hospitably entertained forestry students from Bangor during their annual tour of French forests. One of these representatives, Prof. P. Silvy-Leligois, of Nancy, brought with him a message of good wishes from the École Nationale des Eaux et Forêts.

From the foundation of the University College of North Wales until 1926 the scientific departments were housed near the harbour. The old building, which is now demolished, was opened by Lord Kelvin (then Sir William Thomson) in 1885. The original intention had been to build more spacious accommodation by extending the College's main building in Upper Bangor (finished in 1910); but after the First World War it was decided that a major part of the North Wales Heroes Memorial Fund should be used for providing new science buildings on a site in Deiniol Road. These buildings were completed in 1926 and opened by Sir J. J. Thomson.

Until the Second World War, the number of students in the College did not exceed five hundred, less than half of whom were studying scientific subjects, and the Memorial Buildings, as they were called, proved adequate for their purpose. After the War, the size of the College more than doubled, and it became evident that the number of undergraduate scientists, let alone staff and research workers, was likely to remain permanently far larger than the Memorial Buildings could accommodate. It was thus the need for larger teaching laboratories, as well as for better research facilities, which led the College, with the generous support of the University Grants Committee, to embark on an ambitious building programme, involving the complete rehousing of the Botany and Forestry Departments and increased accommodation for the other science departments. As an essential first step, the College bought in 1947 the Tanrallt site adjoining the Memorial Buildings. It is here that the physics extension and the largest of the new buildings, that for botany and forestry, have been built.

All the new science buildings at Bangor have been designed by Sir Percy Thomas and Son, of Cardiff, and they have been built mainly by Messrs. W. T. Nicholls of Gloucester.

The first of the new buildings to be finished was the new chemistry building, which has been in use since 1950. It extends but does not replace the older building (the Orton Laboratories) and is on a closely adjacent site. In honour of Sir James Dobbie (1884–1903), the first professor of chemistry at the College, it has been named the Dobbie Laboratories. Owing to limitations of space, it has had to be built on a steeply sloping and confined site; to fit into this, it has been built in a single story in part over a semi-basement. It provides two teaching laboratories (with overhead services of gas and water) for eighty and sixty-four undergraduate students respectively, as well as a research laboratory for twelve postgraduate students, a departmental library and reading room, together with auxiliary rooms, including a general operations laboratory, an instrument room, a cold room, a room for chromatography, balance rooms and stores. There is also a lecture room seating 220, the largest in the science departments of the College.

The Department of Zoology, like the other science departments, had long outgrown its accommodation. The old Biology Block, previously shared by the Botany and Zoology Departments, has been adapted and completely refitted to provide for the teaching needs of the Department of Zoology and now includes two lecture rooms, a large laboratory for sixty students and another for thirty students, in addition to laboratories for honours degree work, rooms for staff, a workshop, photographic and instrument rooms, service rooms and three small research rooms. It continues to house the extensive museum collections in the fine room originally built for them. This block, however, could not provide enough room for the research work of the Department; consequently, a three-story building with 5,870 sq. ft. of floor space has been built on an adjoining site. On the ground floor the chief feature is two constant-temperature rooms to work from 0° to 40° C. The first floor contains a suite of laboratories, including an autoclave room and experimental theatre, a radioactive isotope room and research laboratories for the Agricultural Research Council Unit of Embryology which is housed in the Department. The second floor includes, in addition to research rooms of various sizes, an instrument room and a cool room fitted for the maintenance of cultures of marine or freshwater aquatic animals. The whole new building can accommodate fifteen research workers.

Accessible to, but separate from, this building, an animal house for small animals had been built with a floor space of 3,000 sq. ft. This is of light construction and is specially designed to exclude rodents and insect pests so far as possible. The details of its design have been published elsewhere*.

The Physics Department has been responsible, in recent years, for teaching some 150 undergraduate students and, like the Chemistry and Zoology Departments, it now uses for its teaching and research a newly constructed block together with a part of the old Memorial Buildings. The former is incomplete and allows for expansion to at least double its present size. It is of red brick, rectangular in plan, with two floors and a flat roof. The upper floor provides teaching laboratories for at least seventy students and includes, in addition to a large general laboratory, a room for experiments in optics

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* Hemmings, W. A., "The Design of Animal Houses". Collected Papers of the Laboratory Animals Bureau, 2 (1954).

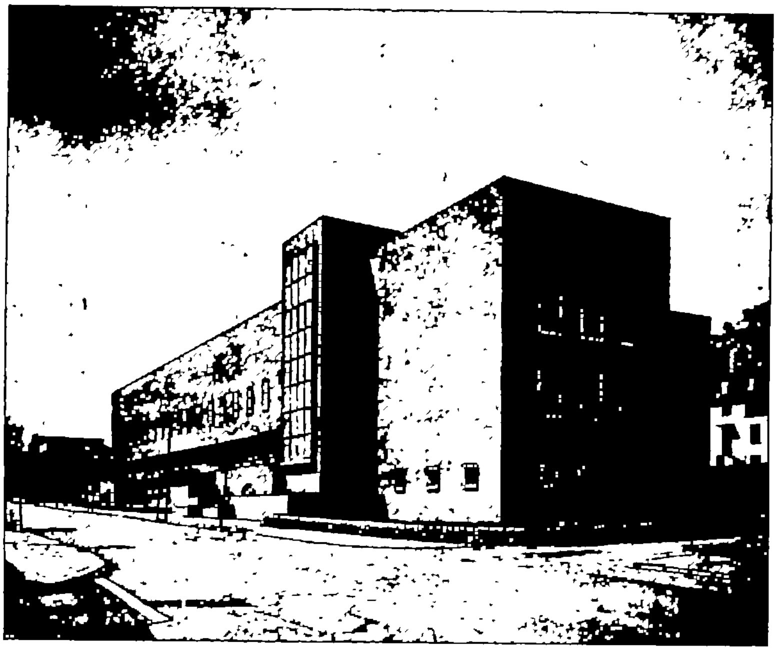

Fig. 1. Botany–Forestry Building, Bangor

and two others for acoustics. More accommodation for research is provided on the ground floor, which is now used for work on nuclear magnetic resonance. Also on the ground floor are the pleasant departmental library and the staff common room.

The botany–forestry building is the largest, as well as the most ambitious in design, of the new buildings at Bangor (Figs. 1 and 2). Since the main frontage of the building stands only a few feet back from the main London–Holyhead road, a dominant consideration in its design was to exclude street noise. Because of this, on the south side of the building facing the road there are few windows and none of large size, except that lighting the main staircase; for the same reason, a large part of this side is occupied by corridors and hall spaces. At first sight, the distribution of windows might give the impression that the interior is poorly lit; but in fact all parts of the building have excellent lighting, particularly the top floor, which houses all the teaching laboratories of the Botany Department; this has a generous provision of roof lights as well as large windows on the north, east and west. The lecture rooms situated in the north-east corner of the building have no windows at all on the wall facing the main road, but are adequately lit as well as almost completely insulated from outside noise. The architect has thus successfully solved the problem of providing at the same time good natural illumination and freedom from noise on a not very easy site.

This is a red brick building on three floors. It has also a semi-basement which allows advantage to be taken of the differing levels of the front and back of the site. In addition, the flat roof is to be provided with two greenhouses, serving as additional laboratories for the physiological work of the Botany Department. Other greenhouses for departmental use are on an adjoining site. About a third of the floor space is allotted to the Forestry Department, the remainder to the Botany Department, which is responsible for training some 150 students, the majority eventually graduating in forestry, agriculture, or one of the pure sciences.

The most striking decorative feature of the building is the large entrance hall panelled with a great variety of ornamental hardwoods.

The Forestry Department, besides rooms for staff and two lecture rooms, has a laboratory for about twenty students, equipped for surveying and engineering drawing as well as for practical classes in forest botany and wood anatomy. There are a large library and reading room and a museum of corresponding dimensions which it is proposed to fill with a variety of exhibits, including dioramas illustrating forests under various systems of management. In addition, the semi-basement contains photographic dark-rooms, a large and well-equipped wood-working shop and a store for the tools, surveying instruments, etc., used by the forestry students in their practical training.

The Botany Department has on the ground floor a lecture room seating 120, a small museum, a

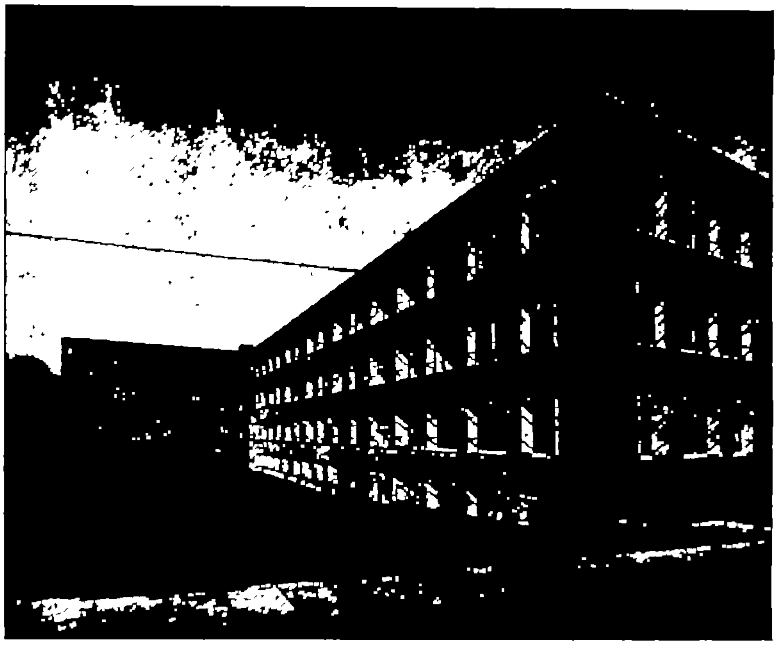

Fig. 2. Botany–Forestry Building, Bangor

herbarium and a research laboratory specially equipped for work on marine and freshwater algae as well as rooms for staff and postgraduate research workers. Further accommodation for staff and post-graduate students is provided on the first floor, which also houses a small lecture room (seating seventy), the library and separate reading room.

On the top floor, which is wholly allotted to botany, there are two large teaching laboratories for general botany, providing places for sixty-two and forty-eight students, respectively. Since these laboratories are placed back to back and divided only by swing doors, they can when occasion demands be treated as a single unit. In these and in the small honours work laboratory (capacity sixteen students) there is ample space for demonstrations and (as in the forestry laboratory) each student is provided with an adjustable 'Anglepoise' lamp and a microscope lamp made to the Department's specification. Only a limited amount of overhead lighting is provided. The small laboratory for advanced mycology is similarly designed.

Also on the top floor are the laboratories for plant physiology. The teaching laboratory, holding sixty students, resembles a well-equipped chemical laboratory. The benches are provided with electrically heated water baths, but not gas, and there are vacuum and compressed air points. There is overhead fluorescent lighting and an adjacent balance room. Near by is a small research laboratory and preparation room.

The semi-basement, in addition to housing the Forestry Department's wood-working shop and instruments store previously mentioned, provides the Botany Department with two photographic dark-rooms, a general photographic room, a workshop and sorting room and two constant-temperature rooms.

In his introductory speech at the opening ceremony. Lord Kenyon, president of the College, said that the completion of the new science buildings was an event second in importance only to the opening of the College itself. He expressed the thanks of the College to the University Grants Committee for the financial support which had made the post-war building programme possible.

Sir Keith Murray then spoke of the significance of the occasion as marking the increasing importance of science, and especially of biology, to-day. That the College had found it necessary to increase the accommodation for all its science departments and not only for some of them illustrated the breakdown of the lines of demarcation between the different sciences and the need for training in the fundamental sciences as the basis of all scientific education.

After emphasizing the growing importance of the biological sciences because of the rise in world population and the consequent pressure on food supply and other natural resources, Sir Keith went on to say that the duty of a university is to turn out men and women with minds which are trained and not merely stored with facts; this training should be carried out not merely by formal instruction in the lecture room and laboratory, but by informal contacts between the students and the more mature minds of their teachers, as well as by the contacts of student with student in daily work and extra-curricular activities. The latter are as valuable a part of a university education as the work covered by the examination syllabus.

Sir Keith Murray was thanked by Sir Emrys Evans, principal of the College, and finally the College's gratitude to the architect and the contractors was expressed by Sir Wynn Wheldon and Lady Artemus-Jones, vice-presidents.

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# PLANT GROWTH SUBSTANCES

## THIRD INTERNATIONAL CONFERENCE

THE Third International Conference on Plant Growth Substances was held at Wye College (University of London) during July 17–22. The organizer was Prof. R. L. Wain, head of the Department of Chemistry in the College and director of the Agricultural Research Council Unit for Plant Growth Substances and Systemic Fungicides. D. F. Wightman acted as conference secretary.

The emphasis of the papers and discussions was on the biochemical aspects of the subject but not confined, as in the preceding conference at Lund in 1953, to considerations of the relationships between chemical structure and biological activity. Although two whole sessions were devoted to this topic, the remaining four on the natural auxins, auxin metabolism and mechanism of action promoted the more vigorous discussions.

The two years that have elapsed since the Lund Conference have seen the almost universal adoption of paper partition chromatography as a tool in the study of naturally occurring plant growth substances. The opening session of the Conference clearly demonstrated how valuable this new tool has been in tackling the involved problems of the nature of the natural auxins. Dr. J. P. Nitsch (Harvard University), in a systematic study of extraction, separation and assay methods, has revealed the dangers of using ether as a solvent for extractions in the cold since enzyme activity may still persist in this solvent. Absolute methanol or ethanol are much to be preferred. He also demonstrated how different solvents could change the pattern of active substances extracted, thus illustrating the dangers of too narrow an application of stereotyped techniques. Another, until recently unsuspected, danger was the use of ammonia as a component of the chromatographic solvent for the separation of acid growth substances. Considerable hydrolysis of certain substances may occur during the running of the chromatogram. This presumably accounts for the interconversions of neutral auxin precursors extracted from a variety of plant tissues by Dr. J. A. Bentley and Mr. S. Housley (University of Manchester). Dr. Nitsch also introduced a new assay technique, using segments from the first internode of oat seedlings. This he claims has a sensitivity greater than that of the oat coleoptile curvature test and can measure quantities of indole-3-acetic acid of the order of 0·001 μgm. This makes it possible to study small quantities of tissue such as apical meristems, 200 mgm. of which is sufficient to allow an accurate assay. In a number of papers and in the discussions which followed, the reliability of the usual colorimetric tests for indole compounds came under review. Both Dr. Nitsch and Dr. A. J. Vlitos (New York) have perfected reliable quantitative methods for measuring colour intensity of spots on paper chromatograms, allowing accurate estimations of indole compounds when present in relatively high concentrations.

Chromatographic techniques in the hands of Prof. Hans Soding and Dr. Edith Raadts (Hamburg) have been turned to the solution of the old enigma of the nature of auxin in the oat coleoptile. Indole-3-acetic acid was found in quantity in the diffusates from apex and base of that organ together with an unidentified growth-promoting substance. Two growth inhibitors and a precursor of indole-3-acetic acid were also isolated. Similar techniques have been employed at Wye College to study changes in growth substance content of the various organs of germinating seedlings (Miss P. M. Cartwright, Mr. J. T. Sykes and Prof. R. L. Wain). The results point to the conclusion that indole-3-acetic acid has no part to play in the germination processes themselves but is important in the growth of the young shoot. One interesting point was the detection of indole-3-carboxylic acid in these seedling extracts, a compound which might be derived from indole-3-acetonitrile by α-oxidation, as shown in the contribution of Mr. R. C. Seeley and his collaborators (Wye College).

Exciting discoveries of new growth substances from the endosperms of seeds were announced by Prof. F. C. Steward (Cornell University). Using a new technique of plant tissue culture, permitting the study of free-floating cells, the separate effects of natural growth substances on cell division, cell expansion and cell differentiation could be followed. Four nitrogenous substances, highly active in stimulating cell divisions, have been isolated from coconut milk by heavy-metal precipitations. One of these substances has been identified unequivocally as 1-3-diphenyl-urea. Its action has been confirmed on carrot, artichoke and potato tissue. Nitrogen-free substances with a similar action have been extracted from immature *Aesculus* fruits and from coconut milk. These substances belong to the general class of leucoanthocyanins, although their final identity is not yet known. It seems, therefore, that the power of stimulating the cell to divide is not the sole prerogative of any single molecule.

The sessions on the relationships between chemical structure and biological activity in the auxins received the greatest share of the formal papers. Prof. H. Veldstra (University of Leyden), in a review of recent advances, directed attention to a range of new substituted benzoic acids the structure-activity relationships of which point strongly to a physicochemical action of the molecule acting via its stereochemical relationships rather than to a purely chemical combination with a receptor at specific reactive points in the molecule. This was to some extent emphasized by the results of Dr. L. C. Luckwill and D. Woodcock (Long Ashton, Bristol), who pointed out that the effects of chlorine substitution in the 2-naphthoxyacetic acids would, on a chemical combination hypothesis, require the unlikely postulate of a specific combination of receptor with five separate points in the auxin molecule. Prof. Veldstra pointed to another interesting development, namely, the discovery that the carboxymethyl-N : N-dialkyldithiocarbamates are active as auxins. This is the first case of an active compound not possessing an unsaturated ring and adds considerable support to Veldstra's physico-chemical hypothesis of auxin activity. Previous work had strongly suggested that in the optically active propionic acid series of synthetic auxins (+) forms were almost always active, whereas the corresponding (−) forms were inactive or auxin antagonists. The work of Dr. J. M. F. Leaper (Ambler, Pennsylvania) and Dr. B. Åberg (University of Uppsala) with the naphthalene derivatives showed this to be an over-simplification, since both forms can be auxins, their relative activities depending on the test plant employed. Prof. R. L. Wain and colleagues (Wye College) described extensive experiments in the structure-activity relationships of homologous series of ω-(2,4-dichlorophenoxy)-alkane carboxylic acids, amides and nitriles. It was shown that the alternation of activity with increasing side-chain length in both acids and amides could be correlated with the appearance of 2,4-dichlorophenoxyacetic acid in the tissue, presumably produced by the β-oxidation of the side-chain. With the nitriles, all homologues showed activity, suggesting the hydrolysis of both —CN and —CH$_2$CN groups to —COOH. A similar alternation of activity in the tomato ovary test was shown by Dr. L. C. Luckwill and D. Woodcock (Long Ashton, Bristol) for the 2-naphthyloxy- series of acids, but here β-oxidation was blocked completely by chlorine substitution in the 3 position in the ring, only the acetic acid being active.

The controversial questions concerning the structure–activity relationships of 'anti-auxins' in root growth were discussed by Dr. B. Åberg (University of Uppsala) and Prof. Hans Burström (University of Lund). Dr. Åberg demonstrated that much of the conflicting evidence from previous work may have been due to the use of different test materials, since wheat roots are much more sensitive and more easily stimulated by anti-auxins than flax roots. In the phenoxy-*iso*-butyric acids and some other similar anti-auxins which stimulate root growth, para-substitution in the ring was shown greatly to increase activity. The dangers of using gross elongation of roots as a measure of activity in these compounds was pointed out by Prof. Burström from a study of the interactions of β-naphthoxyacetic acid (inhibiting auxin), three of its chloro-substituted derivatives, indole-3-acetic acid and α-(3-indole)-*iso*-butyric acid (anti-auxin). There seems to be two phases in root cell elongation on which different compounds may have different actions, may also show different mutual interaction patterns or may not interact at all. The great importance, therefore, of paying due attention to the heterogeneity of the cell elongation mechanism in structure–activity studies was heavily stressed. Out of these considerations active discussion turned on the role of indole-3-acetic acid in normal root growth. No measure of agreement was reached.

Much attention was paid to theoretical considerations underlying structure–activity relationships. Dr. J. van Overbeek (Modesto, California), in a consideration of the properties of a group of suspected auxin antagonists, the maleimides, and a new class of plant growth inhibitors, the phosphenoxides, showed that a close relationship exists between activity and lipoid solubility and suggested, therefore, that ease of penetration through protoplasmic membranes might explain structure–activity relationships. Drs. H. Linser and K. Kaindl (Linz) discussed the relationships of molecular shape and size to stimulatory and inhibitory activity in oat coleoptile growth. An extensive mathematical treatment of the curves relating applied concentration to growth response to single substances and mixtures, based on the concept of molecules competing for various receptor 'holes' at growth centres in the cell, was subjected to some criticism by the physiologists. It was felt that such a simple concept ignored both the fundamental differences in action which must exist between auxins and toxic inhibitors such as eosin and also the possibility of metabolic interactions. This view was supported by the finding of Prof. L. J. Audus and Miss R. Thresh (Bedford College, London) that the auxin antagonist 2,3,5-tri-iodobenzoic acid may exert its physiological actions by lowering dramatically the level of endogenous indole-3-acetic acid in plant tissues. The application of the methods of enzyme kinetics to the study of auxin–anti-auxin interactions, as developed by Prof. J. Bonner (California Institute of Technology), came under full discussion. It was agreed that the technique had its uses, provided it was applied with the greatest circumspection.

Some four or so papers were concerned with the metabolism of indole-3-acetic acid and related compounds in the plant. In a critical review of the biogenesis of this compound, Dr. S. A. Gordon (Lemont) considered new data bearing on the pathways of its production from tryptophan. The current view is that it may be degraded to indole-3-acetaldehyde via either tryptamine or indole-3-pyruvic acid and thence via the aldehyde to indole-3-acetic acid. Alternatively the pathway suggested is a branching at the iminopropionic acid to yield the acetonitrile, which is then hydrolysed to indole-3-acetic acid via the acetamide. However, various considerations were discussed which indicate that the above specific pathways, though potentially operative in plants, do not normally function in indole-3-acetic acid formation. The hypothesis was presented that tryptophan goes to indole-3-acetic acid via a sequence analogous to the pyruvate dehydrogenase mechanism, that is, indole-3-pyruvic acid to indole-3-acetic acid through the acyl lipoate directly or through the coenzyme A ester. The differing abilities of various plant species to hydrolyse indole-3-acetamide and indole-3-acetonitrile to indole-3-acetic acid were clearly demonstrated by Mr. R. C. Seely and collaborators at Wye College. Thus the amide is extensively converted to the acid by pea, tomato and maize tissue but not by wheat and celery, whereas the nitrile is converted by wheat and maize but not by the other tissues. The fate of indole-3-acetic acid fed in high concentrations to tissues was discussed by Dr. A. W. Galston (California Institute of Technology), who showed that a fraction may be actively bound to cytoplasmic proteins. The greater portion, however, is oxidized by the action of a peroxidase system induced by the high indole-3-acetic acid concentrations applied. Both the peroxidase and the peroxide-producing moieties of the total system are so induced. It was suggested that this phenomenon accounts for the normal cessation of cell elongation and the subsequent onset of lignification by the oxidation of lignin precursors of the eugenol type by this induced peroxidase system.

Little attention was given to the role of indole-3-acetic acid in physiological processes in plants. Prof. P. Larsen (University of Bergen) presented data on geotropic responses of roots pointing to the validity of the classical Went–Cholodny theory. The role of auxin in the flowering of short-day plants was discussed by Dr. A. J. Vlitos (Boyce Thompson Institute, New York). Contrary to current theories, indole-3-acetic acid levels in short-day photoinduced plants of Biloxi soy bean and Maryland Mammoth tobacco are much higher than in non-induced plants.

The final session of the conference was devoted to papers and discussion on the mechanism of auxin action. Prof. J. Bonner (California Institute of Technology), in an extensive investigation into the osmotic relations of growing oat coleoptile segments, returned to the conclusions put forward a quarter of a century earlier by Heyn, that the ultimate action of auxin must be in the cell wall. In an elegant series of experiments in which segments were treated with indole-3-acetic acid and then prevented from growing by osmotic means, he demonstrated a persistent effect on wall properties independent of any effect arising as a result of growth. Water permeability was dismissed as a possible factor, from studies with deuterium-labelled water. The results of extensive studies on auxins and absorptive processes were presented by Prof. G. E. Blackman (University of Oxford). The actions of 2,4-dichlorophenoxyacetic acid on growth and absorption of nitrogen, phosphorus and potassium are not obviously related. *Lemna minor* and *Salvinia natans* differ considerably in their responses. Radioactively labelled 2,4-dichlorophenoxyacetic acid is rapidly taken up by these plants, but after four hours a loss from the tissues is observed. The temperature sensitivity of this loss suggests that it is not an exchange action but an active export of the auxin molecule. Pretreatment of plants with very dilute solutions of the acid considerably reduces subsequent uptake, giving a possible explanation of the reduced sensitivity of such pre-treated plants to toxic levels of 2,4-dichlorophenoxyacetic acid treatment. The role of coenzyme A in growth processes mediated by auxin was discussed by Dr. A. C. Leopold (Purdue University, United States). Most striking was the effectiveness of supposed anti-auxins, for example, 2,3,5-tri-iodobenzoic acid, 2,4-dichloranisole and coumarin, in blocking the effective —SH groups in the coenzyme. The inadequacies of a previous theory of growth substances action based on coenzyme A esterification were discussed in the light of new findings. Prof. T. A. Bennet-Clark (King's College, London) presented a new theory to explain auxin action on cell wall extensibility. Evidence was presented that this extensibility might be closely bound up with the state of pectic substances in the growing cell wall and the nature and intensity of the cross-linking forces between the molecules. Further evidence suggested that methylation of these pectic substances and also their relationships with calcium ions might play a part in wall changes and that choline and choline-esterase might be involved. The marked inhibiting action of indole-3-acetic acid on choline esterase activity adds support to these views. Other views on possible mechanisms were expressed during the conference. Prof. H. Veldstra directed particular attention to nucleic acid metabolism, an aspect so far neglected in auxin studies. Prof. F. C. Steward made a similar plea for nitrogen metabolism.

The papers given at the conference are to be published in a special volume which, it is hoped, will appear well before the end of the year.

L. J. AUDUS

# RELATION OF GENETICS TO POPULATION STUDIES

A WELL-ATTENDED joint session of Sections D, I and J (Zoology, Physiology and Psychology) of the British Association took place in Bristol on September 2, the general topic being "Genetics and Medicine".

In the opening paper, Dr. H. Grüneberg (University College, London) discussed the use of "Inherited Diseases in Animals as a Tool in Medical Research". The laboratory rodents have provided a large number of inherited conditions, including many with close counterparts in man. Many of these are caused by single genes; but equally important are inherited diseases conditioned by an array of genes which occur in a high frequency in some inbred strains, but are rare or absent in others. The use of this material opens up certain important fields of research which are inaccessible in man himself. The majority of inherited diseases and anomalies due to single genes arise in early development, and as early human embryos with the initial phases of such anomalies are scarcely ever available for study, a step-by-step investigation of abnormal development is entirely dependent on animal material.

Direct observation shows that the mechanisms underlying abnormal development are often quite different from those of classical pathology. For example, a reduction of the vertebral bodies with absence of the odontoid process of the axis in a mouse mutant is due to an early degeneration of the notochord. Widespread skeletal anomalies associated with the gene for congenital hydrocephalus in the same animal are due to general reduction in size of the mesenchymal skeleton as it is formed, and threshold mechanisms determine the absence of some elements, fusions between others, etc. In a third instance, anomalies of the vertebral column, again in the mouse, are traceable to a faulty distribution of mesenchymal material, too much being used for the intervertebral disks and too little for the vertebræ themselves.

The pathology of development is thus a new field entirely dependent on animal material. The discovery of several inherited types of deafness in the mouse is likely to assist in the understanding of the pathology of human deafness, which is greatly hampered by technical difficulties not encountered in animal material. Important progress has been made by the use of resistant and susceptible strains of animals in analysing the physiological basis for disease resistance. The use of animal material for studying diseases of old age, so familiar in cancer research, was illustrated by amyloid degeneration and cystic kidney disease in a certain strain of mice and its absence in others; what could scarcely have been discovered in man is the fact that this inherited tendency to amyloidosis can be almost completely suppressed on certain low-protein diets.

In a paper on the "Causation in Mental Deficiencies", Dr. J. A. Fraser Roberts (London School of Hygiene and Tropical Medicine) pointed out that gene differences in certain rare types of mental deficiency have provided important general information; for example, the first estimate of an autosomal mutation-rate in vertebrates was made with tuberose sclerosis (epiloia). There is evidence that some modest proportion of severe mental deficiency, in addition to a few rare special types, is determined by recessive genes. The great bulk of mental deficiency, however, is a heterogeneous collection the causation of which presents difficult problems. The most useful division of the mental deficiencies is into two groups which may be ascribed to major errors of development, whether genetic or non-genetic. Mild defect shows the signs of some measure of multifactorial determination, together with multiple environmental influences. In spite of the difficulties of measurement, the evidence seems to point to little real underlying overlapping. The incidence of severe defect among the brothers and sisters of those mildly affected is little if at all greater than in the general population. Conversely, apart from the sibs also severely affected, the intelligence of the sibs of those severely affected is little lower on the average than in the general population. Much, or possibly all, the apparent lowering is an artefact due to the methods of sampling. A substantial part of the resemblance between relatives in level of intelligence (including mild mental deficiency) is probably environmental.

Penrose's studies and Dr. Fraser Roberts's own yield a correlation between first cousins which is double what it should be, given the correlation between sibs. It seems reasonable to conclude that while the genes in common are reduced to one-quarter in cousins as against sibs, environmental similarities fall off much more slowly as relationship becomes more remote. It is possible that some major non-genetic causes affecting intelligence adversely may be identified. For example, there is the definite lowering in twins, as found in the Scottish survey. There is also the evidence that prematurity is much commoner among high-grade and borderline defectives than in the general population.

Dr. E. T. O. Slater (Genetic Unit, Institute of Psychiatry, University of London) gave a brief general report on "Work on Twins in Psychological Medicine", in which he reviewed particularly twin studies on the causes of schizophrenia and of criminality; in the latter, earlier studies had suggested a predominant influence of heredity; but in more recent work, factors like early background and family tradition, special opportunities and temptations have now emerged as significant causes. In Dr. Slater's own work (jointly with Mr. James Shields) on the causes of 'neurosis', the comparison between monozygotic and dizygotic twin pairs has produced evidence that the tendency to neurosis is, at least in part, under genetic control.

The main emphasis of the work was, however, on the environmental causes of the breakdown. These were studied through the differences which were found between the partners of monozygotic twin pairs, the differences being caused by the inter-twin relationship (one twin tending to take on more of the leadership, etc.), the relationship with parents, the marital relationship, by differences in occupational stress and of physical health, and finally by differences in psychological stress other than those covered above. In nearly all cases, causes are multiple, though very often a single factor can be picked out as the most important. Generally, Dr. Slater considers that the causes of neurotic illness are intelligible at a common-sense level and do not seem to require recondite hypotheses. Among causes operating from early in child life, those which persist for years (for example, the type of training) seem to be the most important.

Prof. L. S. Penrose (Galton Laboratory, University College, London) demonstrated in his paper on "Mutation and Parental Age" that human material may in certain cases yield results superior to those usually obtained from experimental animals. The spontaneous mutation-rates of a number of ('dominant') human genes have been estimated by direct observation of freshly arising cases, that is, of abnormal children born of normal parents. In other cases, an indirect method has been used which is based on the supposition that elimination by selection of a gene with deleterious effects must be balanced by newly arising mutations, the overall frequency of the condition remaining approximately constant.

Additional information about possible causes of mutations has now been obtained from a consideration of parental age. For example, if a certain gene is particularly sensitive to ionizing radiation to which parents are exposed throughout their lives, mutations at that locus will be proportional to parental age such that the trait will be twice as common among offspring of parents aged forty as among those with parents aged twenty years. Looked at in another way, the parents of children carrying newly mutated genes will be older than the average parent. Some evidence (unfortunately from maternal ages only) of an increase of mutation-rate with age comes from microphthalmia, and there is less complete evidence of an effect of both paternal and maternal age in the case of epiloia and retinoblastoma. The incidence of achondroplasia (born of normal parents and hence presumably due to a new mutation) depends strikingly on the age of the father, but there seems to be little or no effect of the age of the mother; in the latter case, a possible interpretation is that, while the epiloia locus is sensitive to natural radiation, the achondroplasia locus is sensitive to agencies specially active at some stage in cell division, perhaps chemical mutagens. The relative absence of cell division in the female germ track, as compared with the male germ track, would explain the lack of independent maternal effects. The dependence or otherwise of mutation-rate on parental age thus affords some information on possible causes of 'spontaneous' mutations not so far obtainable from data on spontaneous mutations in animals.

The concluding paper, by Dr. C. O. Carter (secretary, Eugenics Society), dealt with "Genetics and Child Health". In recent years, deaths from diseases of childhood due to environmental causes (mainly infections) have declined sharply. As a result, the groups of diseases mainly or partly due to genetical causes loom much larger. An indication of the changes in relative importance is given by the cause of death in two hundred consecutive children undergoing post-mortem investigation in a children's hospital in each of the years 1914 and 1954. The group of diseases caused by environment was more than two-thirds of the whole in 1914, but less than one-seventh in 1954; the group of diseases mainly genetical in origin was only one-fiftieth of the whole in 1914 but one-eighth in 1954; diseases of mixed causation were less than one-seventh of the whole in 1914, but more than a quarter in 1954, while diseases of unknown causation rose from less than a quarter in 1914 to nearly a half in 1954.

Looking to the future, Dr. Carter believes that, while the environmentally caused group of diseases will continue to fall, the diseases of mixed origin will probably be only slightly reduced by environmental measures. Reduction in the proportion of children born with genes predisposing to these disorders can only be achieved by reducing the average number of generations through which disadvantageous gene mutations can persist in the population. At the moment, such mutations are tending to last longer as new methods of treatment keep those affected alive to an age at which they can bear children. Probably the most ethically correct way of bringing about a reduction in the average number of generations a mutation persists is to enlist the co-operation of parents who are unlucky enough to carry major disadvantageous mutations, in planning to keep the number of their children below replacement-rate.

# OBITUARIES

## Prof. J. C. Flugel

Prof. John Carl Flugel died suddenly at his home in London on August 6. He was one of the few survivors of the small band of British psychologists who received their training at Oxford under William McDougall. McDougall's views on the nature of mind and the way psychological questions should be approached influenced nearly all that Flugel wrote; yet he himself succeeded in developing a wholly original attitude.

His earliest researches were carried out in the laboratory at Oxford, and dealt with such practical problems as intelligence testing, visual adaptation at night, the measurement of mental fatigue and the causes of the oscillations of attention. After his appointment as lecturer at University College, London, he remained for many years in charge of the experimental work in the Department of Psychology. His chief interest, however, lay in the deeper problems such as in those days were relegated to the somewhat dubious regions of psychoanalytic study and psychical research. He was the first professional psychologist to make a serious examination of Freud's early theories. These he endeavoured to re-interpret in terms of current British psychology. Thus, while the medical profession still looked askance at the novel and extravagant doctrines of the Freudian School, he did much to popularize their chief conclusions by recasting them in a more acceptable form. The outcome was a series of papers on psycho-analytical topics which appeared in various scientific journals, and were later collected and re-issued in book form.

Of his larger works, the first was "The Psycho-analytic Study of the Family" (1921), which attracted immediate attention. The most popular was probably his "Psychology of Clothes" (1930). "A Hundred Years of Psychology" (1933) presents an admirable historical review of the development of psychology from 1833 to the date of publication, and is still read as a regular text-book. The lucid style, the flashes of humour, the widespread sympathy and tolerance which distinguish all his writings were also a marked feature of his personal teaching, and endeared him to numerous students who came to his classes from all over the world.

In 1929 Flugel was made assistant professor, and retained this post until his retirement in 1944. A good deal of his time was spent in practical psycho-analytical work with patients and normal persons; and the results led to many valuable contributions to psychological and psychiatric theory. The more important were embodied in his books on "Men and their Motives" (1934) and "Man, Morals, and Society" (1945). He served for some time as honorary secretary of the International Psychoanalytic Association; and in 1948 was elected chairman of the programme committee of the International Congress on Mental Health. Two years later he was appointed president of Section J (Psychology) of the British Association.

To the end of his life Flugel continued to give regular lectures at University College and to take an active part in the work of the British Psychological Society and its numerous committees. But his abiding work lies in his fruitful attempts to synthesize Freudian psychoanalysis with the orthodox tenets of British psychology as taught by Ward, Stout and McDougall.

Cyril Burt

## Mr. Philip Lyle

Philip Lyle, who died on July 15, was the elder son of the late John Lyle, of Weybridge, and grandson of Abram Lyle, the founder of the sugar-refining company which was later amalgamated with Henry Tate and Sons to form Tate and Lyle, Ltd. He was born on November 26, 1885, and was educated at Rugby, in Switzerland and at University College, London. He later applied himself to statistical mathematics, which he put to very good use in the sugar industry.

As a director of Tate and Lyle, first at Plaistow refinery, Philip Lyle participated in raising the low thermal efficiency, poor scientific control and low output of the refinery until it held one of the foremost positions in the world. He paid special attention to losses incurred in sugar refining and consequently to methods of sugar analysis. In 1947 he was responsible for broadening the Company's outlook towards research and enlarging its research activities. As chairman of the Research and Development Committee he was invaluable in guidance and judgment.

Mr. Lyle's own scientific contributions were best known in refinery circles; but a few exceptions include "Heat of Solution of Sucrose", which explained discrepancies in heat balances in refineries. The "Sugar Industry" and "Constructions of Nomograms for use in Statistics" appeared in the *Journal of the Royal Statistical Society* and *Applied Statistics*, respectively. He was a notable member of both the Royal Statistical Society and its Industrial Applications Section, being one of the two secretaries and editors of the former and on the Editorial Committee of the latter. In 1944 he published "Regression Analysis of Production Costs and Factory Operations".

Philip Lyle was a director of the West Indies Sugar Co. of Jamaica, and Caroni, Ltd., of Trinidad. He made a special study of statistical treatment of agronomical problems. He was also a director of Colonial Yeast, Ltd., which had been founded by the Sugar Commission to produce cheap protein and vitamins (Thaysen's *Torula utilis*) needed in the Caribbean, from surplus cane molasses. The product could not find a market there or elsewhere, and the project was abandoned; but his faith in the necessity for protein production to supply under-nourished peoples was unfailing, and he read a paper on the subject before the Nutrition Society in 1950.

The Sugar Reorganization Act, 1936, was responsible for formation of Research Committees *A* and *B*, of which he was a member. The programme for *B* was largely that put forward by him and was adopted in part by the Colonial Research Committee. Other proposals were chemical research into by-product utilization and sucro-chemistry, which were implemented at the University of Birmingham under Sir Norman Haworth and later Prof. L. F. Wiggins. Physico-chemical research at the University of Bristol was financed first by the Commission and later by Tate and Lyle and the British Sugar Corporation.

Among unpublished work which has nevertheless been widely adopted and utilized is his "Analysis of Sugar Grists", in which he showed that the normal frequency curves allowed grists to be expressed in terms of mean aperture and coefficient of variation.

So much for his interests and work. What of the man? To meet Philip Lyle was to like him. To know him was to admire, respect and love him. His encouraging manner, his friendly approach, his sunny smile (the same to people in all walks of life) made everyone his friend, and effort on his behalf a pleasure; Browning might have altered the lettering of "Pippa passes". He leaves a widow, a daughter, two sons, one of whom is following in his footsteps, several grandchildren and innumerable friends.

H. O. S. de Whalley

## Sir Francis McClean

Frank McClean was best known to the outside world as the great patron of aviation and the founder of amateur and naval flying in Great Britain. Born on February 1, 1876, and educated at Charterhouse, Clifton and Coopers Hill, he served with the Public Works Department in India during 1898–1902. After flying in two Gordon-Bennett balloon races in 1907–8, he flew with Wilbur Wright at Le Mans in the latter year. He bought land in the Isle of Sheppey for his early flying experiences on heavier-than-air machines and lent aircraft to the Admiralty so that naval officers could learn to fly. After some pioneering work in submarine photography, he caused some sensation by flying up the Thames in a seaplane, passing between the upper and lower parts of the Tower Bridge and under London Bridge. He joined the R.N.A.S. on the outbreak of the First World War, served on Channel patrol and then became chief instructor at Eastchurch. When the R.A.F. was formed he took a commission, but resigned in 1919.

McClean's other great interest lay in astronomy; in this he was influenced by his father, Dr. Frank McClean. He organized two eclipse expeditions, to Flint Island in 1908 and to Port Davey in Tasmania in 1910. He also joined an expedition led by Sir Norman Lockyer to Vavau Island in 1911. He was a joint founder of the Norman Lockyer Observatory on Salcombe Hill, Sidmouth, serving under his friend, Sir Richard Gregory, on its council. The Frank McClean Dome and the twin telescope and sidereal clock which it houses bear further witness to his generosity. His 21-in. siderostat, bought for his eclipse expeditions, was presented by him to the Cambridge Observatories. With his brothers, he was a generous benefactor also to the Coins and Manuscripts Departments of the Fitzwilliam Museum, Cambridge. Other social activities are reflected in his holding the office of High Sheriff of Oxfordshire in 1932 and the presidency of the Royal Aero Club for two spells. He was the senior member of the Royal Astronomical Society Club, and was much loved by a wide circle of friends in flying and astronomical circles. He died on August 11 after a long illness, leaving a widow and two daughters.

F. J. M. Stratton

# NEWS and VIEWS

## Chemistry at Nottingham:

### Prof. F. E. King, F.R.S.

PROF. F. E. KING, who has recently resigned the Sir Jesse Boot chair of chemistry in the University of Nottingham to become director in charge of research at British Celanese, Ltd., carried out his earliest researches with Prof. J. R. Partington in the University of London, mainly on inorganic and physical chemical subjects. He then went to Oxford, where he became in turn demonstrator and lecturer in the Dyson Perrins Laboratory, and also lecturer in organic chemistry at Magdalen and at Balliol Colleges. His work at Oxford covered a wide field; but particularly noteworthy, in chronological order, were the long series of papers which Sir Robert Robinson and he published on the chemistry of eserine (physostigmine) and on laudanosine; his work on potential chemotherapeutic agents, particularly derivatives of quinoxalines, iminazoles, cinnolines and arylamines; and his work on the structure of extractives from hardwoods. This very difficult branch of natural-product chemistry has been his major interest during recent years, and he has obtained some conspicuously successful results, for example, the elucidation of the structure of ferreirin and homoferreirin obtained from the heartwood of *Ferreirea spectabilis*. British Celanese, Ltd., is providing facilities for the continuation of this work under Prof. King's supervision. He was elected to the chair at Nottingham in 1948 and to fellowship of the Royal Society in 1954.

### Prof. A. W. Johnson

DR. A. W. JOHNSON, who succeeds Prof. King at Nottingham, received his early training at the Imperial College of Science and Technology, London, after two years of preliminary industrial experience. He remained at the Imperial College during 1936–42, his research work being chiefly on the synthesis of vitamin A. For the next four years he was research chemist at the Dyestuffs Division of Imperial Chemical Industries, Ltd., where he worked mainly on the chemistry of acetylene, which was then a rapidly developing subject and upon which he wrote a two-volume treatise that appeared in 1946 and 1950. In 1946 he went to the University of Cambridge, where he was appointed assistant director of research and, later, University lecturer in chemistry, and was also elected Fellow and Steward of Christ's College. His work at Cambridge with Sir Alexander Todd has been mainly on the chemistry of the tropolones and on the constitution of the deeply coloured compounds isolated from certain species of aphids, and later upon the structure of vitamin $B_{12}$. The work on this vitamin has been carried out in collaboration with the chemical staff of Glaxo Laboratories, Ltd., and ultimately with the help in the crystallographic field of Dr. Dorothy Crowfoot Hodgkin and others; all the main points in the structure of this vitamin have thus now been elucidated (see *Nature*, August 20, p. 325). Dr. Johnson was awarded the Meldola Medal of the Royal Institute of Chemistry in 1946, and was Tilden Lecturer of the Chemical Society in 1953. Prof. King's resignation has deprived the University of Nottingham of an outstanding teacher and research worker; but the University is indeed fortunate in securing, in Dr. Johnson, a successor who also possesses this invaluable combination of qualities.

## Veterinary Pathology at Liverpool:

### Prof. D. L. Hughes

MR. D. L. HUGHES, head of the Veterinary Science Division of Messrs. Boots Pure Drug Co., Ltd., has been appointed to the chair of veterinary pathology in the University of Liverpool in succession to Prof. R. E. Glover, who has become principal and dean of the Royal Veterinary College, London. Prof. Hughes is well known even beyond the confines of his own profession, both as a research bacteriologist and administrator. Born in 1912, he studied at the Royal Veterinary College and obtained the diploma of membership of the Royal College of Veterinary Surgeons in 1934; two years later he was awarded the diploma in bacteriology of the University of London, and more recently the fellowship of the Royal College. Being keenly interested in research and particularly in the bacteriology of animal disease, Hughes quickly established a reputation for integrity and accuracy at the bench and in the written and spoken word. Although he is probably best known for his researches into bovine mastitis, undertaken principally while on the staff of the Agricultural Research Council's Field Station at Compton, and later at the veterinary laboratories of Messrs. Boots Pure Drug Co., Ltd., his published works command wider horizons and are not confined to bacteriology alone. Outside the laboratory he brings to the roles of administrator, lecturer and committee man the attribute of a quiet and direct manner; to the British Veterinary Association he gives much time and energy as an active member of its Council and as chairman of the editorial committee of the *Veterinary Record*. His many friends and colleagues will wish him the best of good fortune in his new appointment.

## Council of Scientific and Industrial Research, India:

### Prof. M. S. Thacker

PROF. M. S. THACKER has been appointed director of the Council of Scientific and Industrial Research, India, in succession to the late Sir Shanti Bhatnagar. Born on December 3, 1904, he received his early education at Ahmedabad and Bombay, and graduated in engineering from the University of Bristol in 1927. He worked as electrical engineer with Bristol Corporation until 1931. He then joined the Calcutta Electric Supply Corporation and served there as a senior technical officer until 1947. In that year he joined the Indian Institute of Science, Bangalore, as head of the Power Engineering Department, and in 1949 he was appointed director of the Institute. Prof. Thacker is a member of several learned scientific and professional bodies in India, the United Kingdom and the United States. He has been associated as delegate with the International Commission on Large Dams, the International Conference on Large Electricity Systems, Paris, the World Power Conference, the World Metallurgical Congress and the Unesco Advisory Committee on Arid Zone Research; at the New Delhi session in October 1954 he was elected chairman of the Committee on Arid Zone Research. Prof. Thacker has served on the Board of Scientific and Industrial Research and the Board of Engineering Research of the Council of Scientific and Industrial Research, India. In the Republic of India Day honours on January 26, 1955, Prof. Thacker was the recipient of the award of Padma Bhushan.

## The British Institution of Radio Engineers: Premiums for 1954

The British Institution of Radio Engineers has awarded the following premiums for papers on the subjects indicated, published in the *Journal* of the Institution during 1954: *Clerk Maxwell Premium* (the premier award of the Institution), to F. N. H. Robinson (Clarendon Laboratory, Oxford), microwave shot noise in electron beams and the minimum noise factor of travelling-wave tubes and klystrons; *Heinrich Hertz Premium*, to Dr. T. B. Tomlinson (formerly of the University of Southampton), partition components of flicker noise; *Louis Sterling Premium*, to L. H. Bedford (Marconi's Wireless Telegraph Co., Ltd.), problems of television cameras and camera tubes; *Sir J. C. Bose Premium*, to S. Deb (Institute of Radio Physics and Electronics, University of Calcutta), the decay of emission from an oxide-coated cathode due to adsorption of matter liberated from the anode; *Brabazon Premium*, to J. W. Jenkins, J. H. Evans, G. A. G. Wallace and D. Chambers (A. C. Cossor, Ltd.), a high-definition general-purpose radar; *Marconi Premium*, to W. T. Brown (British Telecommunications Research, Ltd.), some factors in the engineering design of very-high-frequency multi-channel telephone equipment; *Leslie McMichael Premium*, to Dr. G. N. Patchett (Bradford Technical College), a critical review of synchronizing separators, with particular reference to correct interlacing; *Students' Premium*, to R. W. Walker (King's College, Newcastle upon Tyne), an electronic random selector. Premiums have also been awarded to the following authors of papers read at the Industrial Electronics Convention, held at Oxford in July 1954: P. Huggins (Sargrove Electronics, Ltd.), statistical computers as applied to industrial control; C. W. Miller (Metropolitan-Vickers Electrical Co., Ltd.), industrial radiography and the linear accelerator; K. Kandiah and D. W. Chambers (Atomic Energy Research Establishment), multi-electrode counting tubes; J. L. Thompson (J. Langham Thompson, Ltd.), wire strain-gauge transducers for the measurement of pressure, force, displacement and acceleration; and M. T. Elvy (Redifon, Ltd.), electronic heating and the woodworking industry.

## The Rubber-Stichting

The Rubber-Stichting (Rubber Foundation), established in 1936 with headquarters in Delft, is one of several research organizations operating in Europe and in the Far East in the interests of natural rubber. Financed by means of a cess levied on rubber produced in Indonesia, the recently announced intention of the Indonesian Government to remove the Foundation to Bogor has come as a severe shock to those interested in research on rubber. The staff, numbering more than two hundred, show little inclination to emigrate, and the possibility of the work in progress being stopped must be faced. The Rubber-Stichting has been engaged in fundamental research for long enough for its work to have won world-wide recognition. It is impossible here even to mention all of it; but of particular significance is its work in the field of latex, which, as a result, can now be used for the direct preparation of chlorinated rubber, rubber hydrochloride, cyclized rubber, and even ebonite. The preparation of reinforced rubber by the formation in the latex of synthetic resin complexes has been of particular interest from both the theoretical and practical points of view. In the laboratories at Delft pilot-plant research has been carried out on flame-resistant latex foam and rubber hydrochloride monofilaments; asphalt-rubber compositions for roads have been developed, a fleet of cars has been used for road-testing experimental tyre compositions, and cement-latex compositions for flooring have been studied. Fundamental investigations have been undertaken relating to vulcanization, abrasion, and the permeability of rubber. It is interesting to recall that out of the fifty papers accepted for presentation at last year's International Rubber Technology Conference, four emanated from the Rubber-Stichting.

A great deal of success has been achieved in publicizing the advantages and possibilities of rubber among technical men in other industries, in the education of rubber technologists, and in the holding of international symposia and conferences on different aspects of rubber technology. An efficient documentation centre for rubber is maintained, especially noteworthy for its work on correlation of rubber patents. In this field it has worked in close co-operation with the Intelligence Division of the Research Association of British Rubber Manufacturers, in which connexion mention must be made of its share in preparing and maintaining the International System for Classification of Rubber Information, the secretariat of which is at Delft.

## Education in East Africa

Four years ago the Nuffield Foundation showed its interest in African education by sponsoring, jointly with the Colonial Office, the Jeffery and Binns Missions. It has now given further assistance to the education of Africans by making a grant of £50,000 towards the work of the Institute of Education at Makerere College, Uganda. A fifth of this sum will provide research accommodation and other facilities for the work of the Institute, while the balance forms an endowment fund enabling a Nuffield Research Fellow to pursue some line of educational study important to East Africa. In choosing the subject of the first research project, it was borne in mind that the Binns Mission had directed attention to the need for better courses in vernacular languages and English in the primary schools of East Africa, and advocated a much earlier start in the teaching of English than hitherto. But little is known about the best methods of teaching English to the children of East Africa, and an imperfect knowledge of the language holds up their education in all subjects well into the secondary school. After consultation with the Directors of Education of East Africa, and with their unanimous support, it has been agreed to devote the first few years of the Nuffield grant to an attack on problems of teaching English and the teaching of other school subjects in English.

## Research on the Tropical Swamps of East and Central Africa

The Nuffield Foundation has given £21,900 for a four-year scheme of research on the biology of tropical swamps, to be directed by Prof. L. C. Beadle, professor of biology in Makerere College, Uganda. The area covered by swamps in East and Central Africa is enormous. In them are accumulating a large proportion of the plant nutrients washed in from the surrounding land which are being preserved under anaerobic conditions. Exploitation by drainage and dry cultivation has begun; but this is not the only, nor, in the long run, necessarily the best method, since the organic matter is rapidly oxidized and the conditions under which it accumulates are destroyed. Wet cultivation of suitable crops (for example, rice) or use of the nutrients for fish culture are possible alternatives. But too little is known about the chemistry and biology of swamps and of the changes which occur on drying. It is the purpose of this scheme to provide information which may assist in framing a long-term policy. The main chemical and microbiological transformations in the water-logged material, the ecology of the swamp vegetation, the biology of the oligochæte worms and other invertebrates and their part in the processes of decomposition, the adaptation of fish to swamp conditions, and the scarcity in untouched swamps of the principal malarial mosquito, *Anopheles gambiae*, are some problems which require investigation. All of them are of practical importance; but there are some aspects which are of fundamental interest—for example, the adaptations to a predominantly anaerobic environment. Work has already been started by Prof. L. C. Beadle in the zoological field and in the botanical field by Dr. Edna M. Lind, reader in biology at Makerere College, and the East Africa Malaria Research Institute has been collaborating. With the new Nuffield grant it is now possible to employ a chemical microbiologist and a zoologist from Europe, and two graduates from Makerere College.

## West African Tsetse Flies

THE taxonomy and systematics of tsetse flies from the Congo region belonging to the *Glossina palpalis* group—that is, to the sub-genus *Nemorhina*—which are of considerable importance from the medical point of view, since they carry human trypanosomiasis, have been the subject of an intensive study by A. de Barros Machado in a work entitled "Révision systématique des Glossines du groupe *palpalis* (Diptera)" (Pub. Cult. No. 22, Museu do Dundo; pp. 189+107 figs.+8 tables; Lisboa: Companhia de Diamantes de Angola, 1954). Intensive collecting was carried out by the author over Angola and the Belgian Congo. Much of the investigation was carried out in the Museum of Dundo; but this was supplemented by work in the British Museum, the London School of Hygiene and Tropical Medicine, the Museum of the Belgian Congo and the University of Porto. Thus practically the whole of the relevant material, including type material, was critically examined and compared. The specimens are carefully described morphologically, particular attention being paid to the copulatory organs and the range of each species and sub-species considered and illustrated. There are no plates; but the excellence of the paper and reproduction of the many photomicrographs renders them unnecessary. The geographical distribution of each form is carefully determined. The one distribution that appears remarkable is that of *Glossina tachinoides*, which has its main centre between long. 10° W. and 20° E. (there is a slip in the text on p. 151 which on line 7 gives longitude 10° E. instead of 10° W.) and a small subsidiary centre in the Sudan near longitude 34° E. As the author points out, another record of this species from the south-west of Arabia cannot be regarded as satisfactorily established. In passing, it is interesting to note that the form along the border of Tanganyika is *Glossina fuscipes martinii*, while that along the Uganda border is *G. fuscipes fuscipes*. The author recognizes and treats fully *Glossina fuscipes*, *G. palpalis* and *G. pallicera*, all of which are polytypic, and *G. tachinoides*. What is known of the ecology and inter-subspecific fertility of the various forms is adequately set forth and discussed. The paper is extremely well printed and will undoubtedly form a classical work of reference for future work.

## Coconut Milk Growth Factors and Tumorous Growth

IN further investigations of the growth and metabolism of plant cells, F. C. Steward, S. M. Caplin and E. M. Shantz (*Ann. Bot.*, N.S., 19, 29; 1955) have considered the phenomenon of tumorous growth in its relation to growth factors of the kind found in coconut milk, that is, the liquid endosperm of *Cocos nucifera*. This new investigation stems from the observation that coconut milk can induce rapid proliferation in cultures of certain mature tissues (carrot root explants consisting of secondary phloem), that is, in cells which would not normally have undergone further division—a result, in short, reminiscent of the growth of plant tumours. These investigators have now shown that aqueous extracts of plant tumours, induced by *Agrobacterium tumefaciens* on *Bryophyllum* and *Kalanchöe*, can be used as a substitute for coconut milk in the tissue-culture procedures used in their laboratory. On the basis of extensive experiments they have shown that tumours of this kind yield extracts possessing a growth-promoting effect similar to that of coconut milk. This effect may be enhanced by, though it is distinguishable from the effect of, added casein hydrolysate in the basic medium. Tumour extracts were consistently more active than extracts of stems and leaves of the same plants, and of normal, non-tumorous plants. The effect of coconut milk, which is replaceable wholly or in part by tumour extracts, is primarily an effect on cell division in the carrot tissue.

## Zygotropism in *Mucor*

IN further physiological studies of the Mucorales, G. H. Banbury has investigated the zygotropism of the zygophores of *Mucor mucedo* (*J. Exp. Bot.*, 6, 17, 235; 1955). In addition to positive zygotropism between (+) and (−) zygophores, there is claimed to be a corresponding 'repulsion' between zygophores of the same mating type, (+) from (+) and (−) from (−). The stimulus appears to be transmitted by the diffusion of a volatile substance from one zygophore to another. A tentative explanation of the phenomena described is advanced, based on two postulated volatile hormones, each evolved by zygophores of one mating type only, stimulating growth in zygophores of its own mating type and retarding it in those of the opposite type. The results of these new investigations appear to dispose of the 'mitogenic ray' and 'accidental contact' theories of earlier workers.

## Visual Education

IN co-operation with Unesco, the Central Council for Health Education has produced the latest issue of its *Health Education Journal* as a symposium on visual education (13, No. 1). The contributors are drawn from many parts of the world and, besides members of the Council's own staff, include such distinguished people as "Fougasse" on propaganda posters and Walt Disney on the development of animated cartoons. The use of moving films in combating human and animal disease in Tanganyika is described by N. F. Spurr, while not the least valuable article is one by Dr. A. L. Knutson, of the United States Public Health Service, who suggests ways in which the effectiveness of visual material may be evaluated.

## Ultrasonic Testing of Concrete

The Road Research Laboratory deals with the non-destructive testing of concrete in its Technical Paper No. 34, entitled "Testing Concrete by an Ultrasonic Pulse Technique", by Dr. R. Jones and E. N. Gatfield (pp. 48 + 2 plates. London: H.M.S.O., 1955; 2s. 6d. net). Until recently, the only way in which the physical characteristics of concrete and the changes brought about by ageing and other causes could be determined was by tests to destruction carried out on specially prepared specimens. These tests, though useful, are not entirely satisfactory, and a method of measuring changes in the quality of concrete *in situ* by transmitting an ultrasonic pulse through concrete has been extensively investigated and developed at the Laboratory. The ultrasonic equipment described consists of two piezoelectric transducers placed on opposite faces of the concrete under test, and the pulses are timed electrically as they pass from one transducer to the other through the concrete. The time of transmission indicates the characteristics of the concrete and the presence of internal cracks. Any deterioration due to weakness or poor compaction can be detected. Examples are given of the practical applications of the method. The ultrasonic technique can also be used for testing road surfaces; this involves the use of reflexion, the sound pulses being reflected back by the lower surface of the concrete. The difficulty here, however, is that the method is only satisfactory when the underside of the concrete is relatively smooth. In practice, transducers having natural frequencies of 50–200 kc./s. are used because of the upper limit to the frequency imposed by the attenuation of the concrete. The repetition frequency of the pulses is 50/sec., and the accuracy of measurement of the time of propagation of a pulse of longitudinal vibrations between the two transducers is of the order of ½ per cent for concrete. Full details of the apparatus used and of the experimental technique are given in an appendix. Brief reference is made also to applications of the technique to materials other than concrete, for example, soil-cement, rocks, ceramics and wood.

## Catalogues of the Exhibits on Heat at the Science Museum, London

Two well-produced illustrated handbooks have been compiled by J. A. Chaldecott, of the Science Museum, London, giving detailed descriptions of the exhibits in the collection of heat and thermal instruments at the Museum. The exhibits are arranged in a number of groups, each dealing with one aspect of the subject, and these groups are further divided into sub-groups within which the exhibits are arranged so far as possible in chronological order. The first handbook, "Heat and Cold" (pp. 64 + 6 plates. London: H.M.S.O., 1954; 3s. net), covers thermal expansion, calorimetry, change of state and critical state, heat and heat transfer, refrigeration and low temperatures, and altogether 166 individual exhibits are listed. In addition, details are given of nine portraits of distinguished workers in the field of heat. The other handbook, "Temperature Measurement and Control" (pp. 65 + 4 plates. 1955; 3s. 6d. net), is limited in content to the various types of thermometers, pyrometers, thermostats and temperature recorders, and 153 exhibits are listed. A reference list of thermometers and temperature-recording instruments kept in the meteorology collection of the Museum is appended for completion. In accordance with the 1948 recommendations of the Ninth General Conference on Weights and Measures, 'Celsius' is used for the temperature scale previously known as 'Centigrade'. In both handbooks the catalogue entries consist of the substance of the descriptive labels attached to the various exhibits in the Museum. The details given are most informative, and should be of considerable value and interest to physicists and to those concerned with the history of science. Though modern apparatus is by no means excluded, the emphasis is naturally on the original and earliest forms of thermal instruments. The descriptions of these in most of the text-books is now often so inadequate or incorrect that authors and students would be well advised to use the handbooks, together with a visit to the Museum, for details of particular instruments. For the more serious student, the handbook also provides the reference to the article in which the apparatus or method was originally described or to the maker or designer of a particular item. Photographs of the exhibits and lantern slides may be purchased, and the latter can also be borrowed.

## Energy Expenditure in Man: Symposium in London

The Nutrition Society is arranging a symposium on "Energy Expenditure in Man", under the chairmanship of Prof. R. C. Garry, to be held at the National Institute for Medical Research, London, N.W.7, on October 15. Papers will be read on the following topics: the development of experimental methods for determining the energy expenditure of man (Prof. C. G. Douglas, Oxford); modern techniques for measuring energy expenditure (Mr. H. S. Wolff, London); the value of energy expenditure measurements in nutritional studies (Dr. O. G. Edholm, London); daily energy expenditure by man (Dr. R. Passmore, Edinburgh); energy expenditure and age (Dr. J. V. G. A. Durnin, Glasgow); energy expenditure in athletic activities (Mr. H. R. Noltie, Leeds). Further information can be obtained from the honorary programmes secretary of the Society, Dr. R. J. L. Allen, c/o Beecham Foods, Ltd., Brentford, Middlesex.

## The Story of Pharmacy: Exhibition in London

An exhibition on "The Story of Pharmacy" has been set up by the Wellcome Historical Medical Museum at the Wellcome Building, Euston Road, London, N.W.1, to coincide with the Sixteenth General Assembly of the International Pharmaceutical Federation, which is meeting in London during September 19–23. The exhibition will be opened by the president of the Federation, Sir Hugh Linstead, on September 19, following the presidential address with which he will open the Assembly. All the objects to be shown at the exhibition have been selected from the collections at the Wellcome Museum and cover the history of pharmacy and related subjects from the earliest times to the advent of antibiotics. The exhibition is sub-divided into the following periods: prehistory, Assyria, Babylonia and Ancient Egypt; Græco-Roman period; the medieval world; the sixteenth century; the seventeenth century; the eighteenth century; and the nineteenth and twentieth centuries. Many of the objects, books and manuscripts to be displayed are noteworthy not only for their historical and scientific value but also for their beauty as works of art. The exhibition will remain open to the public (admission free) for several months.

### Swiss Society for Natural Sciences: Annual Meeting

The 135th annual meeting of the Swiss Society for Natural Sciences will be held in Porrentruy, Pruntrut, during September 24–26. The general proceedings will open with an address by the president, Dr. E. Guéniat, director of the Normal Teaching College of Porrentruy, on the scientific work of Jules Thurmann (1804–55). Prof. R. L. Gautheret (Sorbonne, Paris) will speak on physiology and nutrition in tissue-culture. Other topics will be: Swiss researches in Central Africa (a programme of scientific films); finalism and physicism (a symposium under the chairmanship of Prof. F. Gonseth, of Zurich); calculating machines in the service of technique and science (Prof. E. Stiefel, of Zurich); and tracking down carriers of hereditary diseases (Prof. A. Franceschetti, of Geneva).

### Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: G. D. Badger (senior agricultural officer, Uganda), senior agricultural officer (superscale), Uganda; G. S. Cowley (senior agricultural officer, Kenya), assistant director of agriculture (field services), Kenya; G. S. Gollop (senior agricultural officer, Kenya), provincial agricultural officer, Kenya; P. L. Hotchin (agricultural officer, Mauritius), senior agricultural officer, Mauritius; A. E. Moss (assistant director of agriculture, Gold Coast), deputy director of agriculture, Gold Coast; E. J. Honore (conservator of forests, Kenya), deputy chief conservator of forests, Kenya; P. C. Lancaster (principal research officer, Federation of Nigeria), director of forestry research, Federation of Nigeria; D. G. B. Leakey (assistant conservator of forests, Kenya), conservator of forests, Kenya; K. R. M. MacDonald (conservator of forests, Northern Region, Nigeria), chief conservator of forests, Northern Region, Nigeria; R. M. Palmer (senior assistant conservator of forests, Sierra Leone), conservator of forests, Sierra Leone; R. V. H. Porter (assistant conservator of forests, Kenya), conservator of forests, Kenya; T. I. Rees (senior assistant conservator of forests, Western Region, Nigeria), conservator of forests, Western Region, Nigeria; R. Smeathers (deputy conservator of forests, Trinidad), conservator of forests, British Guiana; J. A. R. Bates, specialist officer chemist (agricultural), Federation of Nigeria; B. L. Batwell, agricultural officer, Northern Rhodesia; J. R. Simpson, chemist, Agricultural Department, Uganda; J. Walker, agronomist, Somaliland Protectorate; J. Jago, government chemist, Zanzibar; J. P. de C. Walsh, assistant conservator of forests, Northern Rhodesia; J. V. Huhta, mining geologist, Sierra Leone; D. J. Slater, geologist, Federation of Malaya; A. J. Warden, geologist, Somaliland Protectorate; R. Q. Craufurd, scientific officer, plant breeder, Sierra Leone; J. Thorsen, veterinary officer, Northern Region, Nigeria.

### Announcements

Mr. H. A. Sargeaunt, at present scientific adviser to the Army Council, has been appointed assistant to Dr. H. P. Robertson, of the United States, scientific adviser to General Gruenther, the Supreme Allied Commander, Europe. Mr. Sargeaunt will be succeeded as scientific adviser to the Army Council by Mr. Patrick Johnson, formerly director of studies at the R.A.F. College, Cranwell, and since 1952 dean of the Institute of Armament Studies, India.

Prof. J. Heyrovský, academician of the Czechoslovak Academy of Sciences Section of the Czechoslovak Academy of Science, Prague, has been elected president of the Polarographic Society in Great Britain (see *Nature* of January 1, p. 20). He hopes to deliver an inaugural address in the near future.

Edward Longstreth Medals of the Franklin Institute, Philadelphia, have been awarded to C. Waller, of Ilford, Ltd., and Dr. R. Berriman, of Kodak, Ltd., for their work on the development of photographic emulsions especially designed for the study of nuclear particles and events.

Mr. E. Ll. Harry, provincial director of the West Midland Province, National Agricultural Advisory Service, has been appointed director in Wales in succession to the late Mr. D. Walters Davies. Dr. D. H. Robinson, deputy provincial director for the West Midland Province, will succeed Mr. Harry in that area.

The British Oxygen Co., Ltd., has awarded the following three fellowships for postgraduate research: R. Clarkson (formerly of the University of Manchester), chemistry, at the University of Oxford; R. A. H. Pool, inorganic chemistry, at the University of Oxford; and D. I. Wilkinson, organic chemistry, at The Queen's University, Belfast.

The following appointments in the University of London have been announced: Mr. H. L. Elvin, director of the Department of Education of Unesco, to the University chair of education with special reference to education in tropical areas, tenable at the Institute of Education; Dr. A. H. M. Arnold, head of the Electronics Section of the Electricity Division of the National Physical Laboratory, to the University readership in electrical engineering tenable at King's College.

The Trustees of the Ciba Foundation for the Promotion of International Co-operation in Medical and Chemical Research are offering five awards, of an average value of £300 each, for the period 1955–56, for research relevant to basic problems of ageing. Entries will be judged by an international panel, and in making the awards preference will be given to younger workers. The work submitted should not have been published before July 31, 1955. Further particulars can be obtained from the Director and Secretary to the Executive Council of the Ciba Foundation, 41 Portland Place, London, W.1, to whom entries must be sent by February 10, 1956.

The Swiss Federal Institute of Technology, Zurich, will hold its centenary celebrations during October 17–23. A programme of lectures and excursions, primarily intended for the old students' association, will be held during October 17–20.

Erratum. In the leading article in *Nature* of August 27, p. 365, par. 1, it is stated that "earlier hopes that alginates would serve as a technically and economically desirable source of chemicals have been disappointed"; this should read "earlier hopes that seaweeds would serve as a . . . source of chemicals other than alginates. . . ."

# COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, AUSTRALIA

## REPORT FOR THE YEAR 1953–54

THE sixth annual report of the Commonwealth Scientific and Industrial Research Organization, Australia, covering the year ended June 30, 1954*, again stresses the difficulties in attracting first-class men to research careers in science. The position became markedly worse during the year and is regarded as alarming. At the beginning of the year there were vacancies for 112 research officers, for which the minimum requirement is a good honours degree, and at the end of the year there were still 109 such vacancies. Recruitment of technical officers, however, was satisfactory; but concerted efforts to recruit scientific officers from overseas, mainly the United Kingdom, had most disappointing results, and the Executive believes that it is a matter of great urgency that the prospects for specialists and highly qualified professional scientific workers in Australia, both in public and private employment, should be greatly improved. Expenditure for the year was £4,861,873, of which £3,615,121 was on normal research activities and £98,271 as grants to bodies such as the Commonwealth Agricultural Bureaux. £569,038 was expended from the Wool Research Trust Account (for which £390,807 was received from the Department of Commerce and Agriculture), £372,399 from the Wool Industry Fund and £205,081 on sundry projects for which grants were received from outside bodies.

In the Division of Soils, the group concerned with soil mineralogy is developing into a new section, and a small new unit for field-work has been set up at the Irrigation Research Station, Griffith, N.S.W. A new soils laboratory has been established at Canberra, and a Soil Survey Co-ordination Committee in Victoria, while a further such Committee is being organized in Western Australia, where the soil survey of the Swan valley is complete. In the low-fertility lands of the Tintinara district of upper south-east South Australia a soil map and report on three hundred square miles have been completed and also field-work on four hundred and fifty square miles of similar lands in the Tatiara district. In soil chemistry an investigation into the ion-exchange relations of various cation-dominant soils has been completed, and in further experimental work on the availability of manganese and other heavy elements an improved method has been devised for the extraction of divalent manganese from soils, based on the use of salts of ethylenediamine tetraacetic acid. Typical Western Australian lateritic profiles have been examined spectrographically, and possible correlations in the concentrations of copper, gallium, magnesium, manganese, molybdenum and vanadium in samples of Urrbrae loam are being examined. A simple method has been devised for extracting the exchangeable cations in calcareous soils, and studies of the interactions of sodium, potassium, calcium and magnesium indicate that calcium has a marked effect on the determination of magnesium in a flame spectrophotometer. Further work is being carried out on the effect of initial water content on the water stability of soil aggregates, and studies have been made of the virulence and incursion strains of *Rhizobium trifolii*, while attempts are being made to isolate proteins and saccharides from soil humus by electrophoresis.

The Division of Plant Industry has considerably expanded the work in agrostology and agronomy in Queensland, and good progress is reported in work which is to open up the coastal lowlands of south-eastern Queensland for intensive pasture development. At Canberra evidence was obtained that clovers may compete with grasses for the nitrogen which they themselves assimilate, and that grass development may suffer from competition for nitrogen by the associated clover. For full efficiency of assimilation of nitrogen by legumes, it seems necessary to utilize the nitrogen they incorporate in the soil, either as hay removed from the area or by cropping. In genetics a programme of inter-specific hybridization in the Australian grasses is planned, while inoculation experiments with *Phytophthora infestans* on *Acacia*, *Cassia* and *Erythrina* spp. showed that the parasite penetrates the leaf epidermis but is checked by a severe 'defence' reaction which is similar to the lesion reaction known in cereals infested with rusts and some other parasites. Systemic absorption of streptomycin by potato and tomato plants led to a change in the reaction of the host to infection by *Phytophthora infestans*, the causal organism of late blight.

Most of the work at Hobart on the physiology of apples in relation to storage disorders is concerned with the effect of manurial treatment on cell size and physiology in relation to keeping quality. Extensive agronomic and breeding studies on safflower (*Carthamus tinctorius* L.) were continued, and also breeding for resistance to tobacco mosaic. Resistance in the variety Ambalena is associated with slow multiplication and spread of the virus followed by inactivation within the plant. A method has been developed for the determination of molybdenum in soils, and considerable progress was made in the study of the effects of lime on the nodulation of clover. Factors affecting the response to fertilizers were being examined, and a study of the effects of deficiencies of essential elements on the amino-acid composition of plants was continued. Contrary to the established view, glutamine has proved superior to asparagine as a source of nitrogen for the growth of isolated embryos of *Medicago tribuloides*, and quantitative relations between glutamine and asparagine were being established for a range of leguminous and non-leguminous embryos. Surveys to classify and map plant communities were proceeding in the Southern Tablelands, Macquarie and New England regions of New South Wales, and in the rain-forest regions of Queensland and northern New South Wales. An investigation was initiated on the biochemistry of morphogenesis in plants, particularly the induction mechanisms underlying the formation of a new meristem during regeneration and its subsequent mode of differentiation. Studies on root concentration and chloride content in native pastures at Deniliquin, New South Wales, indicated that the growth of grasses in the *Atriplex vesicaria* community was limited by 0·23–0·43 per cent of sodium chloride in the 3–9 in. depth. A pot trial using grey clay soil and sandy loam soil from areas which had been under native pasture, and from other areas which had been under fertilized irrigated pasture for six years, showed that 'Krilium', while greatly improving the aggregate stability of both loam and clay soils and reducing the mass shrinkage of the latter, depressed yields on clay soils and increased them slightly on loam soils, the effect being most marked on soils which had not been irrigated. The ecological survey of the coastal lowlands of south-eastern Queensland continued, and work was commenced on the genetical aspects of selected pasture legumes and grasses relevant to their improvement and adaptation to coastal and sub-coastal Queensland.

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* Commonwealth of Australia. Commonwealth Scientific and Industrial Research Organization. Sixth Annual Report for the Year ending 30th June, 1954 (1953–54). Pp. vi+372. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1954.)

An important part of the work of the Irrigation Research Station at Merbein, Victoria, deals with the reclamation of deteriorated horticultural lands which have not responded to tile drainage. Of the horticultural crops, vines for dried fruit are the most important, and investigation of some of the components of sultana-yield continued and also of manurial and cultural practices. Flowering and fruiting in citrus have been further investigated and the programme of tomato breeding for field and glasshouse continued. The work of the Irrigation Research Station at Griffith, N.S.W., has been designed to lay the basis for an effective counter to water-logging and salting and to develop more efficient techniques in the use of irrigation water.

The Animal Genetics Section of the Division of Animal Health and Production, which was established in 1952 with the co-operation of the University of Sydney, besides investigating the application of genetics to animal breeding, endeavours to introduce university students interested in genetics to the techniques and concepts of quantitative inheritance. It has been found that, whereas heritability of response to a simple antibody is high, heritability of response to a complex one is low. Following the demonstration by the Division of Biochemistry and General Nutrition that areas in South Australia abandoned as useless for agriculture can be transformed for efficient production when trace deficiencies of zinc and copper have been rectified, complementary work on pasture improvement has shown that vast areas of Australia, particularly in regions of low rainfall, can also be rendered more productive after trace-element adjustments have been made. An investigation on chronic fluorosis in sheep, now virtually complete, has proved that waters containing 10 p.p.m. fluorine are harmful to grazing stock and that the untoward effects of chrome fluorosis on the general well-being of the sheep arise primarily from the teeth lesions. A main activity of the Division's work on sheep during the year has related to the effects of molybdenum on the copper metabolism of the sheep and to the effects of imposing considerable doses of sulphate, etc., on relatively high intakes of molybdenum. Administration of a supplement equivalent to 1 mgm. cobalt/day as a drench once a week completely protected sheep from '*Phalaris* stagger', a fatal malady occurring spasmodically among sheep grazing essentially on the perennial grass *Phalaris tuberosa*. Research on the biological activity of complex ions was continued by the Division in collaboration with the University of Sydney. Further therapeutic trials were carried out with antibiotics against staphylococcal mastitis in dairy cattle and studies were being made to determine the factors responsible for outbreaks of hæmonchosis. In an investigation to discover a chemical method of assessing the resistance of strains of ticks to acaricides, it was found that when DDT is dissolved in normal primary alcohols, butyl, amyl and hexyl alcohols gave the greatest penetration.

The work of the Division of Entomology continued to be increasingly concerned with the more fundamental aspects of entomology. In current research on the cattle tick, the emphasis has shifted to the strategic timing of dipping, so as to ensure that from time to time all the ticks in a given area are exposed to dipping, and not merely those which happen to infest the animals at a given moment, and to the 'spelling' of pastures, with a similar object. In Western Australia more attention was being given to ecological studies on the earth mite and lucerne flea than to chemical treatment, and promising results were obtained in the campaign in Sydney for eradicating the Argentine ant. A study was commenced of the ecology and pathology of the black beetle. Using the sheep blowfly (*Lucilia cuprina*) as experimental animal, work was continued on the way populations accommodate themselves to external stresses. The study of the effects of airtight storage conditions on the grain weevil, *Calandria granaria* L., has shown that all stages are killed by the reduction in oxygen due to the respiration of the insects and the grain.

The work of the Wildlife Survey Section on myxomatosis has included regional surveys to assess the seasonal performance of the disease and to collect information on local variations, intensive investigations into the ecology and behaviour of insect vectors, and work on variant strains of the virus. A field-station for the intensive investigation of the kangaroo and euro problem has been established in north-western Australia. The Australian Mainland Survey Unit of the Land Research and Regional Survey Unit concentrated its effort in the Leichhardt-Gilbert area. The Section has also made a survey of Nauru Island and conducted some agricultural research in North Australia, including problems of dryland agriculture and a programme of testing plant introductions.

The work of the Division of Fisheries was again limited to coastal waters, because only two small research vessels were available. A detailed histological study of the reproductive cycle of the western subspecies of the Australian salmon continued, and a study of the relative abundance of estuarine species in Lake Macquarie, New South Wales, and their interaction was commenced in conjunction with environmental studies on the hydrology, microbiology and planktology of the Lake. An extensive survey in February 1954 of the south-western Tasman Sea demonstrated the path of the east Australian current in this area and the continuity between southern Tasmanian waters and the deep Tasman Sea waters below the 12° C. isotherm.

Despite progress in the investigations on beef, methods for the elimination of 'drip' from frozen and thawed beef are unlikely to be found in the near future. The precise water requirements of a number of strains of bacteria causing spoilage or food poisoning have been defined, and the amounts of water in various foods which will permit the growth of these organisms can now be predicted. A dip of sodium *o*-phenylphenoxide has proved the most effective method of reducing the green mould which is the chief cause of wastage in oranges grown in the natural rainfall districts. Using the maturometer and experimental techniques developed by the Division of Food Preservation and Transport, it has been found that the general developmental pattern of varieties of peas tested at Geneva, New York, agrees with that determined in Australia. Respiration studies have led to a hypothesis connecting the energy liberated by respiration with the energy-requiring processes in the cell, and this hypothesis has been used to interpret the sudden rise in respiration associated with the ripening of fruits. Attempts are being made to find improved methods of storage for apples.

The Division of Forest Products continued the study of the anatomy of tubers occurring in the south-west Pacific area and completed a detailed study of the influence of chip shape on the delignification of *E. regnans* wood by sodium sulphide and by sodium hydroxide. Studies were commenced on the rheological properties of hand sheets made from typical pulps of different qualities. A pressure membrane apparatus has been designed to study sorption of water by wood at relative humidities above 98 per cent; a quantitative comparison of creep at constant stress with stress relaxation at constant deformation showed that wood behaves approximately as a linear viscoelastic body, but attempts to establish an empirical formula for the relation between impact strength and moisture content were unsuccessful. Studies were commenced on the influence of physical conditions on vapour movement in hardwoods.

The work of the Division of Building Research continued on similar lines to that of the previous year. Information obtained from the study of the mechanism of the failure of concrete under load has led to a tentative theory of rupture of concrete in which the criterion of failure is a function of the shear-strain energy per unit volume and the volumetric expansion. Thermal and X-ray examination of synthetic gypsum indicated that the conditions of precipitation influence the behaviour during dehydration. In the Wool Textile Research Laboratory at Melbourne, work on the fundamental properties of the proteins of the wool fibre has been intensified, with particular emphasis on methods for separating and analysing the protein entities present. Further research in weaving and dyeing was commenced at the Geelong laboratory, while work on the physical properties of the wool fibre and assemblies of wool fibres continued at the Sydney laboratory. The Plant Fibres Section completed mill-scale trials on the so-called aerated retting of flax, and a comprehensive investigation of the effect of atmospheric temperature and humidity on the performance of various fibres during spinning; it also continued basic studies on flax-retting bacteria as well as its study of the treatment of flax and other fibres with sodium hydroxide.

The Division of Industrial Chemistry commenced a programme of basic research into the properties of uranium di- and tri-chlorides. Satisfactory methods have been evolved for the production of commercially pure thorium nitrate, and studies on the electro-reduction of hexavalent chromium solutions have shown that the hydrogen chromate ion is much more easily reduced than the normal chromate ion and plays an important part as an intermediate product. A detailed study of the phototropic darkening of synthetic titanium dioxides when contaminated with iron oxide has shown that chromium, nickel and copper also produce a phototropic effect and that, although some of the rutile modification of titanium oxide (and also moisture) must be present, the most intense coloration, with iron, develops for the smallest conversion of a pure anatase modification to the rutile form. Investigations of the factors which, by causing mechanical stresses, decrease the life of the linings of rotary cement kilns continued, and an extensive series of measurements of the rates of organic reactions at pressures up to 15,000 atmospheres has shown that those reactions which produce ions from neutral molecules are assisted by pressure, whereas the converse reactions are suppressed. A new extraction process using solvents has been devised and demonstrated on the separation of alkaloids, and very promising results have been obtained in small-scale out-of-doors tests of the use of thin films of long-chain alcohols to retard the evaporation of water.

Work has also continued on the structure of crystalline and non-crystalline proteins, on the chemical physics of the solid state, the determination of molecular structure by X-ray diffraction and electron diffraction methods, and on the improvement of experimental techniques and development of new instruments, including a mass spectrometer, an electron microdiffraction camera, a microtome and an atomic absorption spectrophotometer. In organic chemistry, work continued on the pyrrolizidine bases responsible for liver damage in stock, and structural studies of the three minor bases of *Heliotropium europaeum* and an investigation of *Lupinus pilosus* were completed. Further work was done on increasing the unsaturation of olefinic substances with the view of converting low-grade non-drying oils into more valuable materials with drying properties, and the study of the phenol-formaldehyde with *o*-6-xylenol and excess alkali showed that the reaction is complex with regard to the concentration of xylenol, formaldehyde and hydroxyl ion. In chemical engineering most of the resources have been directed to the study of the techniques and reactions in the gasification of low-rank coals.

Further work was done on the magnetic separation of chromite from ilmenite, and a study was being made of the ignition and combustion characteristics of Australian coals with particular reference to their evaluation for combustion; the mechanism and rate of formation of methane in pressure gasification were being studied to provide a better understanding of the Lurgi gasification process, and the effect of pressures up to fifty atmospheres on the rate of the primary steam-carbon reaction was also being investigated. In physical metallurgy the titanium project has been extended to include the deformation and mechanical properties of titanium and its alloys at both normal and high temperatures, and the study of the creep of lead and its alloys continued. The Division of Tribophysics continued its work on the same general lines as in the previous year, including studies of the adsorption of long-chain organic compounds on solids of various types, of the mechanical properties and composition of films of long-chain compounds, and of solutions containing metallic ions. Measurements of energy stored in deformed nickel were continued, and studies of the effects of antioxidants on the decomposition of benzoyl peroxide indicated that free radicals are not involved.

The maintenance of Commonwealth standards of measurement is shared by the Divisions of Metrology, Physics and Electrotechnology, which comprise the National Standards Laboratory. The work on standards of length and their international comparison continued, and another important piece of work by the Division of Metrology was a very accurate determination of changes in density of strained material on annealing. The principles and practice of vibration and shock isolation were also investigated; to increase the precision of maintenance of the International Temperature Scale, the Division of Physics constructed new apparatus for the primary fixed points defined by the boiling points of water and sulphur and was constructing a precision manometer for measuring the controlled pressures at which boiling occurs. A new method has been devised for the measurement and control of humidity, using a small ionic crystal as detector. Particular attention was given to the thermal and electrical conductivities of solids at very low temperatures. In the Division of Electrotechnology the special resistor for building up from one to a hundred ohms was completed and tested, and work continued on the relation between the chemical and physical structure of organic and some complex inorganic compounds and their dielectric properties. Besides dielectric measurements on a wide range of urea occlusion compounds, a portable bridge was made for measuring the temperature and salinity of estuarine waters to a depth of sixty feet.

The Division of Radiophysics continued its fundamental work in rain and cloud physics and in radioastronomy, and has also investigated a proposed method of navigating long-range aircraft by measuring the distance from the terminal points of the path. Ionosphere measurements were concentrated on studies of the anomalous $F2$ region, the conductivity of the ionosphere, and storm morphology and ionization movements in the ionosphere. In atmospheric physics the work included the study of the dry-monsoonal circulation which predominates over the west and north-west of Australia; an intensive investigation of the transfer of heat and water vapour from the ground surface to the atmosphere, of the frictional influence of the ground on the wind and of the prevention of frost in citrus; and a scientific study of the natural processes which give rise to cloud and rain and of possible methods of stimulating rainfall by artificial means, in which powerful microwave radar techniques have been of great assistance. Observations of radio-frequency radiation from cosmic sources and from the sun were continued, and a method was devised of obtaining an effective pencil-beam aerial of high aperture and angular discrimination at relatively low cost. Work on the analysis of rainfall records was concluded, and although the electronic computer could not be completed in accordance with the original design specification, it has been operated with reasonable efficiency on a wide range of problems.

# SCIENTIFIC RESEARCH AND MAN-POWER IN THE UNITED STATES

IN addressing the sixth annual conference on industrial research at Columbia University, New York, Dr. A. T. Waterman, director of the National Science Foundation, outlined the survey of scientific research and development in the United States which is being conducted by the National Science Foundation. For the fiscal year beginning July 1, 1955, the United States expenditure on research and development is expected to exceed 4,500 million dollars, 2,400 million of which will be borne by the Federal Government.

Dr. Waterman anticipates that a fourth volume of the Foundation's continuing study, "Federal Funds for Science", covering the years 1954–56, would be published shortly. He notes that 98 per cent of the total funds are accounted for by seven of the twenty departments or agencies of the Federal Government which reported funds for scientific research and development, and that, of these twenty, only the National Science Foundation and the Smithsonian Institution have used all their research funds for basic investigations. The Foundation has also undertaken a historical summary of Federal funds for science during 1900–54 and an analysis of the Federal financing of higher education. One of the agricultural experiment stations was expected to be complete late this year. A history of the activities of the Federal Government in science during 1789–1940, by Dr. H. Dupree, was reported as being almost complete, and the most significant data on scientific man-power in the Federal Government are being compiled in a separate monograph. A study of the financial support of graduate students (which covered 152,000 of the 225,000 graduate students of 1954) is nearing completion. Twenty-five per cent of the students covered held teaching or research assistantships or fellowships in April 1954, and 20 per cent were enrolled in the natural sciences.

A preliminary report on foundation expenditures for scientific research, covering seventy-seven foundations with assets totalling 3,000 million dollars and an income of 166 million dollars, of which about 16 per cent went for scientific research and development, indicates that only forty-three of the foundations gave support to scientific research at all and that this support is decreasing in comparison with other fields of study, while there is a trend from the support of basic research towards applied research and development. Industry conducts about 65 per cent of the national industrial research effort and finances 42 per cent of this total; but the industrial survey is not yet complete, and although a preliminary survey has been made of research being conducted by trade associations, studies of the economic implications of research are still in the planning stage. A preliminary draft has been received of a report on shortages of scientific and engineering personnel in industrial research, and studies are being sponsored of three problems: the loss of talent through educational 'drop-out'; estimating the supply of technical and professional man-power for 1965; and methods for determining demand and supply of technical personnel. It is hoped to present the findings of these studies in a series of general reports.

# PLASTICITY OF MATERIALS

## SYMPOSIUM IN LONDON

A TWO-DAY symposium on plasticity, arranged by the Armament Research and Development Establishment (Ministry of Supply), Fort Halstead, with the co-operation of representatives from universities, establishments of the Department of Scientific and Industrial Research, and industry, was held in London at the Assembly Hall of the Royal Empire Society during July 4–5. The director of the Armament Research and Development Establishment, Mr. Ewen M'Ewen, opened the symposium with an address of welcome to about eighty delegates, in which he reminded his audience that the subject of plasticity was forged in the genius of Saint-Venant; he stressed the continuing progress in the subject, particularly within recent years.

In four sessions of the symposium, eleven papers were presented and discussed. The papers taken as a whole represented a fair cross-section of the general nature of the work on plasticity proceeding in various centres not only in Great Britain but also elsewhere. Thus typical problems with a bias towards either engineering, physics or mathematics were described. The wealth of variety in the problems currently receiving attention was apparent, and this situation should increasingly attract research workers to this field. An adequate summary of the papers would perforce either be very lengthy or assume that the reader had a detailed knowledge over a wide horizon in the general field of plasticity. As most of the material presented is either already available or will become available in due course, an account will be given in this article only of the discussion that followed the papers.

After Prof. D. G. Christopherson had introduced the discussion, Prof. H. Ford directed attention to the practical importance of the Bauschinger effect and to the development of anisotropy in continued plastic deformation as, for example, in cold rolling; he made a plea for the theoretical study of the effects of departure from the assumptions of isotropic plasticity. Dr. J. F. W. Bishop replied that Prof. R. Hill had formulated a theory of anisotropic plasticity. The real obstacle to progress lies in the intrinsically difficult nature of the governing equations, and the incorporation of anisotropic effects in the theory does not pose the major problem. Dr. Bishop emphasized the importance of studying the inter-relation of crystalline and macroscopic plastic properties of metals in order to develop further the physical basis for the mathematical theory of plasticity. Otherwise, this theory will necessarily involve at least some features at a phenomenological level.

Dr. J. W. Macoll said that he has observed a recent trend towards a preference for the Tresca yield criterion, as opposed to that of von Mises, for a material under combined stress, in the theoretical treatment of problems. This is due largely to reasons of mathematical simplicity. He was glad to note the remarks of Dr. Bishop justifying, on the basis of the physics of single metal crystals, the occurrence of singular points on the yield surface. Singular points are, of course, an essential feature of the Tresca yield criterion. Dr. Macoll thought that more attention to the physical basis of the mathematical theory of plasticity, previously emphasized by Dr. Bishop, might not only point the way to, but would also justify, simpler mathematical approaches in macroscopic plasticity. Prof. Christopherson then raised the general question of the computation of bounds to the solution of problems. In reply, Mr. A. P. Green said that the methods available are not of sufficient generality. He also expressed the opinion that the relationship between the mathematician's ideal rigid-plastic material and actual metals requires further careful exploration. In respect of one of Dr. Macoll's remarks he cautioned against the facile assumption that the analytical solution of a problem is always moderately insensitive to changes in the yield condition and plastic potential, and counter-examples were recalled.

Mr. H. G. Hopkins returned to Prof. Christopherson's question, and said that the fundamental trouble is that a general method of construction of sequences of approximate solutions which converges to the true solution of a problem in plasticity is not available at the present time. In this respect there is a sharp contrast to problems of elasticity, where such methods are available and are much used in technical applications. Prof. Christopherson added that one difficulty is to decide *a priori* the extent of plastic regions. He went on to ask about general theorems in visco-elasticity. Mr. D. R. Bland said that any general theorems involving potential energy would be applicable to dynamic elasticity, and that there are few theorems known in that field. Therefore, it seems that such theorems in visco-elasticity will concern the dissipation function as well as the potential function. Dr. H. Kolsky made a plea for a greater volume of experimental work on visco-elastic solids to provide more adequate data for the theoretical treatment of problems in this field. Prof. Christopherson was impressed by the apparent simplicity of the theoretical models used to simulate the actual mechanical behaviour of visco-elastic solids. Dr. Kolsky replied that the degree of agreement is not always completely satisfactory, and this is why more accurate experimental data are needed. Mr. Bland observed that recent work of his indicates that the theoretical analysis of certain visco-elastic problems can be based directly on the complex modulus versus frequency relation instead of proceeding via the stress–strain relations.

H. G. HOPKINS

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# BRAZILIAN SOCIETY FOR THE PROGRESS OF SCIENCE

## ANNUAL MEETING

THE seventh annual meeting of the Brazilian Society for the Progress of Science (Sociedade Brasileira para o Progresso da Ciência) was held during July 4–9 at the Engineering School in Recife, Pernambuco. The president for the meeting was Dr. Anísio Teixeira, director of the National Institute of Pedagogical Studies of the Brazilian Ministry of Education, and the inaugural lecture on "Some Aspects of the Development of Mathematics in Brazil" was delivered by Dr. Leopoldo Nachbin.

The chief guest was Prof. Bernardo Houssay, of Argentina, who delivered a lecture on "General Considerations on Research and its Role in Latin America". Other foreign guests included Dr. L. Leloir, also from Argentina, and the science officer of the British Council in Brazil, F. M. Beatty, who lectured on British scientific travellers in the north and north-east of Brazil. Some 136 scientists and others attended this year's meeting. The programme included about 160 papers, mainly on biological subjects. Local scientists contributed especially to the sessions on nutrition in the north-east of Brazil and on mycology. In addition, special symposia were held on spot tests, experimental psychology and education, enzyme activity and, of more general interest, on "Science and Humanism". A memorial lecture on Einstein was given by Prof. Mario Schenberg, of the University of São Paulo. The principal functions were attended by Dr. Gilberto Freire, the well-known Brazilian sociologist.

The meeting was pleased to hear the message, read before one of the lectures, bearing fraternal greetings from the British Association for the Advancement of Science. The next meeting is planned to take place in Ouro Preto (Minas Gerais) in July 1956.

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# PROBLEM OF REWARDING RESPONSIBILITY

IN the past twelve months much has been heard of the skill differential between craftsmen and labourers; for example, engineering tradesmen and labourers; building tradesmen and labourers; and, more recently, footplatemen and other railway workers. Less easy to define, though just as pertinent a problem, is the wage relationship in many manufacturing industries between various categories of unskilled or semi-skilled process workers. There is also the problem of wage relations between workpeople paid by results and those paid by time-rates for whom no opportunity to earn incentive bonus has been provided. There are, of course, many other differentials, such as those based on sex and age, time and place. Differentials are sometimes as potent a source of friction in industrial relations as the question of the wage-level itself; their effects have been elaborated by G. R. Moxon and H. J. Perkin (*Personnel Management*, 37, No. 332; June 1955).

Before 1914 the rates of pay for unskilled workers were 50–65 per cent of those for apprenticed craftsmen; to-day they are nearer 80 per cent. The pace at which differentials have narrowed has accelerated since the War. The trend is accounted for by the bargaining strength of trade unions, particularly among the less skilled, in conditions of labour shortage and, latterly, very full employment; by the social conscience of what constitutes a fair minimum time-rate of wages; by social insurance and by acceptance of the wider application of the principles and practice of collective bargaining, conciliation and arbitration. The practice of giving the same general wage increase to all grades is the most obvious post-war feature of the drive towards a more egalitarian distribution of the national product.

Yet, difficult as is this problem of differentials, it is doubtful whether it can compete in complexity, obscurity or long-term significance for the well-being of industry, with the problem raised by the narrowing of another group of differentials, those based on responsibility. It is substantially true that the premium paid to those who direct, organize and supervise the work of others has dwindled as fast as the premium paid to skill.

This is not a problem peculiar to industry; it is found wherever responsibility is exercised: in the Civil Service, banks, local government and, probably, most professions, and is part of the general trend towards greater equality between traditionally middle-class and working-class occupations. Indeed, the problem may well be more acute outside industry than it is inside, where the employer can more readily assess and determine fair differentials to be paid for various positions of responsibility.

In their article, Moxon and Perkin explore the social and economic setting in which the problem has come about, and discuss some of the factors which give it its peculiarly intractable shape.

Their discussion is chiefly concerned with middle and junior management—overseers, foremen, departmental managers and technical assistants, whose training demands that they should exercise leadership, organize work, use and keep abreast of modern management, methods and controls, but whose living standards are being overtaken from below.

The problem is obscure because information about salaries is not available except under privilege. The problem is complex because it is by no means confined to the comparative size of the pay-packet. That it also includes questions of status, privilege, job security and pension rights—in all of which there has been a narrowing of the traditionally held differential—is obvious.

The background to the problem is formed by the social revolution of the past half-century. Fifty years ago society was a tall pyramid with many steps. A small group at the top was very rich, and a somewhat larger group very comfortably off: together, this top 1 per cent of income earners received nearly 30 per cent of the nation's income. At the bottom about a third of working-class families lived below the poverty line.

Fifty years of revolutionary reform have changed all that. Graduated taxation has levelled down the incomes, and, to a smaller extent, the capital of the rich. At the same time, social services and the remarkably rapid rise of the lower-paid worker have practically abolished poverty.

This means that the great majority of family incomes fall, after tax, within a narrow range of annual income—say, from £300 to £2,000. There is thus much room for differential awards. While the real earnings of almost all manual workers have risen (though skilled and adult male earnings less than unskilled, women's and juveniles'), salaries in real terms have in most cases been reduced.

At the same time, alongside the growth of the Welfare State, the trend towards greater equality of security and amenity has been reinforced by developments within the factory itself. Shorter hours, the five-day week, paid and longer holidays, canteen facilities, and the growing implementation of pension schemes, are extending to the manual worker a share of the privileges once exclusive to staff.

This measure of equality greatly aggravates the problem of rewarding responsibility. In many cases, middle and junior managers know that at least some of the workers they supervise enjoy a standard of living higher than their own.

The paradox is due to arbitrary differences in family circumstances, operating within a smaller net income range. First, the number of earners in the family, especially since the earnings of women and juveniles have increased, can make a significant difference. In general, the higher the status, the less likely is it that wife or children will contribute to the family budget.

Secondly, in spite of family allowance, tax reliefs and social services, commitments vary disproportionately from family to family. It is traditional for the salary earner to maintain standards of dress and spending appropriate to his status. His expenditure on other commitments, notably housing and possibly education, will be greater than the wage-earner's.

The problem of differentials in industry is substantially the same problem as that faced by society as a whole: how to share out inadequate resources between the various claimants. More specifically, it is a problem of two competing demands: the demand for fair shares and the demand for incentives for skill, initiative, ingenuity and responsibility.

To such problems there is no perfect solution. Any system of rewards must of necessity be a compromise—a reconciliation of incompatible claims. The compromise should provide a reasonably satisfactory reward for those who, inside and outside industry, carry the responsibility for upholding and extending our standards of life. This problem of rewards for responsibility is less critical and less explosive than that of differentials due to skill. The skill differential compels attention because its holders are organized and can use the force of a pressure group to publicize their grievances and gain their ends. No such relief is open to responsibility-holders.

Nor can they hope for a reversal of the social revolution which has aggravated the narrowing of their differentials. It is most improbable that there will be any return to the inequalities of pre-war days. For the narrowing of differentials there is no remedy but acceptance.

There are a number of factors helping to predispose responsibility-holders to accept a reasonable narrowing of differentials. First, the rewards of responsibility are not limited to material benefits, in cash or in kind. There are satisfactions to be gained from the exercise of responsibility itself: from a sense of doing a worth-while job. The Americans, but not the British, have inculcated that feeling into their industrial management at all levels.

Secondly, differences in monetary reward matter less once basic provision is secured for the major needs of life. The hardships experienced by some salary earners are, on the long view, comparative only, and take on an unreal appearance when set beside the poverty the social revolution set out to cure.

Thirdly, many of the responsibility-holders of to-day have risen, often via State-aided education, from lower down the social scale. They are less conscious of a traditional standard of living that they must maintain.

If the narrowing continues, what are the dangers which may result from it? There are two which are of real concern. One is that discontent may develop to the point where recruitment to positions of responsibility falls off and shortages occur; this appears to be the case with science teachers and with dentists. The other is that discontent will sap initiative and result in an immersion in unprogressive routine. Either, if it became widespread in industrial management, might make all the difference between a rising rate of productivity and a falling one.

The great enemy of all differentials is inflation. The pay-packet of the wage earner, especially the less skilled, has on the whole kept ahead of prices. Inflation seems to have become an instrument for re-allocating the national income in favour of those with the biggest bargaining power. Worse than its effect on the immediate purchasing power of salaries is its effect on savings and pension funds.

A stabilization of prices is extremely desirable; but it demands a self-restraint on the part of organized labour on which it would be unrealistic to rely. Many firms are already countering the narrowing responsibility differential by reviewing and re-assessing staff salaries whenever new wage settlements are made. It would be an act of prudence and justice if all followed the lead of the best. Though the problem has not reached the proportions of a crisis, no one can view with equanimity any further narrowing of the differential based on responsibility.

There are no quick solutions to the problem of rewarding responsibility. It is a matter for patient, long-term bargaining and readjustment.

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# ATMOSPHERIC POLLEN

H. A. HYDE (*Proc. Linn. Soc.*, 165, 2, 107; 1955) has contributed new observations on the frequency of occurrence of pollen in the atmosphere which seem likely to be of interest to other investigators, including students of floral biology and quaternary botany, plant breeders, and members of the medical profession who are concerned with the problems of pollen allergy. The gravity slide method was used in making this pollen census. In the course of some ten years work, and making use of twelve different collecting stations, it has been possible to determine about 90 per cent of all the grains on the slides and to assign these to one or other of sixty-five different types.

The principal pollen types, listed in the order of their numerical importance, begin with the Gramineae with 48·3 per cent, followed by *Ulmus* with 11·6 per cent, *Quercus* 8·2 per cent, and so on down to *Ranunculus* with 0·41 per cent, and the sedges with 0·22 per cent. Variations in the pollen catch and in the preponderance of the different types from year to year in relation to weather conditions are considered and some interesting conclusions drawn. These are but indications of the several records presented and discussed.

On the subject of hay-fever, the author writes: "No kind of pollen is likely to evoke symptoms in a significant number of people unless it is formed and liberated in large quantities and is buoyant (so becoming and remaining airborne) and unless the source plant is widely and abundantly distributed. The results of the Cardiff pollen census, when considered in the light of this principle, show that the chief hay-fever plants of Great Britain are relatively few in number, viz., the grasses considered as a single group (since all kinds of grass pollen are generally assumed to be similarly antigenic), certain trees, viz., the oaks, ash, the elms and plane (notably in London), and certain herbs, viz., the plantains, docks and sorrels, and possibly common nettle. It is necessary before forming a diagnosis on a particular patient's hay-fever to be able to show that his symptoms coincided with or at least fell within the period during which he was actually inhaling the pollen concerned. For this purpose reference to the frequency diagrams is essential."

# GROWTH AND TITRATION OF THE VIRUSES OF FOOT-AND-MOUTH DISEASE AND VESICULAR STOMATITIS IN KIDNEY MONOLAYER TISSUE CULTURES

By R. F. SELLERS

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AN accurate method of virus titration has been developed by Dulbecco. The method involves the counting of plaques produced by the destructive action of the virus on susceptible cells grown as a monolayer in tissue culture, and has been applied to the titration of the virus of equine encephalomyelitis, Western type (*WEE*), on chick embryo monolayers[1] and of poliomyelitis virus on monkey kidney monolayers[2]. Recently, my observation that the virus of vesicular stomatitis is cytopathogenic in tissue culture has led to the titration of this virus by the production of plaques on chick embryo monolayers and on ox embryo kidney monolayers. A necessary condition for the successful application of this technique is that the virus should multiply in the cells and produce destructive changes[3]. Since the virus of foot-and-mouth disease causes lesions in the infected animal similar to those caused by the virus of vesicular stomatitis, it was decided to investigate and compare the multiplication and destructive action of the two viruses in monolayer tissue cultures grown from kidneys of susceptible animals, and in particular to see if the accurate method of plaque counting could be applied to the titration of the virus of foot-and-mouth disease.

The method of preparation of the tissue cultures followed closely that described by Dulbecco and Vogt[2], including the solutions used. Kidneys of ox embryo, calves and pigs were obtained fresh from the abattoir. The capsule was removed and the cortex cut into small pieces, washed in warm phosphate-buffered saline, *p*H 7·5, and digested in 0·3 per cent trypsin in phosphate-buffered saline. The cell clusters thus obtained were washed three times in phosphate-buffered saline, and after a final centrifugation of three minutes in a calibrated centrifuge tube at 500 r.p.m. the packed cells were suspended in a hundred times their volume in a mixture consisting of 6 per cent ox serum and a synthetic solution (Waymouth, C., personal communication) which contained phenol red in a concentration of 0·0015 per cent. 10-ml. amounts were pipetted into 80-mm. Carrel flasks or 6-oz. flat-sided 'Pyrex' bottles, and the cultures were incubated at 36° C. Antibiotics were added to all solutions (100 units penicillin and 100 μgm. streptomycin per ml.); the supernatant fluid was changed every 48 hr. Patches of epithelial cells were observed on the second day and a continuous cell layer formed in four to eight days; ox embryo kidney and calf kidney cultures took less time to form the monolayer than the pig kidney cultures. The cell sheet consisted mainly of epithelial cells; but fibroblasts were present especially after long incubation.

The strains of virus used were as follows:

*Foot-and-mouth disease.* (1) Strain 997 of Waldmann *O* type (*O* 997). This strain, originally recovered from an outbreak of the disease in cattle in Great Britain, has been maintained for three years by passage in surviving epithelial tissue from the tongues of cattle. A filtrate of this culture virus was used to initiate the series of passages in the ox embryo kidney cultures. (2) Strain *M* 11, Vallée *O* type (*M* 11). This strain was originally recovered from an outbreak of disease in cattle in Mexico. A filtrate of tongue epithelium suspension from the twelfth cattle passage was used for calf kidney cultures. Virus of the same cattle passage was passaged four times in pigs, and a filtrate of the fourth-passage foot epithelium was used as starting material for the infection of the cells of the pig kidney cultures.

*Vesicular stomatitis.* A strain of virus of the Indiana type (*Ind. C*) maintained by passage in hen eggs for several years. Pooled egg fluid was used as a source of virus.

Serial passage in tissue culture was made by transferring the supernatant fluid of an infected culture, diluted with phosphate-buffered saline, to a fresh tissue culture. At 24-hr. intervals the cultures were examined under a low power of the microscope, and the supernatant fluid withdrawn for titration. In the case of the virus of foot-and-mouth disease, the titration was carried out by the intraperitoneal inoculation of 7-day old mice[4] with the appropriate serial dilutions and in later experiments by the plaque-count method on pig kidney cultures. The virus of vesicular stomatitis was titrated by the plaque-count method using chick embryo monolayers[1]. The overlay for the cultures consisted of 1·8 ml. of 2·8 per cent washed agar, 1·8 ml. of two-fold Earle's saline[5], 1·2 ml. of synthetic solution and 0·75 ml. of ox serum.

In Table 1 are shown the details of the titres obtained at each passage of the virus of foot-and-mouth disease, strain *O* 997, in cultures of ox embryo kidney and calf kidney together with the dilution at each passage. Evidence of multiplication of the virus is clear, since

Table 1. MULTIPLICATION OF THE VIRUS OF FOOT-AND-MOUTH DISEASE, STRAIN *O* 997, IN OX EMBRYO KIDNEY CULTURES AND IN CALF KIDNEY CULTURES

| Source of virus | Passage | Time after inoculation (hr.) | Dilution from previous passage or filtrate | Titre (mouse *ID*50/ml.) |
|---|---|---|---|---|
| Filtrate of supernatant culture fluid of surviving tongue epithelium | | 42 | | $3 \cdot 3 \times 10^4$ |
| Ox embryo kidney cultures | 1st | 48 | 1 : 100 | $3 \cdot 3 \times 10^4$ |
| Ox embryo kidney cultures | 2nd | 24 | 1 : 50 | $> 10^6$ |
| Ox embryo kidney cultures | 3rd | 24 | 1 : 50 | $10^6$ |
| Ox embryo kidney cultures | 4th | 24 | 1 : 100 | $10^7$ |
| | | 48 | | $10^6$ |
| Filtrate of above | 4th | 24 | 1 : 100 | $10^6$ |
| Calf kidney culture | 1st | 21 | 1 : 10 | $5 \cdot 3 \times 10^6$ |
| | | 44 | | $3 \cdot 3 \times 10^6$ |
| Filtrate of above | 1st | 21 | 1 : 100 | $3 \cdot 3 \times 10^4$ |
| Calf kidney culture | 2nd | 24 | 1 : 20 | $8 \times 10^6$ |
| ,, ,, ,, | 3rd | 24 | 1 : 50 | $6 \times 10^7$ |
| ,, ,, ,, | 4th | 24 | 1 : 50 | $6 \times 10^6$ |
| Total dilution | | | $1 \cdot 25 \times 10^{17}$ | |

after four passages in ox embryo kidney cultures and four in calf kidney cultures the titre at 24 hr. was 6 × 10$^{6}$ mouse *ID*50 per ml., although the original inoculum had been diluted by a factor of 1·25 × 10$^{17}$. On microscopic examination of the infected cultures, small clusters of necrotic debris could be seen lying among the cells of the monolayer; but the cells were unaffected and continued to metabolize as shown by the change in colour of the phenol red in the medium. Some cultures in which multiplication had occurred were fixed and stained with hæmotoxylin and eosin after 48–72 hr. incubation. In these cultures the cells were less numerous than in control cultures without virus, but showed no gross pathological change. Epithelial cells and a few fibroblasts could be detected in both sets of cultures.

In the course of three passages in calf kidney cultures, the original inoculum of the virus of foot-and-mouth disease, strain *M* 11 (titre 2·1 × 10$^{8}$ mouse *ID*50 per ml.), was diluted by a factor of 5 × 10$^{4}$, and the titre of the third passage at 24 hr. was 6 × 10$^{6}$ mouse *ID*50 per ml. The infected cultures showed the same change as that described for strain *C* 997, namely, clusters of necrotic tissue lying among healthy cells.

The virus of vesicular stomatitis, strain *Ind. C*, an egg-passaged strain, multiplied readily in calf kidney cultures. The titre of the second passage at 24 hr. was 2 × 10$^{7}$ plaque-forming doses/ml., whereas the initial titre was 7 × 10$^{3}$ plaque-forming doses/ml. In contrast to the action of the virus of foot-and-mouth disease in calf kidney cultures, the increase of the virus of vesicular stomatitis, strain *Ind. C*, was accompanied by destruction of all cells. 24 hr. after the addition of a small amount of virus, patches of round cells could be seen among the healthy cells in the monolayer, and by 48 hr. no cells remained on the glass surface of the culture flask, but round cells and necrotic debris were floating in the medium. The addition of a large amount of virus caused destruction of the cells by 24 hr. All types of cell in the culture appeared to be affected.

The virus of foot-and mouth disease, strain *M* 11, derived from the fourth-passage foot epithelium of the pig multiplied readily in pig kidney cultures. Titres not less than 10$^{6}$ mouse *ID*50/ml. were consistently recorded at each passage after 24 hr., and at the eighth passage the titre was 5·9 × 10$^{6}$ plaque-forming doses/ml., although the original inoculum (titre 2·1 × 10$^{8}$ mouse *ID*50/ml.) had been diluted by a factor of 1 × 10$^{25}$. From the first passage onwards the multiplication was accompanied by destructive changes in the culture. The epithelial cells lost their polygonal shape, became round and floated off the glass into the medium. Not all the epithelial cells were affected at the same time, but by 48–72 hr. only a few fibroblasts remained attached to the glass surface. Dilutions of the sixth-passage virus in phosphate-buffered saline were used to infect cultures, and after ½ hr. adsorption at 36° C. the monolayers were covered with an agar overlay. After 48 hr. incubation they were stained with a 1/20,000 solution of neutral red in Earle's saline[5]; on removal of the solution, plaques could be seen. They appeared as pale areas of irregular shape 1–4 mm. in diameter, surrounded by the living cells which had been stained by the neutral red. Microscopic examination showed that the central zone of the plaque consisted of unstained necrotic debris; around it could be seen unstained round cells, similar to those already described, and strands of stained epithelial cells and fibroblasts which, projecting towards the centre among the round cells, gave the plaque its irregular outline. Plaques have also been produced at the eighth and subsequent passages, and titrations performed so far appear to give support to the demonstration by Dulbecco and Vogt[3] of a linear relationship between number of plaques and virus concentration. In Table 2 is set out the number of plaques obtained at each dilution of the eighth-passage virus. Although many comparative titrations have not been made, the titres obtained by mouse inoculation and by plaque count are in fair agreement. For example, the titre of the eighth passage by plaque count was 5·9 × 10$^{6}$ plaque-forming doses/ml. and by mouse inoculation it was 10$^{7}$ mouse *ID*50/ml. Both the destructive effects of the virus on the cells of the monolayer and the formation of plaques can be inhibited by the addition of immune serum to the virus, indicating that both effects are produced by the action of the virus. Virus from the fourth and sixth passage inoculated into pigs caused the appearance of typical lesions of foot-and-mouth disease.

Table 2. MULTIPLICATION OF THE VIRUS OF FOOT-AND-MOUTH DISEASE, STRAIN *M* 11, IN PIG KIDNEY CULTURES: NUMBER OF PLAQUES AT EACH DILUTION OF VIRUS

| Source of virus | Dilution of virus (0·1 ml.) | No. of plaques per culture | Average | Titre (plaque-forming dose/ml.) |
|---|---|---|---|---|
| *M* 11 Pig kidney culture 8th passage 24 hr. | 1 : 10$^{2}$<br>1 : 10$^{3}$<br>1 : 10$^{4}$<br>1 : 10$^{5}$ | Confluent<br>Confluent<br>74, 42<br>7, 5 | —<br>—<br>58<br>6 | —<br>—<br>5·8 × 10$^{6}$<br>6 × 10$^{6}$ |

The virus of foot-and-mouth disease, strain *C* 977, from the fourth passage in calf kidney culture was used as inoculum for pig kidney cultures; the titre of the fourth-passage organism at 20 hr. was 10$^{6}$ mouse *ID*50/ml., although the original inoculum (titre 5·3 × 10$^{5}$ mouse *ID*50/ml.) had been diluted by a factor of 4 × 10$^{11}$. During its multiplication, strain *C* 997 produced destructive changes on the cells of the culture similar to those described for strain *M* 11. An attempt at the third passage to produce plaques was successful, and they showed no apparent difference from those caused by strain *M* 11.

The behaviour of the virus of vesicular stomatitis, strain *Ind. C*, on pig kidney cultures resembled closely its behaviour on the calf kidney cultures. A titre of 8·4 × 10$^{7}$ plaque-forming doses/ml. was obtained at the second passage after 42 hr., although the original inoculum derived from the second passage in the calf kidney culture (titre 5·7 × 10$^{7}$ plaque-forming doses/ml.) had been diluted by a factor of 5 × 10$^{7}$. Multiplication of the virus was accompanied by cell destruction from the first passage onwards.

The specificity of the viruses used was checked by complement fixation tests on infected cultures or on virus suspensions from susceptible animals used in titration.

The fact that multiplication of the viruses of foot-and-mouth disease and vesicular stomatitis has been shown to occur in monolayer tissue cultures of the calf and pig kidney suggests the possibility that the viruses might multiply in the kidneys of infected animals. However, no gross pathological changes which could have been taken as evidence of multiplication have been described, and although the virus of foot-and-mouth disease has been demonstrated in the kidneys of animals slaughtered at the height of infection, the amount of virus present was never greater than could be accounted for by the blood present in the organ[6].

The difference in cytopathogenicity *in vitro* of the two viruses is interesting in view of the similarity of the site and type of lesions in the infected animal. The virus of vesicular stomatitis grew well in all the cultures, destroyed all types of cells present, and produced round plaques on ox embryo kidney monolayers (unpublished observations, 1954). The virus of foot-and-mouth disease grown in the calf kidney cultures caused little damage to the cells, and consequently the calf kidney monolayers were not suitable for plaque production. In the pig kidney cultures the virus destroyed the epithelial cells and plaques could be produced. The presence of a few fibroblasts resistant to destruction by the virus gave the plaques the irregular outline referred to above; but this should not seriously detract from the usefulness of the plaque count method for the titration of the virus.

The strains of the virus of foot-and-mouth disease employed were both 'cattle' strains in that they were recovered originally from field outbreaks in cattle and have been maintained since by passage only by inoculation of cattle or by culture in cattle tissue. Strain *M* 11, which has been used in other experiments in this Institute, has proved to be highly invasive for cattle, producing regularly an extensive generalized infection in contact exposure tests. In pigs, on the other hand, it has been found recently in contact exposure tests that *M* 11 is of low invasiveness for pigs, inapparent infection being more frequent than overt infection. It seems surprising, therefore, that the cytopathogenic changes were greater in pig kidney cultures than in calf kidney cultures. Although only two strains of the virus of foot-and-mouth disease have been used, it appears likely that this difference is due rather to some property of the tissue culture than of the virus strain.

The differences between the pathological changes produced by the viruses of foot-and-mouth disease and vesicular stomatitis in the kidney monolayers studies are of fundamental interest for research on the virus–cell relationship. Both viruses have multiplied readily in spite of these differences, and these cultures therefore suggest a source of material other than tongue epithelial tissue for virus production; but it is perhaps the use of the pig kidney monolayer cultures for the accurate titration of the virus and the isolation of pure-line strains of virus that are of most immediate application in foot-and-mouth disease research.

It may be noted that the virus of vesicular exanthema, which produces similar lesions in pigs, has been successfully grown with cytopathogenic changes in pig kidney tissue cultures by McClain *et al.*[7] and now by me. In addition, I have demonstrated, with two strains of the virus of different immunological type, the formation of plaques with the agar overlay method. The plaques resemble in morphology those produced by the virus of foot-and-mouth disease. Titrations of the virus of vesicular exanthema have been carried out by the plaque count method, and I have shown also that the effects of the virus on the cells of the monolayer and the formation of plaques were inhibited by the addition of the appropriate type-specific immune serum, to the virus.

[June 6

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# BLOOD COUNTS IN DOMESTIC ANIMALS IN THE GOLD COAST

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In the course of investigations carried out at our laboratories at Achimota on the trypanosomes of domestic animals in the Gold Coast, it has been found that the hæmatological values obtained for goats and sheep healthy in appearance and apparently free from trypanosomes differ appreciably from those given by Drastich[1] and Wintrobe[2]. It must be emphasized that their figures are based on a total of six goats and five sheep compared with our own observations on nineteen goats and nine sheep, with a total of 187 counts in the former and 41 in the latter. In our hæmatological studies, there were two distinct types of both goats and sheep: (*a*) West African dwarf goat, (*b*) West African long-legged goat (sahel), (*c*) West African dwarf forest sheep, and (*d*) West African long-legged sheep. These breeds of goats and sheep constitute the main types encountered in the Gold Coast and indeed over the greater part of West Africa. The West African dwarf goat and the West African dwarf forest sheep originally occurred in the whole area of West Africa south of lat. 14° N., whereas the West African long-legged goat and the West African long-legged sheep had their origin farther northwards into the interior of Africa.

The hæmatological values given in Tables 1–4, and corpuscular constants shown in Table 5 (for fifteen West African dwarf goats and four West African long-legged goats and based on 167 and 20 blood counts, respectively), are in general agreement with those of Drastich and Wintrobe. The methods of determination used in the present work were: red blood cell and leucocyte counts, Dacie[4]; packed cell volume and erythrocyte sedimentation rate, Wintrobe[2]; hæmoglobin, M.R.C. grey wedge photometer[3]; anticoagulant used, double oxalate mixture[4]. It would

Table 1. BLOOD COUNTS IN 15 WEST AFRICAN DWARF GOATS

| Index of animal | No. of counts | Red blood cells (mill./c.mm.) | Vol. of packed red cells (ml./100 ml.) | Hæmoglobin (gm./100 ml. blood) | Leucocyte count (thousands/c.mm.) |
|---|---|---|---|---|---|
| G.D. 8 | 63 | 10·44 ± 1·77 | 20·9 ± 2·93 | 7·9 ± 0·83 | 13·36 ± 3·17 |
| G.D. 5 | 18 | 12·61 ± 1·86 | 25·1 ± 3·14 | 9·2 ± 0·91 | 13·62 ± 3·92 |
| G.D. 41 | 4 | 12·92 | 22·0 | 8·6 | 12·33 |
| G.D. 43 | 4 | 12·10 | 25·0 | 9·1 | 17·30 |
| G.D. 52 | 11 | 13·20 | 24·3 | 9·1 | 14·30 |
| G.D. 53 | 11 | 14·96 | 28·8 | 10·6 | 14·31 |
| G.D. 79 | 8 | 12·36 | 28·5 | 12·4 | 11·99 |
| G.D. 81 | 2 | 12·04 | 26·5 | 8·5 | 12·40 |
| G.D. 86 | 1 | 12·80 | 26·0 | 8·8 | 15·06 |
| G.D. 92 | 2 | 11·92 | 25·5 | 8·2 | 14·20 |
| G.D. 94 | 2 | 11·99 | 23·0 | 7·4 | 14·10 |
| G.D. 61 | 24 | 14·35 ± 1·48 | 32·7 ± 2·57 | 10·7 ± 0·85 | 13·61 ± 2·50 |
| G.D. 26 | 7 | 12·02 | 21·6 | 8·1 | 18·07 |
| G.D. 58 | 1 | 14·92 | 29·0 | 10·4 | 13·25 |
| G.D. 63 | 9 | 12·77 | 23·0 | 8·9 | 19·64 |
|  | 167 | 12·77 ± 2·34 | 25·6 ± 4·68 | 9·2 ± 1·61 | 14·64 ± 3·28 |

Table 2. BLOOD COUNTS IN 4 WEST AFRICAN LONG-LEGGED GOATS

| | | | | | |
|---|---|---|---|---|---|
| G.L. 72 | 3 | 15·58 | 29·0 | 10·0 | 15·28 |
| G.L. 74 | 11 | 11·89 | 25·0 | 7·9 | 12·65 |
| G.L. 75 | 3 | 13·65 | 30·0 | 9·8 | 10·52 |
| G.L. 87 | 3 | 12·65 | 26·0 | 7·9 | 12·53 |
|  | 20 | 13·44 | 27·5 | 8·9 | 12·75 |

Table 3. BLOOD COUNTS IN 3 WEST AFRICAN DWARF FOREST SHEEP

| | | | | | |
|---|---|---|---|---|---|
| S.D. 3 | 1 | 10·75 | 24·0 | 11·1 | 18·30 |
| S.D. 7 | 2 | 8·65 | 31·0 | 11·1 | 10·90 |
| S.D. 9 | 2 | 10·98 | 31·0 | 10·4 | 13·48 |
|  | 5 | 10·13 | 28·7 | 10·9 | 14·23 |

Table 4. BLOOD COUNTS IN 6 WEST AFRICAN LONG-LEGGED SHEEP

| | | | | | |
|---|---|---|---|---|---|
| S.L. 13 | 3 | 8·90 | 24·3 | 9·8 | 7·17 |
| S.L. 14 | 3 | 7·47 | 24·7 | 9·4 | 6·60 |
| S.L. 18 | 12 | 8·66 | 26·0 | 9·2 | 10·85 |
| S.L. 20 | 3 | 9·51 | 26·0 | 9·9 | 8·47 |
| S.L. 21 | 12 | 8·47 | 23·6 | 8·5 | 9·55 |
| S.L. 22 | 3 | 8·22 | 30·7 | 9·0 | 8·92 |
|  | 36 | 8·54 ± 1·35 | 25·9 ± 3·36 | 9·3 ± 0·92 | 8·59 ± 2·21 |

Table 5. AVERAGE HÆMATOLOGICAL VALUES FOR GOATS AND SHEEP BY DRASTISCH (ref. 1), WINTROBE (ref. 3) AND PRESENT WRITERS

| Animal | Recorder | Red blood cells | Vol. of packed red cells | Hæmoglobin | Leucocyte count | Mean corpuscular volume | Mean corpuscular hæmoglobin | Mean corpuscular hæmoglobin concentration |
|---|---|---|---|---|---|---|---|---|
| Goat | Drastisch | 18·70 | 30·0 | 9·8 |  | 16 | 8 | 32 |
| Goat | Wintrobe | 17·33 | 33·2 | 11·4 | 7·4 | 19 | 7 | 35 |
| Dwarf goat | Present writers | 12·77 | 25·6 | 9·2 | 14·64 | 19·97 | 7·20 | 36·08 |
| Long-legged goat | " " | 13·44 | 27·5 | 8·9 | 12·75 | 20·52 | 6·61 | 32·23 |
| Sheep | Drastisch | 10·90 | 38·5 | 11·8 |  | 35 | 11 | 31 |
| Sheep | Wintrobe | 10·50 | 35·7 | 12·9 | 5·0 | 35 | 13 | 35 |
| Dwarf sheep | Present writers | 10·13 | 28·7 | 10·9 | 14·23 | 28·30 | 10·72 | 37·88 |
| Long-legged sheep | " " | 8·54 | 25·9 | 9·3 | 8·59 | 30·29 | 10·88 | 35·91 |

seem, therefore, that the low values for the number of erythrocytes recorded, in the third column of Table 5, for these goats in the Gold Coast are accurate standards for these animals in this region of West Africa.

The marked differences evident in column 7, Table 5, between the mean corpuscular volume of the erythrocytes of the sheep investigated by us and that cited for sheep by both Drastisch and Wintrobe are due to the much higher values recorded by them for the volume of packed red cells (column 4, Table 5). These figures, taken by themselves, indicate that the red blood corpuscles of the West African dwarf forest sheep and the West African long-legged sheep in the Gold Coast are smaller than those regarded as normal for sheep, at least, when based on determinations quoted by Drastisch and Wintrobe.

In addition to the hæmatological values included in Tables 1–5, the erythrocyte sedimentation-rate was also recorded in all cases, and it varied, irrespective of the breed of the animal, in the goat from 0 to 1·0 and in the sheep from 0 to 5·0 mm. in one hour. In many of the goats, the fragility of the erythrocytes was also measured in different strengths of sodium chloride solutions[6]. All of them showed a very high degree of fragility of their red cells, the hæmolysis being slight at 0·8 and virtually complete in all cases at 0·65 per cent concentration.

Judging from these results, and also from general observations made on the blood content of other domestic animals, particularly cattle and horses, in the Gold Coast, it would seem that apparently healthy animals in this territory either have an inherently lower hæmatological value than the normal standards, or that they suffer from the effects of some anæmia-producing factor or factors so far undiscovered. The anæmia might well be due to some dietary deficiency for normal blood production, or to a pathenogenic organism hitherto undemonstrated. It is noteworthy in this respect that similar findings have been recorded in Africans of the Gold Coast by Colbourne, Edington and Hughes[7]. Further, trypanosomes of various species, especially *Trypanosoma vivax* and *T. congolense*, frequently cause in farm animals in the Gold Coast, besides an acute type of trypanosomiasis, an insidious and chronic form of disease; this, although producing an anæmic condition, often proves exceedingly difficult to recognize clinically or by examination of blood smears for the presence of the parasites, even when repeated daily over many weeks.

No blood parasites were detected, however, at any time in the goats and sheep included in these studies, and the internal worms were entirely confined to nematodes, judging by the ova recovered in samples of the fæces. Even the nematode infections were light, the number of ova seldom exceeding 1,500 per gm. of fæces. As expected, *Haemonchus contortus* constituted by far the most abundant species.

[May 28

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Identity of Cephalosporin *N* and Synnematin *B*

A SPECIES of *Cephalosporium* isolated in Sardinia was reported, in 1948, to produce an antibiotic which inhibited the growth of a number of Gram-positive and Gram-negative bacteria[1]. This antibiotic, which was only obtained in a crude form, was not characterized chemically. In 1949 certain members of the genus *Cephalosporium*, including one that was believed to constitute a new species, were reported in the United States to produce a water-soluble antibiotic called synnematin[2]. In 1951 further studies were reported on the new species and its antibiotic, synnematin[3]. These studies included the determination of chemical and biological properties of the antibiotic. The new species was later named *Cephalosporium salmosynnematum*[4]. In 1951 work in England revealed that the *Cephalosporium* from Sardinia produced a family of antibiotics, cephalosporin *P* 1–5 inclusive, which could be extracted into common organic solvents, and a water-soluble antibiotic with quite different properties. The latter was named cephalosporin *N*[5]. Further work disclosed the presence of another antibiotic named cephalosporin *C* which is closely related to cephalosporin *N*[6].

In 1953 cephalosporin *N* was reported to be a new type of penicillin, and it was suggested that cephalosporin *N* and synnematin might be identical[7]. In the meantime, synnematin was separated into two components called synnematin *A* and synnematin *B*, the former being apparently less soluble in methanol than the latter[8]. Subsequent work on cephalosporin *N* showed that this substance was a penicillin the side-chain of which was derived from D-α-aminoadipic acid[9]. Cephalosporin *C* also contained sulphur and yielded D-α-aminoadipic acid on hydrolysis[6].

The toxicity of both cephalosporin *N*[10] and synnematin *B*[11] to laboratory animals is extremely low. Doses as large as 5 gm./kgm. have been given intravenously without noticeable ill-effects. Cephalosporin *N* has been reported to resemble benzylpenicillin in some of its pharmacological properties[10], and synnematin *B* has been used successfully for the treatment of *Salmonella* infections in mice, chicks and man[11].

We now wish to report that we have exchanged samples of highly purified cephalosporin *N* and synnematin *B* and have obtained strong evidence that the two substances are, in fact, identical. Assays in different laboratories have indicated that the cephalosporin *N* unit[12] is between six and nine times as large as the synnematin *B* unit[8]. The evidence for the identity of the substances may be summarized as follows:

(1) The two products showed the same relative activities (within the experimental error) against strains of *Staphylococcus aureus*, *Salmonella typhi*, *Salmonella typhimurium* and *Sarcina lutea*. The activity of both products was destroyed by incubation with penicillinase.

(2) The two products were indistinguishable, with respect to antibacterial activity, when run on paper chromatograms in a variety of solvent systems. In each case the activity was associated with the major ninhydrin-positive spot. Similarly, the products were indistinguishable when subjected to ionophoresis on paper at *p*H 7.

(3) After hydrolysis with acid, the sample of synnematin *B*, like that of cephalosporin *N*, showed two main spots on paper chromatograms, corresponding to penicillamine and D-α-aminoadipic acid respectively. D-α-Aminoadipic acid was isolated from the hydrolysate. Dinitrophenyl α-aminoadipic acid was isolated from a hydrolysate of the product obtained by allowing synnematin *B* to react with 1-fluoro-2 : 4-dinitrobenzene.

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## Some Observations on the Crystal Structure of a Chlorine-substituted Vitamin $B_{12}$

WE have recently obtained direct confirmation of the correctness of certain features of our outline structure of vitamin $B_{12}$[1] in a rather interesting way.

It has been shown by Ford *et al.*[2] that an *E. coli* mutant requiring $B_{12}$ can produce biosynthetically, from factor *B* and various substituted benziminazoles, vitamin $B_{12}$ analogues containing benziminazoles other than 5 : 6-dimethylbenziminazole. One of these, in which the two methyl groups are replaced by chlorine atoms, has since been prepared for us by Dr. K. H. Fantes and Mrs. C. H. O'Callaghan, of Glaxo Laboratories, by a method similar to the one previously used for obtaining the benziminazole analogue of vitamin $B_{12}$[3]. Air-dry crystals of this chlorine-containing compound give X-ray photographs which are exceedingly similar to those of air-dry vitamin $B_{12}$; only in a few cases, changes in the relative intensities of the weaker X-ray reflexions can be observed by eye. From measured intensities recorded on a Weissenberg photograph of one of the chlorine-containing crystals, we calculated a projection of the electron density down the crystal needle axis, [001], using signs based on the cobalt atom contributions previously found for air-dry $B_{12}$ itself. The depth of the electron-density projection here is 16 A.; accordingly few, if any, of the atoms present can appear separately resolved. But at exactly the positions expected for the methyl groups from our earlier analysis, extra electron density appears

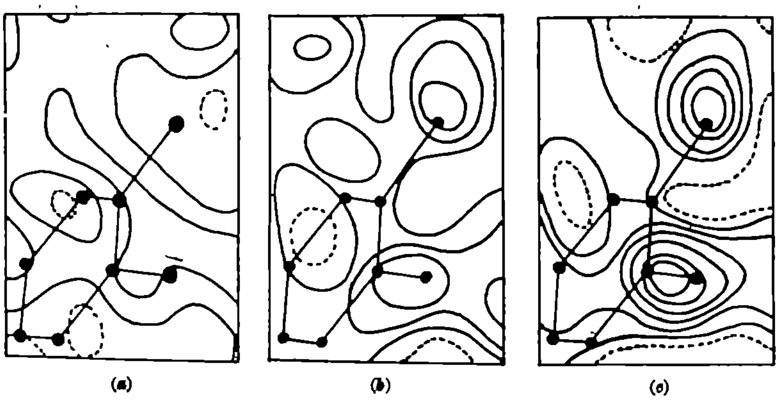

Fig. 1. Electron density over the benzene ring seen in projection down the *c* axis for (*a*) air-dried $B_{12}$; (*b*) chlorine-substituted $B_{12}$, calculated with terms having signs based on cobalt contributions alone; (*c*) chlorine-substituted $B_{12}$, calculated with terms based on signs derived through intensity changes on isomorphous replacement. Contours at intervals of 2 $e/A^2$ above the 4 *e* contour which is dotted

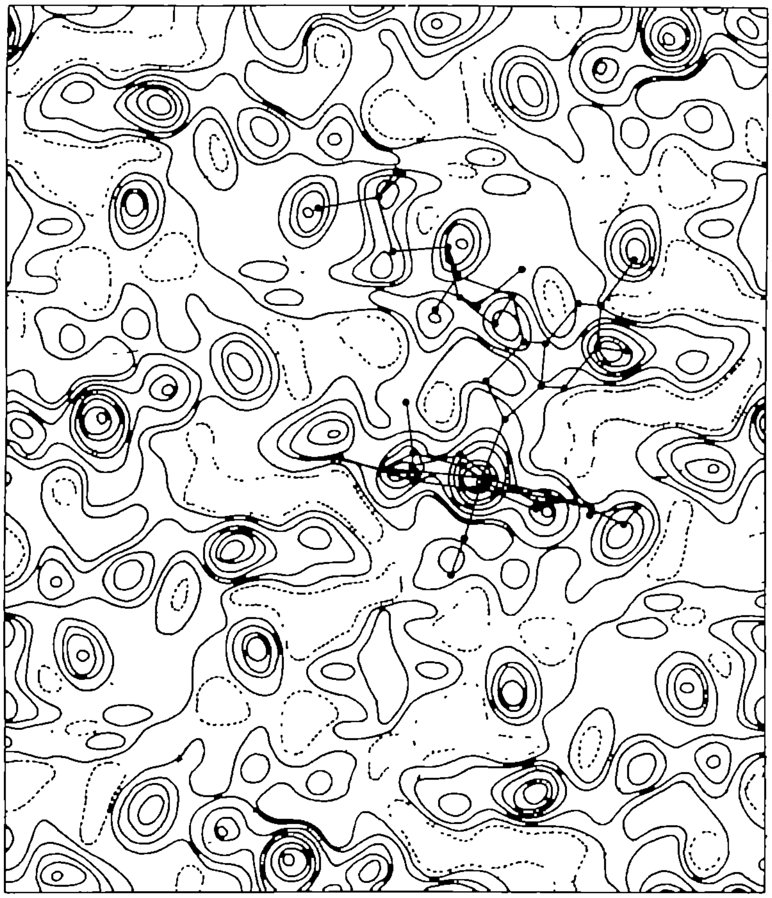

Fig. 2. Electron density calculated for chlorine-substituted vitamin $B_{12}$ seen in projection down the *c* axis and corresponding with Fig. 1(*c*). The positions derived for atoms in the 'planar' group, benziminazole, ribose and phosphate groups in air-dried $B_{12}$ crystals are drawn in

corresponding with the change methyl to chlorine (Fig. 1 *a*, *b*), while the rest of the electron-density pattern is largely unchanged. If we now accept these positions as the sites of the methyl or chlorine groups, we can calculate precisely the changes to be expected in the structure factors from the changes in scattering factor methyl to chlorine. Direct comparison with the observed changes shows good general agreement and makes it possible considerably to improve the sign determination over that based on the cobalt atom positions alone; 5 terms change sign and 17 additional terms can be given signs, making it possible to insert 73 out of a total of 81 terms in a new electron-density calculation. The electron density projection shown in Fig. 1 *c* and Fig. 2 is the new, sign-determined, projection of electron density for the chlorine-containing vitamin.

These observations prove that the atoms of the benziminazole group are closely in the positions derived for them in the earlier work on vitamin $B_{12}$ itself, with N3 directly linked to the cobalt atom. They also illustrate how sensitive the intensities of the X-ray reflexions are even to small changes in chemical composition and they confirm the reliability of the methods we are using for structure analysis. The absolute scale of the observed intensities, for example, we derived by the statistical method suggested by A. J. C. Wilson[4]. No modification of scale proved necessary to correlate the old observations on $B_{12}$ itself with those of the chlorine-containing vitamin. Again, neither chlorine (atomic number 17) nor cobalt (27) has a high scattering factor relative to the total $F_{000}$ of about 800 calculated for the whole $B_{12}$ molecule + water of crystallization. But both these scattering factors, and that of 16 for the difference 2Cl–2Me, are of sufficient magnitude relative to the estimated statistical average $\bar{F}_{hkl}$ of about 42, in the scale of one $B_{12}$ molecule, to be used in phase determination. The present measurements illustrate very clearly the reality of the low electron density peak pattern observed in the three-dimensional distribution calculated for air-dry $B_{12}$ with terms phased on cobalt contributions alone and previously used for atom placing; and the proof that this peak pattern was an accurate indication of the positions of the atoms of the benziminazole group gives us all the more confidence in accepting it as evidence for the structure of the chemically unknown part of the $B_{12}$ molecule[4].

The use of micro-organisms for synthesizing heavy-atom derivatives for crystallographic purposes is not quite new. Dr. E. Kleiderer and Dr. O. Behrens (Lilly Laboratories) did very kindly prepare iodobenzylpenicillin by a similar fermentation process for crystallographic examination in 1946; only the fact that the structure of penicillin was by that time established made unnecessary the further investigation of this compound by X-ray analysis. It seems likely that this synthetic approach may prove useful in other still more complex investigations of natural products.

We are much indebted to Dr. K. Fantes, Mrs. O'Callaghan and Dr. E. Lester Smith for the crystals of the chlorine-substituted vitamin.

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## An Effect of Antibiotics produced by Plankton Algae

The clear blue oceanic water in the tropics and subtropics, where the standing crops both of phytoplankton and zooplankton are extremely low—the reason why the water is so clear and blue—should on this account show very low organic productivity by the plankton algae. Measurements with the carbon-14 method have shown this to be true[1].

So-called 'light-and-dark bottle' oxygen experiments by Riley[2], verified by other workers, seem, however, to indicate that the areas with the clear, blue water should be some of the most productive sea areas of the world. Steemann Nielsen[1] therefore rejected the use of the oxygen method in clear oceanic water. The difference in oxygen consumption between light and dark bottles, which was assumed by Riley to be due to photosynthesis, may have nothing to do with this process. It was suggested that antibiotics produced by the plankton algae in the light reduce the intense bacterial activities occurring in the dark bottles as soon as natural sea water is enclosed in bottles. In ocean water from all depths, about 5 mgm. organic matter is present per litre. The intense bacterial activity does not occur if the water is *in situ* (Keys, Christensen and Krogh[3]). The presence of the surface at the inner walls of the bottles is responsible for the bacterial growth[4].

Laboratory experiments with the freshwater green alga *Chlorella pyrenoidosa* and the marine diatom *Thalassiosira nana* have now produced the experimental background for this suggestion. Two of these experiments are presented below.

(1) Normal culture medium for *Chlorella* containing 8 mgm. glucose and 4 mgm. peptone per litre was incubated with bacteria, and a definite very small number of *Chlorella*. The rate of photosynthesis per cell was measured in advance in a special experiment using a higher concentration of the alga but the same oxygen technique as in the main experiments. Normal 'light-and-dark bottle' oxygen experiments were carried out here lasting three days including three light periods (44 hr. altogether) alternating with three dark periods. The rate of photosynthesis during the whole experiment, computed from the special experiment and corrected for growth, was 0·024 ml. oxygen per litre.

| | |
|---|---|
| Oxygen consumption in dark bottles | 3·59 ± 0·02 ml. oxygen per litre |
| Oxygen consumption in light bottles | 2·92 ± 0·03 ml. oxygen per litre |
| Reduction in oxygen consumption in light bottles compared with dark bottles | 0·67 ± 0·04 ml. oxygen per litre |

The oxygen consumption in the dark bottles is due to the respiration by the bacteria. The rate of this respiration is thus reduced in the light bottles. It is evident that the difference between the light and the dark bottles is not due to *Chlorella* photosynthesis, which constitutes only 3–4 per cent of this difference. In a corresponding series made simultaneously with bacteria but without *Chlorella* added, the oxygen consumption was the same in the light and in the dark bottles.

(2) Similar experiments were carried out with a culture of the marine plankton diatom *Thalassiosira nana* inoculated with bacteria from the Sound. In a 'light-and-dark bottle' oxygen experiment lasting three days (48 hr. in the light), oxygen consumption was 4·96 ml. per litre in dark bottles and 4·34 ml. in light bottles. The reduction in light bottles compared with dark bottles was 0·62 ml. oxygen per litre. According to experiments made with a 300-times higher concentration of the diatom during 4 hr., the rate of photosynthesis per 48 hr. in the main experiment—corrected for growth—was 0·035 ml. oxygen per litre. Photosynthesis presents thus only 5·7 per cent of the difference between the light and dark bottles.

The experiments presented show that the presence of algae, presumably due to production of antibiotic, effects a reduction in the oxygen consumption of the bacteria in the light bottles. The production of antibiotics by plankton algae has been shown, for example, by Pratt *et al.*[5]. It was verified during the present investigation that antibiotics may be found in filtrates from algal cultures.

Whereas in oligotrophic water in Nature the reduction of bacterial respiration due to antibiotics makes the oxygen technique inapplicable for measuring organic productivity, the influence in eutrophic water must be very limited.

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## A Possible New Vitamin $A_1$ Isomer in the Eyes of Crustaceans

In a recent communication, Kampa[1] reports a new photosensitive pigment in the eyes of euphausiid crustaceans. This prompts the recording of some observations at this laboratory from a series of investigations of vitamin A components in marine animals.

During this investigation we recently obtained a fresh sample of the deep-sea prawn, *Pandalus borealis*. The vitamin A content of the eyes of this decapod was determined by our routine method, namely, chromatography of the unsaponifiable matter mainly according to Gridgeman *et al.*[2]. The ultra-violet absorption curve departed to the left from the expected vitamin $A_1$ curve, $E_{310 m\mu}/E_{325 m\mu} = 0{\cdot}926$, $E_{300 m\mu}/E_{325 m\mu} = 0{\cdot}823$, and $E_{350 m\mu}/E_{310 m\mu} = 0{\cdot}424$. The vitamin A content was 150 I.U. per gm. fresh tissue. No vitamin $A_2$ was present, $E_{693 m\mu}/E_{620 m\mu}$ in the Carr–Price reaction being 0·005.

The maleic acid anhydride reaction, according to Robeson and Baxter[3], gave 70·6 per cent recovery, showing mainly or only *cis*-configuration. The prawns had been exposed to daylight during sampling and removing of the eyes, thus complete bleaching may be assumed. These results, together with the biological potency of 50 per cent compared to the chemical estimations as observed by Fisher *et al.*[4], point to the occurrence of a new vitamin $A_1$ isomer in crustacean eyes, possibly the Δ-3.5-di-*cis*-isomer, postulated by Hubbard and Wald[5]. Unfortunately, fresh samples of these crustaceans cannot be obtained until next winter, thus further investigations have to be postponed.

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# High-potency Vitamin $A_2$ Oils from Indian Freshwater Fish

Vitamin $A_1$ occurs predominantly in the liver oils of marine fish, whereas vitamin $A_2$ is found largely in freshwater fish liver oils. The mode of action of vitamins $A_1$ and $A_2$ is not certain; but their role in vision, giving rise to the pigments rhodopsin and porphyropsin respectively, in the retina is now well established[1]. Due to paucity of high-potency freshwater fish liver oils as well as their labile nature, vitamin $A_2$ has not yet been obtained in a crystalline form. The spectroscopic properties[2,3] and the biological activity[4] of vitamin $A_2$, which is approximately 40 per cent of that of vitamin $A_1$, have been determined with the purest preparation obtained.

Data on the vitamins A content of Indian freshwater fish liver oils measured spectrophotometrically are not available, and not much is known of the relative distribution of vitamins $A_1$ and $A_2$. The present communication gives the result of work carried out on fish in large freshwater reservoirs in the States of Mysore and Madras.

Fresh livers were ground with acid-washed sand and anhydrous sodium sulphate, and oil was extracted with light petroleum (40–60°). The combined extracts were reduced in bulk at low pressure (yield of oil, approximately 5 per cent). An aliquot of the oil was saponified, made up to a known volume in spectroscopic *cyclo*hexane, and absorption spectra and colour test were determined without delay using a Beckman spectrophotometer. The assay of the oil was carried out according to the standard spectrophotometric method of Cama and Morton[3]. The vitamins $A_1$ and $A_2$ content of these highly potent oils are recorded in Table 1. Investigations by chromatographic technique[5] on the oils were also carried out using 5 per cent weakened Merck alumina. The results on one oil are recorded in Table 2.

Table 1. Spectroscopic Data on Freshwater Fish Liver Oils using Ultra-violet Spectra and the Antimony Trichloride Colour Test

| Name of species | *E*(1%, 1 cm.) 351 mμ vitamin $A_2$ | *E*(1%, 1 cm.) 693 mμ vitamin $A_2$ | *E*(1%, 1 cm.) 620 mμ vitamin $A_1$ | Corrected | |
|---|---|---|---|---|---|
| | | | | *E*(1%, 1 cm.) 351 mμ vitamin $A_2$ | *E*(1%, 1 cm.) 325 mμ vitamin $A_1$ |
| 1. *Callichrous bimaculatus* | 259 | 618 | 329 | 211 | 26 |
| 2. *Ophiocephalus striatus* | 265 | 582 | 311 | 200 | 25 |
| 3. *Wallago attu* | 127 | 307 | 157 | 106 | 11 |

Table 2. Spectroscopic Properties of Fractions obtained by Chromatography of *Wallago attu* Oil on 5 per cent Weakened Merck Alumina

| Fraction | Solvent | Max. (mμ) | *E*(1%, 1 cm.)* 350 mμ | Component |
|---|---|---|---|---|
| 1 | Light petroleum (40–60° C.) | 350, 370, 390 | 0·121 | Anhydro-vitamin $A_2$ |
| 2 | ,, ,, | 290, 336·7, 345 | 1·72 | — |
| 3 | ,, ,, | 285, 350 | 86·80 | Vitamin $A_2$ ester |
| 4 | 2% ether-light petroleum | 330 | 14·00 | Vitamin $A_1$ alcohol |
| 5 | 5% ,, ,, | 330, 350, 370, 390 | 2·25 | — |
| 6 | 10% ,, ,, | 285, 350 | 12·65 | Vitamin $A_2$ alcohol |
| 7 | 15% ,, ,, | 330, 355, 370 | 0·933 | — |
| 8 | 20% ,, ,, | 336·7, 350 | 0·844 | — |
| 9 | Ether | 330 | 1·81 | Oxidized vitamins $A_1$ and $A_2$? |

Gross *E*(1%, 1 cm.) at 350 mμ of the whole oil, 127·0. Total *E*(1%, 1 cm.) at 350 mμ of the fractions, 121·128.

* Expressed in terms of weight of original oil.

From the results in Table 1, it is evident that vitamin $A_2$ predominates largely over vitamin $A_1$ ($A_2/A_1$ approximately 9/1). Moreover, the oils have a very high vitamin $A_2$ content relative to oils previously reported in the literature[6]. Chromatographic investigations show that most of the vitamin $A_2$ in the oil is present in the ester form without the simultaneous presence of vitamin $A_1$ ester (presence of 693 mμ band and absence of 620 mμ band with the antimony trichloride colour test on the vitamin $A_2$ ester fraction). Vitamin $A_1$ is present in the alcohol form only, and a small amount of vitamin $A_2$ alcohol was also present. This was also confirmed for the other two highly potent oils.

Attempts are being made to extract large quantities of such typical oils for further detailed studies and characterization.

We wish to thank Dr. H. D. R. Iyengar, fisheries officer, Mysore State, and Mr. M. Unni, assistant director of fisheries, Mettur Dam, for help in procuring the fish livers in a fresh condition, and Prof. K. V. Giri for his interest in the work. The financial assistance of the Council of Scientific and Industrial Research is gratefully acknowledged.

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## Adrenaline and Noradrenaline in Tissues of Normal, Insulin-treated, and Adrenalectomized Rats

ADRENALINE and noradrenaline have been estimated in nine rat tissues using an extension of the method of Weil-Malherbe and Bone for blood[1–3]. Satisfactory evidence for the specificity of the procedure has been obtained from comparisons with biological assay and by paper chromatography. The mean concentrations of noradrenaline and adrenaline in rats with a mean weight of 235 gm., and the means of the percentages of adrenaline in the mixture of amines (referred to below as 'adrenaline/catechol ratio') are shown in Table 1. The latter is both higher and more uniform than has been found by other workers and corresponds with the higher 'adrenaline/catechol ratio' found by Weil-Malherbe and Bone in blood[2,3]. The distribution of noradrenaline does not appear to support the current hypothesis that in general its concentration can be correlated with the density of adrenergic nerve fibres[4,5].

Table 1

| Organ | Noradrenaline (mμgm./gm.) | Adrenaline (mμgm./gm.) | Adrenaline (per cent) |
|---|---|---|---|
| Heart (20)* | 530 ± 47·7 | 179 ± 19·0 | 25·9 ± 1·66 |
| Brain (6) | 458 ± 53·8 | 212 ± 8·05 | 30·7 ± 1·71 |
| Spleen (8) | 230 ± 45·9 | 74·4 ± 12·9 | 25·4 ± 2·62 |
| Diaphragm (20) | 219 ± 12·0 | 54·1 ± 6·53 | 19·6 ± 2·12 |
| Kidney (20) | 158 ± 17·3 | 42·7 ± 5·00 | 21·9 ± 1·48 |
| Liver (20) | 87·1 ± 7·23 | 24·6 ± 3·64 | 21·0 ± 1·68 |
| Retroperitoneal fat (8) | 62·0 ± 13·8 | 20·2 ± 5·57 | 23·1 ± 3·79 |
| Lung (8) | 61·6 ± 7·33 | 22·9 ± 1·57 | 28·0 ± 2·78 |
| Leg muscles (20) | 52·4 ± 3·90 | 15·0 ± 1·53 | 22·4 ± 1·80 |

* Number of estimations

The effects of insulin on the concentrations of adrenaline and noradrenaline in heart, kidney, liver, diaphragm and leg muscles have been investigated by analyses carried out 2½ hr. after subcutaneous injection of 7 units insulin/100 gm. body-weight. Insulin produced significant increases ($P < 0.01$ or $0.001$) of the 'adrenaline/catechol ratio' in all five organs. There were significant increases ($P < 0.001$) in the absolute concentrations of adrenaline in heart and kidney (64 and 42 per cent respectively), and a significant increase (23 per cent) of noradrenaline in the heart. The increased concentrations of adrenaline brought about by insulin were not nearly so marked as those found by Hökfelt[6] in the heart and liver of rats; this may be largely due to his lower initial concentrations of adrenaline. In contrast also to his findings, there were only probably significant differences between the effects of insulin actions of ½, 2 and 3½ hr. duration.

The concentrations of adrenaline and noradrenaline in heart and kidney were investigated six weeks after bilateral demedullation, and three to four weeks after bilateral adrenalectomy in untreated rats and in rats given insulin. Both operations reduced the adrenaline concentrations of heart and kidney, and in kidney the noradrenaline concentration was also reduced; in the heart it was increased. The greatest change was a 31 per cent loss of noradrenaline in the kidney.

In demedullated and adrenalectomized rats, insulin did not significantly increase the adrenaline concentration of either heart or kidney ($P > 0.1$), but still produced probably significant increases of the 'adrenaline/catechol ratios'. The altered effect of insulin on adrenaline concentration brought about by operation was very significant for heart muscle ($P < 0.001$). In heart muscle, operation also significantly altered the effect of insulin on noradrenaline concentration, from an increase to a decrease. The changes of adrenaline and noradrenaline concentrations which are produced by insulin in hearts of normal rats seem therefore to depend on medullary secretion. This may be in contrast to kidney, in which operation changed, probably significantly, only one of the effects of insulin, namely, it reduced the usually large rise in adrenaline concentration.

The presence of fairly high concentrations of adrenaline and noradrenaline in heart and kidney some weeks after adrenalectomy seems to indicate the ability of the rat to synthesize or store these amines, either in the heart and kidney, or in other organs from which transfer takes place. Transfer to the kidney occurs in the course of excretion[3].

Three experiments have been carried out on the effect of age (weight) on the percentage of adrenaline in the mixture of catechol amines in the heart and kidney of normal rats and of rats given insulin. The 'adrenaline/catechol ratios' are shown in Table 2.

Table 2

| | Mean weight of rat, 145 gm. | Mean weight of rat, 240 gm | Difference |
|---|---|---|---|
| Heart (untreated) | 21·2 per cent | 26·5 per cent | + 5·3 |
| Heart (insulin) | 33·6 ,, ,, | 39·1 ,, ,, | + 5·5 |
| Kidney (untreated) | 23·7 ,, ,, | 33·1 ,, ,, | + 9·4 |
| Kidney (insulin) | 35·2 ,, ,, | 39·5 ,, ,, | + 4·3 |

The 'adrenaline/catechol ratios' were higher in both the heart and kidneys of the older rats. This ratio in the kidney was less affected by insulin in the older rats than in the younger ones.

Experiments with cortisone are being carried out, and the results, together with the above findings, will be published in detail elsewhere. The work has been supported by a grant from the Medical Research Council.

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## Studies on Transaminase and Decarboxylase catalysed by Extracts of the Silkworm, *Bombyx mori* L.

IN the course of work[1] on the transamination reactions between aspartate and α-ketoglutarate mediated by extracts of the gland and intestines of the silkworm, *Bombyx mori* L., an entirely new ninhydrin-positive spot with an $R_F$ value different from either the glutamate produced or added aspartate was observed when the reaction mixture was resolved on Whatman No. 1 filter paper employing butanol/formic acid/water (10 : 2 : 5) as the solvent.

It was suggested that this additional spot represents a peptide produced by enzymic transpeptidation[2]; but further work on transpeptidation with glycyl peptides and glutathione as the substrates did not confirm this view. A more detailed examination has therefore been made of the circumstances giving rise to this additional spot.

A number of solvents were employed to achieve better separation of the various constituents encountered in this work. While solvent systems like 80·0 per cent aqueous pyridine or propanol could be successfully employed for resolving the new spot from the mixture of aspartate and glutamate, these two salts themselves were inseparable, and therefore water-saturated phenol was employed. After resolving the various constituents from the 'reaction mixture', the position due to the new spot, determined separately by running a test strip and staining it with ninhydrin, was eluted, hydrolysed and re-chromatographed; but the position of the spot on the second chromatogram did not alter and corresponded to α-alanine. On subjecting another aliquot of this sample and an authentic specimen of α-alanine to chemical deamination with nitrous acid[3], lactic acid was detected from the deamination reaction product, confirming the identity of this substance with α-alanine. The route of formation of α-alanine from aspartate is through β-decarboxylation, and therefore the enzyme which catalyses this reaction is termed β-decarboxylase.

Amino-acids active in these transamination reactions other than aspartate are α-alanine, phenylalanine and the amide of aspartic acid. Aspartate is by far the most active among these compounds. When asparagine is employed as the substrate instead of aspartate, transaminase activity is diminished by about 65·0 per cent. Decarboxylase is, however, completely inhibited, because the β-carboxyl group in asparagine is replaced by the amide linkage.

Further, there is no appreciable decarboxylation even with aspartate when the latter is employed alone as the substrate. Addition of traces of α-ketoglutarate (*M*/2,000) to enzyme–aspartate mixture in a buffer of *p*H 7·0 increases the activity to 400 per cent. This concentration of the keto-acid is so small that activity due to transamination is not appreciable and even not detectable. Dialysis of the crude extract against distilled water at 0° C. inactivates irreversibly the activity due to decarboxylase, but does not affect transaminase activity. The effect of carbonyl-trapping agents such as hydrazine, hydroxylamine and semicarbazide on both transaminase and decarboxylase are similar, and are inhibited to more or less the same extents. Addition of pyridoxal phosphate to dialysed enzyme extracts does not, however, restore the decarboxylase activity.

A similar enzyme system bringing about decarboxylation of aspartate in the β-position has been shown to occur in cell-free extracts and cell suspensions of *Cl. welchii SR* 12, which is also stimulated by the addition of traces of a large number of α-keto-acids[4].

The discovery of an enzyme system in the glands of the silkworm capable of converting aspartate to α-alanine is of particular significance from the point of view of the synthesis of precursors of silk fibroin. This mechanism secures for the organism an additional source of endogenous α-alanine, which constitutes about 20·0 per cent on the weight of silk.

I thank Profs. M. Sreenivasaya, J. V. Bhat and M. S. Thacker for their interest in this work, and the Central Silk Board for financial assistance. It is hoped to publish a fuller account elsewhere.

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## Effect of 8-Azaguanine on Enzyme Formation

The dependence of enzyme formation on nucleic acids has now been established by studies with disrupted *Staphylococci*[1]. It is not yet clear whether the presence of ribonucleic acid as such or the process of synthesis of ribonucleic acid is essential for enzyme synthesis. Gale and Folkes[1] found that the development of certain enzyme systems was enhanced by the presence of ribonucleic acid extracted from the cells, whereas such extracts were without effect in promoting the synthesis of β-galactosidase, which required the presence of a mixture of purines and pyrimidines and was abolished by ribonuclease. Pardee[2], studying the formation of β-galactosidase in mutants of *Escherichia coli* requiring uracil, found that enzyme formation only took place in the presence of added uracil and, if the supply of uracil was limiting, enzyme synthesis ceased as soon as the supply of uracil was exhausted. He concluded that ribonucleic acid synthesis was essential for enzyme formation, the finished nucleic acid being metabolically inert. Similar conclusions have been drawn by Spiegelman, Halvorson and Ben-Ishai[3] as a result of investigations on inducible enzyme synthesis in *Escherichia coli* and in yeasts.

It has been shown previously that the formation of the adaptive enzyme β-galactosidase in *Staphylococcus aureus* is inhibited by the purine analogues 2 : 6-diaminopurine and 8-azaguanine, the latter becoming incorporated into ribonucleic acid[4]. It was suggested that such incorporation rendered the ribonucleic acid non-functional in enzyme formation. It has now been found that the synthesis of catalase and glucozymase by *Staphylococcus aureus* is also sensitive to azaguanine under certain conditions. When enzyme formation takes place in intact washed cells which have been grown anaerobically in glucose, and then incubated in a medium containing salts, amino-acids, glucose and galactose, the formation of β-galactosidase and catalase is almost completely suppressed by 100 μgm. azaguanine/ml. If glucose is omitted from the incubation mixture, incorporation of azaguanine is decreased and inhibition of enzyme formation lessened. Fig. 1 shows the effect of adding azaguanine to the incubation mixtures at intervals during the synthesis of β-galactosidase.

If the analogue is added at the beginning of the experiment, no enzyme formation occurs; if it is added after induction has taken place, enzyme formation is inhibited and ceases soon after the addition. Similar results have been obtained for the formation of either catalase or glucozymase, under appropriate conditions.

The inhibition of enzyme formation by azaguanine can be reversed by the further addition of guanine, xanthine or hypoxanthine. Reversal is not obtained

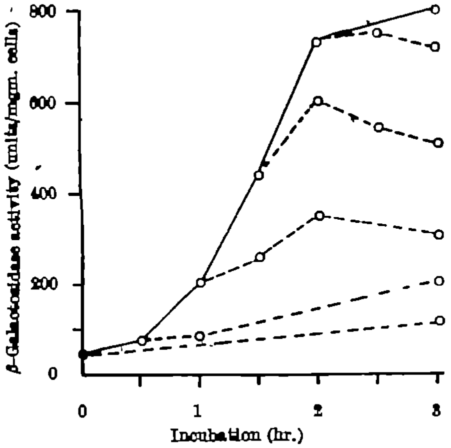

Fig. 1. Effect of time of addition of azaguanine to systems synthesizing β-galactosidase. System comprised *Staph. aureus* (2 mgm./ml.), 17 amino-acids (400 μgm./ml. of each), glucose (1 mgm./ml.), galactose (20 mgm./ml.) in a buffered salts solution. Azaguanine (100 μgm./ml.) added at time 0, 0·5, 1·0, 1·5 and 2 hr. Formation of β-galactosidase in control system shown in full lines; formation of enzyme after the addition of azaguanine shown in broken lines

by uracil or thymine and only rarely by adenine. When the inhibition is reversed by guanine, the incorporation of azaguanine into the ribonucleic acid does not diminish but there is a considerable formation of new ribonucleic acid, as measured by the incorporation of $^{14}$C-uracil. Reversal can be brought about by addition of guanine up to 90 minutes after the addition of the analogue; if incubation with azaguanine has taken place for longer than this period, no reversal of the inhibition of catalase formation can be obtained; reversal of the inhibition of β-galactosidase formation is still possible, although synthesis occurs at less than the control rate after addition of guanine.

In the case of glucozymase formation, sensitivity to azaguanine varies with the phase of culture of the cells used for the experiment. Fig. 2 shows that synthesis of glucozymase in cells harvested during the exponential phase of growth is little affected by concentrations of azaguanine which abolish β-galactosidase formation. As growth ceases, the synthesis of glucozymase becomes more sensitive to azaguanine; the synthesis of β-galactosidase is completely sensitive to the analogue at all phases of growth. It seems probable that the synthesis of β-galactosidase is dependent upon a co-synthesis of ribonucleic acid, so that the present results are in agreement with the suggestions put forward by Pardee[2] and Spiegelman *et al.*[3]. Nevertheless, the results in Fig. 2 indicate that it is not possible to draw conclusions on protein synthesis in general from studies on inducible enzymes only, since the formation of glucozymase, under certain conditions, appears to be little dependent on coincident ribonucleic acid synthesis.

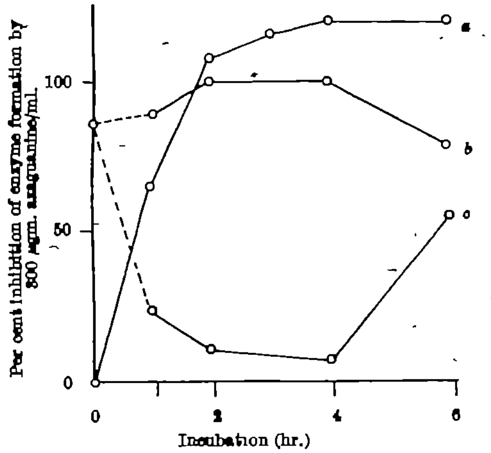

Fig. 2. Sensitivity of enzyme formation to azaguanine at various stages of growth. Cells growing in a glucose/casein hydrolysate medium. Samples were taken at times indicated and the ability of the cells to synthesize enzyme, in the system described for Fig. 1, in the presence or absence of azaguanine (300 μgm./ml.) determined. *a*, Growth; *b*, β-galactosidase formation; *c*, glucozymase formation

The above results can be correlated with the conditions necessary for the development of enzymes in disrupted *Staphylococci*, as described by Gale and Folkes[1]. They found that, whereas synthesis of glucozymase was stimulated by staphylococcal ribonucleic acid, β-galactosidase formation required a supply of purines and pyrimidines and was not affected by staphylococcal ribonucleic acid. All these findings could be explained on a basis of differing degrees of functional stability of the various nucleic acids concerned in the syntheses of different enzymes.

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## Occurrence of Chitin in the Epicuticle of an Arachnid *Palamneus swammerdami*

In a previous communication[1], it has been pointed out that the epicuticle of *Palamneus swammerdami* conforms to the basic pattern suggested for insects in consisting of a non-chitinous lipoprotein layer overlaid by a layer of wax. However, more extended observations carried out since then indicate the presence of chitin in this layer, which is masked in some way so that it is not readily revealed by the usual histochemical tests. Blower[2] reported that in myriapods a layer of the cuticle, which he considered the outermost, resembles the epicuticle of insects in histochemical and staining reactions. Only the presence of chitin in it prevented him from homologizing it with the epicuticle. However, he ignored the presence of a layer external to the one he described as the outermost, for he doubted its histological validity, considering it as a diffraction effect. In a recent study of *Palamneus*[1,3], it has been shown that the layer referred to by Blower corresponds to the exocuticle and is distinct from the epicuticle, which lies external to this layer. Cloudsley-Thompson[4] also described in arachnids and myriapods a similar colourless epicuticle external to the tanned exocuticle. The present communication gives the evidence for the presence of chitin in the epicuticle.

The epicuticle of *Palamneus*, which can be separated by treatment of entire cuticle with chlorated nitric acid, is a thin whitish membrane. From a study

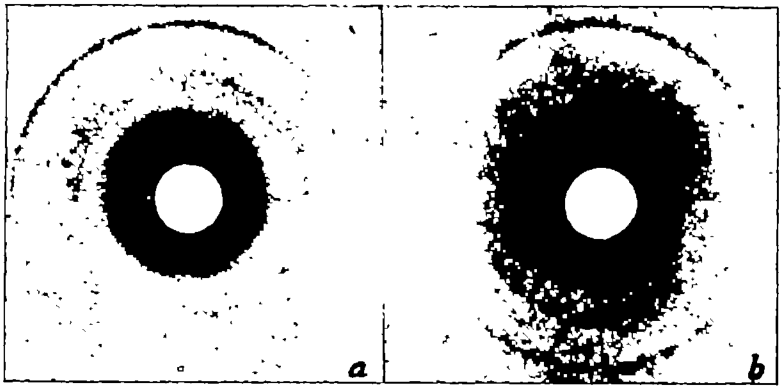

Fig. 1. X-ray diffraction patterns of (*a*) epicuticle of scorpion, and (*b*) purified chitin from cuticle of cockroach, both taken with the surface perpendicular to the X-ray beam under identical conditions (*d* = 5 cm., copper $K\alpha$ radiation)

of the sections of this membrane stained with Mallory, it was found that it agrees in all respects with the epicuticle already described[3]. X-ray diffraction patterns of this membrane taken with the X-ray beam both parallel and perpendicular to the surface showed the presence of spacings identical with those found for chitin[5]. A comparison of the diffraction pattern of the scorpion epicuticle with that of the cockroach, which is known to contain only protein, brings out clearly the entirely dissimilar nature of the two epicuticles, as the latter pattern shows no details except a central halo. On the other hand, the diffraction pattern of the scorpion epicuticle was found to show a remarkable similarity to that obtained with purified chitin (Figs. 1*a* and *b*). In view of this surprising observation, chemical tests were made on this membrane.

A portion of the membrane was prepared for the chitosan test by treating it with concentrated potassium hydroxide for 6 hr. at 180° C. On addition of iodine and sulphuric acid, it took up a deep orange colour. Controls prepared with crab cuticle showed that the epicuticle was dissolved by the potassium hydroxide treatment, and the endocuticle which survived was coloured deep violet, a characteristic of chitosan. On adding 3 per cent acetic acid the material from the crab treated with potassium hydroxide dissolved; but in the case of the scorpion epicuticle there was no such effect. However, the scorpion preparation reacted to treatment with concentrated nitric acid, by which it was disrupted. The results recorded above for the epicuticle of *Palamneus* differ in some respects from those obtained for chitin. But the fact that it is able to survive intact violent treatment such as is involved in the chitosan test is suggestive of the presence of chitin. It is remarkable that chitin is still present in the epicuticle, even though this layer has been isolated by subjecting it to prolonged treatment with chlorated nitric acid. Probably its combination with —S—S-bonded proteins may be responsible for this feature. This assumption is supported by the observation that treatment with alkaline sodium sulphide produces a disruptive effect on the material treated with potassium hydroxide. It has already been shown that alkaline sodium sulphide affects the —S—S-bonding in the epicuticle of *Palamneus*[3]. It is therefore suggested that the presence of a protein moiety in combination with chitin may be responsible for this material not giving a positive chitosan reaction.

Further confirmation of the presence of chitin was obtained by hydrolysing the epicuticular material in 4 *N* hydrochloric acid for 8½ hr. in a sealed tube at 100° C. The glucosamine content of the hydrolysate was estimated by the method of Elson and Morgan as modified by Palmer, Smyth and Meyer[6]. The estimated amount of glucosamine was found to be nearly the same as that given by purified chitin under the same conditions, as reported by Hackman[7]. A chromatographic analysis of the hydrolysate for amino-acids indicated the presence of glutamic acid. It appears that the epicuticle consists of chitin with a proportion of protein which, however, does not alter the chitin lattice structure.

A layer corresponding in all respects to the epicuticle of *Palamneus* appears to be present in *Scolopendra* also. The X-ray pattern of this layer is identical with that given by the epicuticle of *Palamneus*.

The implications of these observations in relation to the characteristic features of the epicuticle of arthropods will be discussed elsewhere.

We thank Prof. P. S. Sarma for facilities provided for chromatographic work.

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## Measurement of Surface Pigmentation in Animals

An accurate method of measuring the pigmentation of human and other mammalian hair has been described[1]. This consists in dissolving the hair in urea, and, after dilution to a constant volume, measuring the extinction coefficient of the solution. The same procedure, without any modification, has been found to give reproducible results with feathers (domestic fowl), amphibian skin (common frog), fish skin (plaice) and insect scales (cabbage white butterfly and tiger moth). It seems probable that the method can be used for the estimation of surface pigmentation in all types of animals.

The work has been carried out with the aid of a grant from the Government Grant Committee of the Royal Society.

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## A Method for sampling Arthropods and Molluscs from Herbage by Suction

The insect population in herbage, for example, in rough grassland, is commonly sampled by sweeping. Other arthropods such as mites, centipedes, millipedes and also slugs and snails are obtained by trapping, hand-picking, or by removing part of the habitat for extraction in the laboratory. We have developed a new, more universal method, liable to less personal error than sweeping, which extracts a very high proportion of small invertebrates from rough matted grassland with a suction pump. There is no need to remove a part of the habitat, and the method could be applied widely.

The apparatus is a portable electric blower (Type *N.W.B.E.*) as supplied by Wolf Electric Tools, Ltd., London, and run on the mains supply. A metal barrel (10 in. long, 5·5 in. diam.) is attached to the intake, and on the lid of this barrel is a flexible hose ending in a hard rubber nozzle with a 1-in. aperture. A nylon collecting bag fits inside the barrel and is kept in place by the lid. The apparatus weighs 15·5 lb., and is easily carried.

For sampling, a metal cylinder 12 in. × 12 in. is pressed into the grass, the apparatus is switched on and the nozzle worked back and forth over the area within the cylinder. Two successive extractions each of two minutes with a two-minute interval between were found to be satisfactory. Table 1 shows the extraction-rates based on this procedure and on the numbers remaining behind in the herbage and in the upper few millimetres of soil within the metal cylinder (these being sorted by hand from the material brought back to the laboratory). From approximately 23 sq. ft., 2,945 insects, 1,606 other arthropods and 189 molluscs were extracted.

Table 1

| Group | Mean extraction (per cent) | Group | Mean extraction (per cent) |
|---|---|---|---|
| Collembola—(Arthropleona) | 99·3 | Coleoptera (larvæ) | 70·3 |
| Collembola (Symphypleona) | 100 0 | Hymenoptera (Parasitica) | 97·0 |
| Thysanoptera | 97 5 | Diptera (adults) | 99·2 |
| Auchenorhyncha | 98·1 | Diptera (larvæ and pupæ) | 75·5 |
| Aphidoidea | 99·8 | Isopoda | 98·3 |
| Heteroptera | 98·9 | Acarina | 90·2 |
| Staphylinidae | 92·2 | Araneida | 97·4 |
| Ptiliidae | 97·4 | Diplopoda | 86·1 |
| Other Coleoptera | 92·5 | Chilopoda | 66·7 |
| | | Mollusca | 94·7 |

We shall be glad to supply further information. Full details will be published elsewhere.

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## A Water-soluble Filter for trapping Airborne Micro-organisms

In studies of airborne mould spores as a cause of respiratory allergy, there has been a need for a trap which would not only sample the air efficiently out of doors and give a measure of the number of spores per unit volume of air, but which would also allow the spores to be grown on culture media for identification.

Preliminary experiments early in 1952 indicated that a water-soluble 'wool' of sodium alginate could be used to trap spores. The sodium alginate is not available as a wool but has to be prepared from calcium alginate yarn. Initially yarns of four weights were tried (450/160; 150/60; 100/27; and 50/12, denier/filament (continuous), *Z* twist), but the most uniformly textured wool was produced by the 50 denier/12 filament yarn (from Messrs. Courtaulds, Ltd., Use-Development Organisation, 15 Cross Street, Manchester 2).

The calcium alginate yarn is cut into short lengths (5–10 mm.) and stirred into a relatively large volume of water to allow the yarn to untwist to its constituent filaments, then drained on a Buchner funnel. The resultant mass (calcium alginate 'wool') is soaked in hydrochloric acid (approximately *N*) until all calcium has been leeched out. (Test for removal of calcium by allowing a few drops of the acid solution to drip into a solution of ammonium oxalate—no precipitate indicates calcium removed.) The yarn is again drained off, suspended in 50 per cent alcohol and neutralized with sodium hydroxide. (Allow time for the strands in the centre of the mass to react with the alkali.) The yarn is now sodium alginate and is soluble in water. It receives several washes in 50 per cent alcohol, a final wash in absolute alcohol and is dried at room temperature. Best results are obtained by using throughout relatively large volumes of the suspending liquids, so that the alginate strands are always loosely suspended. The final product appears much like a wad of cotton wool, but it is soluble in water up to 1 part in 10 at room temperature. The higher concentrations are very viscous; but a 2 per cent solution in water has a viscosity about four times that of water, and a 1 per cent solution only about 1·5–2 times the viscosity of water. The wool may be sterilized dry at about 125° C.

The sodium alginate wool has been used for trapping airborne micro-organisms in the following way. The filter holder is a cylindrical brass tube 75 mm. long, 12 mm. diameter and 11 mm. bore. At one end the wall is bevelled on the outside to a sharp edge which during sampling is directed into the wind. Fixed transversely across the bore of the tube, 25 mm. from this sharp end, is a pair of crossed wires providing support for the alginate plug, which is rammed in at this end. (About 0·5 gm. of the wool packs into a plug approximately 10 mm. long, which is more than adequate.) The other end of the tube is connected to a pump. When the desired volume of air has been sucked through the plug, it is pushed out into sterile water which, after complete solution of the plug, is made up to the desired volume. Aliquots of this solution are plated out on culture media for incubation and counting.

For taking samples over several hours at the regular trapping site at St. David's Hospital, Cardiff, a wind-vane mounting similar to that described by Hirst[1] has been used for maintaining the sharp end of the filter tube facing the wind. The rate of suction through the filter is controlled at the mean wind velocity recorded at the site by a Casella three-cup anemometer, and thus sampling is approximately isokinetic[2].

To evaluate the efficiency of the plug in filtering off micro-organisms, several runs were made in which air after passing through the alginate plug was immediately bubbled through dilute agar solution. All this solution was plated out on media and incubated. These plates almost invariably remained sterile.

The alginate wool filter has proved to be very useful for sampling airborne fungi and bacteria which can be cultured. It is particularly suited for work with selective media, since aliquots of the solution of one filter can be plated out on several media. If desired, counts of non-culturable spores may be obtained by microscopic examination of the sediment obtained on centrifuging an aliquot of the solution of the filter. When the filter is used in conjunction with a small hand-operated pump, a simple, efficient and readily portable spore-trap results.

The work was performed at the Asthma and Allergy Research Unit, St. David's Hospital, Cardiff, during the tenure of a research grant from the Asthma Research Council, London. I thank Mr. H. A. Hyde and Dr. D. A. Williams for encouragement, Mr. R. H. McDowell of Alginate Industries, Ltd., for technical advice and Messrs. Courtaulds, Ltd., for supplies of calcium alginate yarn.

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## A Direct Measurement of the Energy Locally Absorbed from a Gamma-Ray Beam

THE energy locally absorbed in a material exposed to γ-radiation has usually been determined indirectly from measurements with an ionization chamber, using the Bragg–Gray formula. The calculation involves the use of two quantities the values of which are not accurately known: $W$, the average energy required to produce an ion pair, and $\rho$ the ratio of the stopping powers of the material and the gas. The direct measurement of the energy absorbed presents some difficulties due to the small rise of temperature which is produced. If a dose corresponding to 300 r. is given to a sample of water, the temperature will rise by only $6{\cdot}7 \times 10^{-4}$ deg. C. However, the development of the thermally sensitive resistors known as thermistors has made possible the detection of a change of temperature of less than $10^{-5}$ deg. C.

In this laboratory a radiation calorimeter has been constructed. The sensitive part consists of a cylinder (2 cm. in diameter, 2 cm. in length) of a given material in which are imbedded a thermistor and a heating coil. The cylinder is suspended in an evacuated and aluminized glass vessel placed in a tank of water the temperature of which is controlled. To minimize the effects of heat transfer and self-heating in the thermistor, an identical dummy cylinder is suspended in another evacuated vessel but does not receive radiation. The thermistors are connected to the opposite arms of a d.c. Wheatstone bridge. A change in temperature of one of the cylinders produces an unbalanced voltage which is amplified and recorded on a self-balancing potentiometer. For calibration, a known amount of energy is dissipated in the cylinder by the heating coil. The thermistors used have a resistance of the order of 100,000 ohms and a negative temperature coefficient of − 4·7 per cent per deg. at 25° C. With the present arrangement it is possible to measure a change of temperature of $10^{-5}$ deg. C. with an accuracy better than 1 per cent.

Experiments have been carried out with absorbing cylinders of carbon and aluminium exposed to the beam from our 1,000-curie cobalt-60 unit. The dosage-rate at the position of the cylinders is about 30 r. per minute. After the energy absorption measurements, the cylinders are replaced by air-filled ionization chambers of the same material and same dimensions. The results of a number of experiments are shown in Table 1.

Table 1

| Material | $E_m$ (ergs/gm. min.) | $J_m$ (e.s.u./gm. min.) | $W\rho_m$ (erg/e.s.u.) | $\frac{(\rho_m)\text{Al}}{(\rho_m)\text{C}}$ | $W$ (eV./ion pair) |
|---|---|---|---|---|---|
| C | $2{\cdot}68 \times 10^3$ | $2{\cdot}41 \times 10^4$ | $0{\cdot}111_2 \pm 0{\cdot}0015$ | 1·000 | $33{\cdot}3 \pm 0{\cdot}5$ |
| Al | $2{\cdot}70 \times 10^3$ | $2{\cdot}75 \times 10^4$ | $0{\cdot}098 \pm 0{\cdot}001$ | 0·881 | $33{\cdot}1 \pm 0{\cdot}5$ |

The second column of Table 1 gives the values of the energy absorbed per gm. per min. and is the average of three determinations for each material. The third column shows the corresponding ionization per gm. of air per min. In the fourth column we find the ratio $E_m/J_m = W\rho_m$. Since air was used as the gas in both chambers, the ratio $(\rho_m)\text{Al}/(\rho_m)\text{C}$ can be obtained. This mass stopping-power ratio (0·881) can be compared with the values calculated from the theoretical data of Whyte[1] (0·886) and Spencer[2] (0·866). If we accept Whyte's values for $\rho_m$, we obtain the values of $W$ for air shown in the last column. The values are about 2 per cent higher than the usually accepted value of 32·5 eV./ion-pair and lower than the value of 35·0 eV./ion pair obtained by Valentine[3]. Further measurements are in progress using other materials (for example, water) and other gases.

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## Mineralogy and Crystal Structure of Chamosite

THE occurrence of the hydrous ferrous silicate, chamosite, in sedimentary ironstones was described by Hallimond[1]. Later, with Harvey and Bannister[2], he concluded that chamosite differed from the iron-bearing chlorites. Brindley[3,4] examined chamosites from laterites and other sources, and concluded that they were of kaolin-type. Many of the variations in X-ray diagrams were accounted for by the existence of two kaolin-type structures, one ortho-hexagonal and one monoclinic, with simply related cell dimensions. In common with some other clay minerals, chamosite had random displacements of layers parallel to the $b$-axis of integral multiples of $b/3$, giving rise to sharp $(hkl)$ reflexions only for $k = 3n$. Brindley concluded from the presence of $(hkl)$ reflexions for $h \neq 3n$ that there were no random $a$-axis displacements of layers within a single structure, similar to the 'mistakes' in the cobalt structure of Wilson[5] and Edwards, Lipson and Wilson[6]. The pure ortho-hexagonal form was found in an iron ore from the main oolitic beds at Corby, Northamptonshire, by Brindley and Youell[7].

Many chamosites from British sedimentary ironstones have since been examined. All have proved to be of kaolin-type structure. It was clear that, while the mixture of ortho-hexagonal and monoclinic forms accounted for X-ray data from the lateritic chamosites which formed the majority of Brindley's material, there were many variations in the ironstone chamosites which still required explanation. The monoclinic kaolin structure has not been detected in any of these ironstones.

The variation was almost entirely observable in the (20$\bar{l}$) reflexions. With the exception of the (200) reflexion, which usually remained sharp, these reflexions varied from sharp lines of intensities in accord with the calculated values to weak, diffuse bands. The basal reflexions and some others remained sharp and exhibited no fading comparable with the (20$\bar{l}$) series. It seems clear that the progressive degeneration of these reflexions corresponds to 'mistakes', in Wilson's sense, of random $a/3$ displacements of layers parallel to the $a$-axis. In extreme cases of disorder, all the (20$\bar{l}$) reflexions were absent, and the powder diffraction pattern showed only those lines common to the ortho-hexagonal and monoclinic structures. This disordered chamosite may be regarded as intermediate between the two Brindley structures, the ortho-hexagonal type having no $a/3$ displacements and the monoclinic type having them between all layers.

The degree of disorder can be correlated with the source of the chamosite and its chemical composition. In the main beds of the Northamptonshire Sand Ironstone, the chamosite, here heavily contaminated with siderite, is very highly ordered. Some material gives perfect (20$\bar{l}$) reflexions, but mostly some fading and broadening occur, typically corresponding to a probability of a fault between layers of 0·05. The main seam of the Cleveland ironstone and the Marlstone ironstone from Banbury contain chamosites in which the (20$\bar{l}$) series is present although generally not as perfectly as in the Northamptonshire main bed chamosite. The chamosite–kaolinite beds of the Northampton Sand Ironstone contain a chamosite which exhibits a high degree of disorder. The Frodingham ores contain at least two types, a completely disordered structure from a chamosite mudstone, and a moderately ordered structure in siderite-rich material. The ordered chamosites are rich in iron. Disordered chamosites appear generally to contain less iron and more aluminium. The alteration of the diffraction pattern during oxidation to a ferric chamosite also corresponds to the introduction of $a$-disorder, or to the increase in $a$-disorder if already present. Both the disorder due to oxidation and that due to variation of source may have a common origin in the reduction of the mean octahedral ionic radius. Ferric chamosite formation involves a change from $Fe^{++}$ 0·83 A. to $Fe^{+++}$ 0·67 A., while passage from iron-rich to iron-poor types is accompanied by replacement of $Fe^{++}$ 0·83 A. by $Al^{+++}$ 0·57 A. It is significant that disordered chamosite is almost invariably accompanied by kaolinite, and ordered chamosite by siderite.

The continuous series from $a$-ordered chamosite to $a$-disordered chamosite may be compared with the corresponding aluminous minerals, $a$-ordered fireclay and $a$-disordered metahalloysite.

Thanks are due to Prof. G. W. Brindley for his interest in the work, and to Prof. J. H. Taylor, Dr. W. Davies and Dr. E. Cohen for specimens. A full account of this work will be published later.

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## Structure in Vitreous Silicates as shown by Low-angle Scattering of X-Rays

VITREOUS substances have been characterized by wide-angle X-ray methods as random, three-dimensional networks possessing no long-range order. Some recent experiments at the lower limits of resolution of the electron microscope[1] have cast doubt on the correctness of this description and suggest that there are regions of different amounts of order in many vitreous silicates.

Since vitreous silicates are somewhat analogous structurally to amorphous organic polymers, it was believed that studies of inhomogeneities in both systems might be related. Accordingly, the low-angle X-ray technique which we use for polymeric systems was applied in a brief survey to some silicate preparations. This technique is capable of detecting inhomogeneities and long-range order below the size limitations of the electron microscope[2].

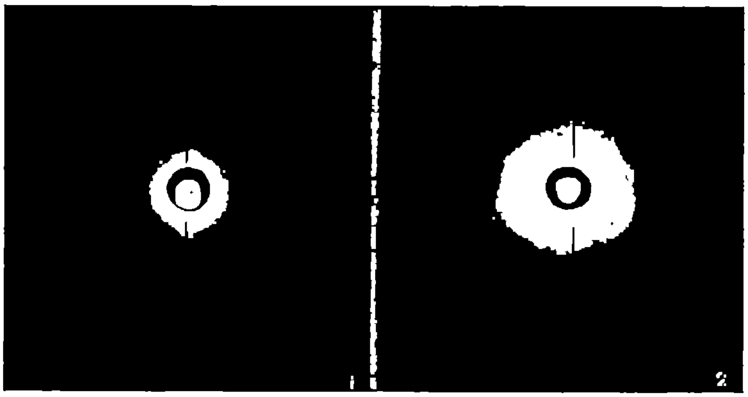

Fig. 1. Low-angle scattering from powder of $Na_2O.MgO.3SiO_2$ quenched into mercury from melt at 1,080° C. Bragg spacing of diffraction ring = 30 A. Sample-film distance = 17 cm.; Kodak 'No-Screen' film, 64-hr exposure; 0·010 in. sample thickness; copper $K\alpha$ (nickel filtered) radiation

Fig. 2. Low-angle scattering from powder of $Na_2O.MgO.3SiO_2$ slowly cooled from melt at 1,080° C. Same exposure conditions as Fig. 1

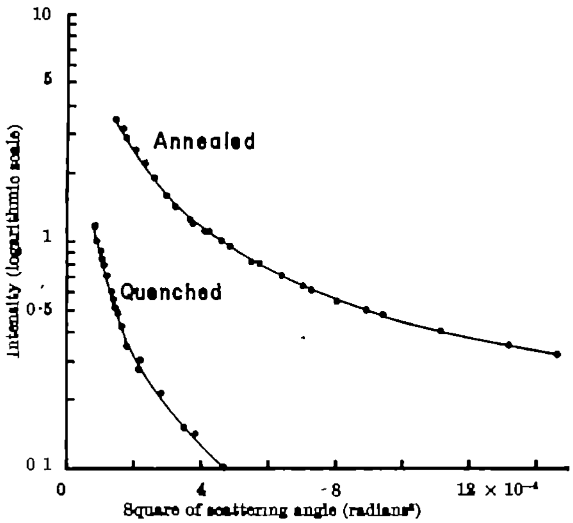

Fig. 3. Diffuse scattering from $Na_2O.MgO\ SiO_2$ powders

X-ray patterns at low angles were obtained using filtered radiation for several powdered-glass compositions subjected to a variety of thermal treatments. It was found that these patterns varied in their amount of diffuse scattering and in the presence of a discrete diffraction ring corresponding to a 30-A. spacing. To our knowledge, neither of these effects has been described for simple glasses. We feel they necessitate a revision of the random network theory of these glasses.

A molten drop of silica was captured in mercury to achieve the maximum cooling-rate; another drop was placed in a platinum crucible in a furnace set at 1,080° C. and allowed to cool slowly to room temperature, annealing it. These two samples, after grinding, produced different low-angle X-ray patterns. The chilled sample showed more intense central diffuse scattering than the slowly cooled sample. On the other hand, only the slowly cooled silica glass showed a discrete diffraction ring; the diameter of this ring corresponded to a 30-A. Bragg spacing.

The results were reversed in $Na_2O.MgO.3SiO_2$ glass. A sample was quenched from 1,080° C. in mercury and a second sample cooled slowly after being stabilized at the same temperature. Diffraction patterns of these samples are shown in Figs. 1 and 2. The diffuse scattering extended farther in the annealed than in the chilled glass, and the diffraction ring was present in the chilled, but not in the slowly cooled glass.

The curves in Fig. 3 were obtained from the densitometer traces of the diffuse scattering on the low-angle films of these $Na_2O.MgO.3SiO_2$ powders which had received the different heat treatments. A plot of logarithm of the intensity versus square of the scattering angle in radians can be used to determine the size of the scattering inhomogeneities[2]. Assuming spherical shapes, the size distributions were obtained by the method of Jellinek, Solomon and Fankuchen[3]. The observed curves were resolved into limiting straight lines which corresponded to the following sizes and fractional proportions:

Table 1

| Cooling-rate | Size and proportion of inhomogeneities |
|---|---|
| Slow | 24 A. diameter, 77 per cent of the observed scattering |
| | 78 A. ,, 23 ,, ,, ,, ,, ,, ,, |
| Fast | 68 A. ,, 55 ,, ,, ,, ,, ,, ,, |
| | 120 A. ,, 45 ,, ,, ,, ,, ,, ,, |

Since we could not record the entire amount of the diffuse scattering to zero scattering angle, these results give a relative proportion of only the smaller inhomogeneities causing the scattering.

It is known that slow cooling compacts glass[4]. The higher proportion of larger inhomogeneities in the quenched $Na_2O.MgO.3SiO_2$ glass suggests that the disorder present at the high temperature was frozen in by the sudden cooling, whereas during slow cooling these regions of low electron density became smaller. Our observation of a reversal of the effects of different cooling-rates in silica glass is supported by the fact that pure $SiO_2$ glass has opposite properties[4] and insignificant thermal contraction[5].

It is possible that the inhomogeneities causing this diffuse scattering are the same as the 'cracks' or 'flaws' proposed by Griffith[6]. He postulated the elongation of these flaws to explain the unexpectedly high strengths of highly drawn glass fibres. The low-angle pattern shown in Fig. 4 of commercial Owens-Corning 'Fiberglas' confirms the presence of inhomogeneities which are elongated in the direction of the fibre axis.

An unambiguous interpretation of the 30-A. discrete scattering cannot be made with our limited results. However, it is fairly certain to us that these diffraction maxima are evidence for a 'two-phase' or 'micellar' nature of glass, and call for a revision of the random network theory of glass.

It appears that the low-angle X-ray technique is capable of elucidating structure in an amorphous material. Since this is the extent of our interest in silicate systems, we hope the questions raised by our brief experiments will be answered by others.

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W. O. STATTON

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Wilmington, Delaware. Jan. 18.

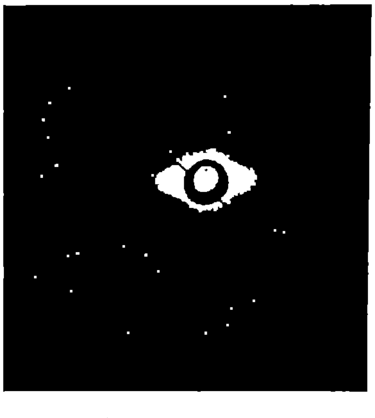

Fig. 4. Diffuse scattering from Owens-Corning 'Fiberglas' showing elongated inhomogeneities.
Sample-film distance = 17 cm.; Kodak 'No-Screen' film; 80-hr. exposure; 0 010 in. sample thickness; copper *Kα* radiation, nickel filtered. Fibre axis vertical

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## Lowered 'Capillary Resistance' after Iontophoresis of Lysergic Acid Diethylamide

There is some evidence that 5-hydroxytryptamine may be concerned in hæmostasis (reviewed by Page[1]); but it is difficult to test directly the hæmostatic effect of the drug in normal persons, because, if it has such a role, it is presumably already available in optimal concentration. An attempt was therefore made to weaken the normal hæmostatic system in man by treatment with lysergic acid diethylamide, which Gaddum, Hameed, Hathway and Stephens[2] have found to be a potent inhibitor of 5-hydroxytryptamine on the isolated rat uterus. Because of its effect on the personality, the drug could not be administered systemically. The effect of the drug was therefore investigated by measuring the 'capillary resistance' in small areas of skin which had been infiltrated by iontophoresis.

Solutions of lysergic acid diethylamide were prepared in 0·05 *M* phosphate buffer, *p*H 5·8–6·5 (depending on the solubility of the sample) at concentrations of $10^{-2}$, $10^{-3}$, $10^{-4}$ and $10^{-5}$ (calculated as base), and 0·4 ml. of a given solution was taken up in a thick blotting paper pad 2 sq. in. in area. This was placed on the skin of the anterior aspect of the arm and was made the anode of an iontophoresis circuit, following the method of Barcroft, Bonnar, Edholm and Effron[3] with adrenaline. A current of 2 m.amp. was passed for 5 min. The pad was removed and hæmostasis was tested by measuring the resistance of small vessels to reduced pressure[4]. After noting any existing petechiæ, the total number of petechiæ in the treated arm was successively recorded after reducing the pressure to 100, 150, 200, 250 and 300 mm. mercury below atmospheric. Each pressure was maintained for 30 sec. and the petechial counts were made after returning the test area to atmospheric pressure after each reduction. The symmetrically placed area of skin on the opposite arm was similarly tested after an identical treatment with buffer alone.

No personality changes were noted after these treatments, which suggests that only a small fraction of the drug contained in the pads entered the skin.

Thirty-one series of petechial counts were thus obtained from both arms (the right arm was treated with the drug in twelve tests and the left arm in nineteen tests) in four subjects (three male and one female). The effect of treatment was investigated as follows. For each arm, the petechial count was plotted against the negative pressure, and the count corresponding to – 275 mm. mercury was estimated by linear interpolation. The pressure required to give, on the opposite arm, the lower of these counts was then estimated in the same way. The difference between these pressures was taken as the response; a positive sign was attached if the higher count at – 275 mm. mercury occurred with lysergic acid diethylamide, or a negative sign if with buffer alone.

The mean responses differed significantly from zero only at the two higher doses, being (with standard error) 56·5 ± 26·3 (ten responses; $P = 0·04$) at a dose of 1/1,000, and 100·5 ± 26·3 (ten responses; $P = 0·001$) at 1/100. The slope of the regression of response on logarithm of the dose of lysergic acid diethylamide was also significant ($P = 0·01$) over all the responses. There was no evidence of a systematic difference between the responses from the two arms, from the different sites, from different subjects or from different days of testing; although the number of petechiæ appearing in the untreated skin at a given site exposed to a given fall in pressure clearly varied from subject to subject, and was higher at proximal than at distal sites.

This method of calculating the response was particularly influenced by the high counts obtained at the extreme negative pressures. Two alternative methods of calculating a response, which gave less weight to the extreme pressures, yielded similar results with regressions significant at $P = 0·06$ and 0·08.

It may thus be inferred that, after this treatment with lysergic acid diethylamide at 1/100, and perhaps at 1/1,000, a larger number of petechiæ were produced at a given site by a given fall in pressure than would otherwise have been expected. Nevertheless, in a small series of tests in one subject, no increase in bleeding time was obtained after the iontophoresis of lysergic acid diethylamide into the nail beds of the fingers: the bleeding time was measured in test and control areas under microscopic observation[5].

The present experiments therefore suggest that 5-hydroxytryptamine may at least be concerned in preserving the integrity of undivided small vessels: that is, in preventing the occurrence of purpura.

We are grateful to Dr. I. D. E. Storey for investigating the electrophoretic mobility of lysergic acid diethylamide; to Prof. J. H. Gaddum for advice and encouragement; and to Sandoz Products, Ltd., for generous supplies of lysergic acid diethylamide.

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May 30.

---

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## Turbidimetric Measurement on Synchronized *Salmonella typhimurium* Cultures

Synchronization of cellular and nuclear division in *Salmonella typhimurium* populations at densities of 1–4 × $10^7$ cell/ml. has been reported previously[1,2]. Two systems for obtaining such synchronization were described, both systems employing temperature shifts between 25° and 37°. In the first system the temperature of a culture which had been growing for ten generations at 25° was raised to 37°. In the period between 5 and 10 min. following the rise in temperature, 80–90 per cent of the population underwent nuclear division as observed cytologically[3], and as inferred from the interaction of the cells with a temperate bacteriophage. On the other hand, cellular division, as measured by colony counts, was delayed for 20–25 min., at which time it took place at an increased rate, finally re-establishing the exponential growth of the culture at the normal 37° rate (see Fig. 1).

In the second system, a culture just entering the exponential phase of growth at 37° was subjected to alternating cycles of 28 min. at 25° and 8 min. at 37°. In this case synchronized cellular division was usually obtained in the third and fourth cycles, cellular division occurring during the 37° period (Fig. 2). On the basis of the interaction of the cells with a temperate phage, it was concluded that nuclear division had also been synchronized.

When these studies were reported it was believed that the two systems bore a simple relationship to one another in that the primary effect of raising the temperature was to induce nuclear division. Recent turbidimetric studies in this laboratory, while not contradicting this hypothesis, have revealed a basic difference between these two systems.

Cultures of *Salmonella typhimurium* were subjected to the two treatments described above and the increase in cell number and mass were followed by means of colony counts and turbidimetry[4] respectively. 6-ml. samples to be studied turbidimetrically were removed and mixed with 0·05 ml. of 40 per cent formalin, and read within 15 min.; identical results were obtained using the Klett–Summerson colorimeter, fitted with a No. 69 filter, and a Hilger spectrophotometer, at λ = 650 mμ.

The results obtained with the two systems are presented in Figs. 1 and 2. As may be seen in Fig. 1, following the single temperature shift from 25° to 37°, the turbidity of the culture continues to rise exponentially at the 37° rate, whereas the counts of viable cells increase at a lower rate. This results in an increase in turbidity, or mass, per cell. The single temperature shock which induces nuclear division 5–10 min. later without inducing a simultaneous cellular division is thus not sufficient to affect the synthesis of new cell material. On the other hand, repeated cycling between 25° and 37° results in a synchronization of both the turbidity increment and cell division (Fig. 2). The repeated induction of both nuclear and cellular division obtained in such an experiment leads the growth of the population to exhibit a synchronous pattern in terms of mass as well as numbers.

In the latter system the growth pattern of the population may be considered to reflect the growth characteristics of the individual cell. Results obtained with Protozoa[5], together with the data in Fig. 2, would suggest that this growth characteristic is as follows: in the normal division cycle of a single *Salmonella typhimurium* cell, cellular and nuclear division are followed by an arithmetical increase in mass, ceasing shortly before the next cell division. A full account of these experiments will be published elsewhere.

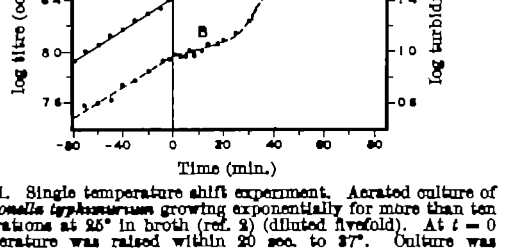

Fig. 1. Single temperature shift experiment. Aerated culture of *Salmonella typhimurium* growing exponentially for more than ten generations at 25° in broth (ref. 2) (diluted fivefold). At $t = 0$ temperature was raised within 20 sec. to 37°. Culture was diluted periodically to maintain a titre of 2–4 × 10⁷. For convenience of representation the time-scale has been doubled after $t = 0$. *A*, ●—●, turbidimetric readings in Klett colorimeter; *B*, ●---● viable titre measured as colony count. Turbidity and colony counts are corrected for culture dilutions. The normal growth-rates at 25° and 37° in broth 5 are represented by the continuous line of curve *A*

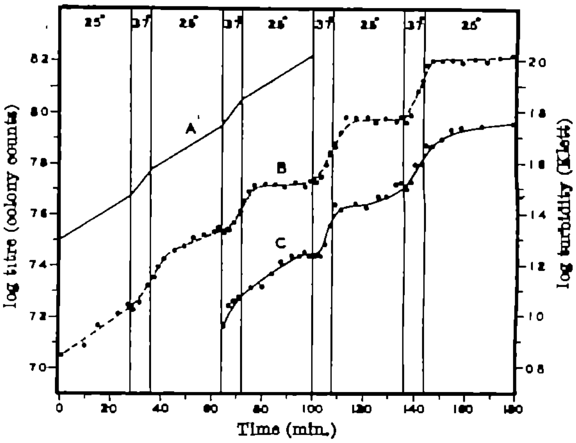

Fig. 2. Repeated temperature cycling experiment. An overnight 37° culture of *Salmonella typhimurium* was diluted 1/100 in broth 5, grown with aeration from $t = -90$ min. to $t = 0$ min. at 37°, and then subjected to alternate cycles of 25° and 37°. The hot or cold broth, added to raise or lower the temperature of the culture, maintained the titre between 2 and 4 × 10⁷ cells/ml. *A*, ——, compound exponential growth curve constructed from the normal generation times of *Salmonella typhimurium* in broth 5 at 25° and 37°; *B*, ●---●, turbidimetric reading in Klett colorimeter; *C*, ●—●, viable titre measured as colony count. Turbidity and colony counts have been corrected for culture dilutions

Two of us wish to acknowledge the support of fellowships: (V. G. B.) U.S. Public Health Service Fellow, National Cancer Institute, and (K. G. L.) Fellow of the American Cancer Society, upon recommendation of the Committee on Growth, National Research Council.

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Copenhagen.
June 9.

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## Approximate Joint Probability Distribution for Wave Amplitude and Frequency in Random Noise

In the study of the observed properties of random noise, for example, ocean wave records, it has been pointed out by Barber[1] that, for a narrow spectrum, the probability distribution of amplitude approximates to the distribution of the wave envelope. Since the latter distribution is simple to use and gives a good fit for the higher waves, the approximation is of practical value, and has been discussed in the literature by Longuet-Higgins[2] and Watters[3].

An attempt has been made to derive an analogous formula for the joint distribution of amplitude and frequency of the main waves, neglecting small waves which occur away from the mean.

Following a suggestion made by Mr. N. F. Barber, it is possible to define the amplitude $R$ of the wave envelope as the modulus of the vector

$$v(t) = R(t) \exp i\theta(t) \qquad (1)$$

in such a way that the original noise signal is represented by the real part of $v(t)$. This definition can be shown to lead to results in accordance with those derived from the usual definition (cf. Rice[4]).

For a narrow spectrum it is reasonable to assume that the angular velocity $\theta'(t)$ will be closely related to the 'instantaneous' frequency (cf. Rice[5]) as recorded by an observer. Consequently the joint probability distribution of $R(t)$ and of $\theta'(t)$ is of interest. This joint distribution, in standard measure, is found to be :

$$2\pi^{-1/2}\, d\alpha\, ds\, s^2 \exp\left[-s^2(1+\alpha^2)\right] \qquad (2)$$

where

$$s = R/E^{1/2} \qquad (3)$$

is the 'normalized' envelope amplitude, and

$$\alpha = E\begin{vmatrix} E & -E_1 \\ E_1 & -E_2 \end{vmatrix}^{-1/2} (\theta' - |E_1|/E) \qquad (4)$$

is the 'normalized' deviation of $\theta'$ from its mean value. Here

$$E = \text{av.}\,(|v|^2),\; E_1 = \text{av.}\,(v'^{*}v),$$
$$-E_2 = \text{av.}\,(|v'|^2) \qquad (5)$$

are coefficients in the Hermitian co-variance matrix of $v(t)$ and its first time derivative.

Evidently the distribution of $\theta'(t)$ is symmetrical about the mean

$$\text{av.}\,\theta' = |E_1|/E \qquad (6)$$

and there is less scatter in $\theta'(t)$ for large values of $R(t)$ than for small. A practical inference is that it would be better, when making visual observations of ocean waves, to estimate mean frequency from the groups of high waves that occur from time to time than by measuring all the waves. A further inference is that the mean frequency of the high waves will tend to the value (6) rather than to the expected half-frequency of zeros $(-E_2/E)^{1/2}$, (Rice[6]), which results when all waves are considered.

A more detailed account of this work will be published in the *New Zealand Journal of Science and Technology*.

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March 11.

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## Use of a Computing Machine as a Mechanical Dictionary

IN considering the application of an automatic calculator to problems of mechanical translation, the first need which arises is the storage of a dictionary[1]. It has been shown[2] that the naïve scheme in which the translation is contained in that storage location the address of which is given by the number that results from numerical encoding of the foreign-language word is not practical, and the procedure which has been adopted up to the present has been to store the dictionary in a sequence of locations. The order of storage is such that the code number of the foreign language portions of the words are in ascending order of magnitude. To select the entry corresponding to a given foreign-language word, the code number of that word is subtracted successively from the dictionary entries starting from the first. The result of such a subtraction will always be negative until the required position is reached, when the searching process is discontinued and the next phase of the translation operation is initiated.

It is evident that, for a dictionary which contains $N$ words, an average of $N/2$ subtractions will be required to locate a word chosen at random. Since $N$ may be between $10^4$ and $10^5$, and the subtraction and access times on many machines amount to about $10^{-3}$ sec., the time to locate a given word will lie between 5 and 50 sec.

To reduce this time, a possible method is to store words which start with the same letter in storage locations the code numbers of which are related to those of the initial letters. This reduces the time of search by a factor of about 26, but has the disadvantage that some blocks of locations will be only partially filled.

An alternative approach to the problem of dictionary search is as follows. For convenience it will be assumed that entries are stored in locations 1 to $N$, and the unknown word is first subtracted from the dictionary entry in location $N/2$. If the result is positive, the required entry is either that contained in position $N/2$, or it is contained in one of the locations $N/2$ to $N$. If the result of the subtraction is negative, the required entry lies in locations 1 to $(N/2 - 1)$. In the former case the comparison is repeated on the entry contained in location $(N/2 + N/4)$, and in the latter case on the entry in $(N/2 - N/4)$. This process is repeated until the unknown position is isolated.

The importance of the method lies in the very small number of comparisons which are needed to isolate an entry. Thus, for a dictionary of $10^4$ words, less than 14 comparisons will isolate any given word, and for $10^6$ words 20 comparisons should suffice. The time of search required for the example quoted earlier would thus be reduced to less than 20 m.sec.

In practical application it is not usual for $N$ to be of the form $2^m$, so that instead of the numbers $N/2$, $N/4$, . . ., etc., it is sufficient to take the nearest integer to these values.

An amusing lecture demonstration is based upon this process. A member of the audience selects a word at random from the "Concise Oxford Dictionary" ; by asking a maximum of 14 questions the lecturer is then able to find the word selected. A simple form of the question is "Does the word come before . . . ?" in the dictionary. Partition need only be approximate and a rough division of the dictionary into ½, ¼, etc., by eye is sufficient.

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May 12.

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# FORTHCOMING EVENTS

### Monday, September 19—Friday, September 23

Fédération Internationale Pharmaceutique (at Senate House, University of London, Malet Street, London, W.C.1), at 9.30 a.m. daily—16th General Assembly.

### Tuesday, September 20—Friday, September 23

Library Association (at Southport)—Annual Conference.

### Wednesday, September 21—Thursday, September 22

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 10 a.m. daily—Conference on "The Correlation between Calculated and Observed Stresses and Displacements in Structures".

### Wednesday, September 21—Friday, September 23

Society for Water Treatment and Examination (at Newcastle-upon-Tyne)—Autumn Meeting.

### Thursday, September 22—Saturday, September 24

British Society of Rheology (at the Washington Singer Laboratories of the University College, Prince of Wales Road, Exeter)—Symposium on "Surface Rheology".

### Friday, September 23—Saturday, September 24

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1)—Symposium on "Some Recent Developments in Magnetic Materials".

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Metallurgist (with an honours degree in metallurgy or A.I.M., and several years practical experience in industry and preferably some knowledge of the metallurgical problems associated with electrical power generation) in the Chief Engineer's Department, Bankside House, London, S.E.1—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting AE/660 (September 23).

Lecturer (with high qualifications in mathematics and good teaching experience) in Mathematics—The Principal, Derby Technical College, Normanton Road, Derby (September 24).

Senior Lecturer (with a good honours degree, and experience in the application of statistics, preferably in industry) in Statistical Methods, a Senior Lecturer (preferably with some industrial experience) in Mathematics, and a Lecturer (with good academic qualifications) in Mathematics—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (September 24).

Economist (with first- or second-class honours degree in economics, statistics or kindred subject, with ability to write clearly and concisely and preferably with knowledge of British agriculture and trade)—The General Secretary, National Farmers' Union, 45 Bedford Square, London, W.C.1 (September 26).

Head of the Physics Department—The Principal, Derby Technical College, Normanton Road, Derby (September 26).

Assistant Experimental Officer or Experimental Officer (graduate) in the Bee Department, for work on bee behaviour—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (September 30).

Assistant Lecturer (with an interest in, and ability to teach, theoretical physics) in Physics—The Registrar, University College of North Staffordshire, Keele, Staffs (September 30).

Lecturers (2) (with a special knowledge of one of the following fields: electrical machinery, vibration analysis and engineering acoustics, communications (other than radio)) in Electrical Engineering—The Secretary of University Court, The University, Glasgow (September 30)

Mathematicians, Scientific Officer grade (with a first- or second-class honours degree in mathematics or equivalent qualifications), at the Ministry of Supply Headquarters in London, for (*a*) to investigate data reduction associated with ballistic instrumentation, with a view to improving methods of presentation of results and to introducing methods of analysis applicable to automatic computing machines; and (*b*) for theoretical and experimental work in external ballistics, analysis of trials results and application to assessment of performance—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.331/5A (September 30).

Professor of Mechanical Engineering at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Ceylon, September 30).

Scientific Officer (with an honours degree in biochemistry or similar qualification) in the Biochemistry Department—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (October 3).

Principals (with a degree in engineering or equivalent, and with industrial and teaching experience) in the Gold Coast Civil Service, to take charge of Technical Institutes—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.114/12/01 (October 4).

Senior Lecturer or Lecturer in Physical Chemistry or Inorganic Chemistry at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 7).

Lecturer in Zoology at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 31).

Assistant Biochemist, Basic grade (with a B.Sc. degree with honours in chemistry or biochemistry or an equivalent qualification) in the Department of Pathology—The Group Secretary, Wolverhampton Hospital Group, The Royal Hospital, Wolverhampton.

Fison Research Fellow (with a good honours degree in science or agricultural science, and postgraduate experience), for work on (*a*) the role of the soil fauna in soil fertility, or (*b*) the mineral nutrition of the leguminous pasture plants—The Registrar, The University, Nottingham.

Hospital Physicist (with an honours degree in physics, and preferably with experience in hospital physics) in the Radiotherapy Department—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford.

Lecturer (graduate of a British university, and with industrial experience) in Power Engineering—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

Lecturer (with a good honours degree and research experience) in Botany, at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2.

Principal Scientific/Senior Scientific Officer (with a first- or second-class honours degree in chemistry or equivalent, a good general knowledge of modern research developments in lubricants and fuels, and preferably with some experience of the petroleum industry) at the Ministry of Supply Headquarters in London, for the initiation and progressing of basic research and development work, in Industry and a Ministry Laboratory, on lubricants and petroleum fuels—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.674/5A.

Research Assistants (honours graduates in chemistry, preferably with a specialized knowledge of inorganic or physical chemistry) in the Department of Applied Science—The Clerk to the Governors, Wolverhampton and Staffordshire Technical College, Wolverhampton.

Senior Chemist (with a good honours degree in organic chemistry or biochemistry, and preferably with some research experience and/or industrial experience), for work mainly concerned with various aspects of cereal chemistry, flour lipids, and the technology of baked products—The Director of Research, British Baking Industries Research Association, Chorleywood, Herts.

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# UNIVERSITIES AND ACADEMIC FREEDOM

PROBABLY the most outstanding feature of university developments in Great Britain in the post-war years is the extent to which both old and new universities have become dependent on State assistance. Whereas in 1920–21 only some 33 per cent of their funds came directly from the Treasury and 12 per cent from local authorities, in 1953–54 no less than 70·5 per cent of their recurrent income came from Parliamentary grants, and 3·6 per cent from local authority grants. Moreover, the proportion of students holding scholarships or some form of award from public or private funds has risen from 45 per cent in 1928–29 to some 71·9 per cent in 1953–54, and these proportions are increasing. At the same time, over the past ten years the universities have drawn from the State practically all the funds for large-scale capital development, instead of, as previously, having to find such funds from endowments or through local effort. While the proportionate financial dependence of the universities on the State has thus increased, the share of the national resources which goes to the universities has also increased very greatly. In 1920–21 the income of the universities in Britain was about £3 million, but in 1953–54 it exceeded £31 million, and the expenditure per student averaged nearly £400 instead of about £75.

This growing dependence of the universities on the State is one reason for the recurrence of discussions on academic independence and autonomy at almost every gathering of university bodies, whether at the Conferences of the Home Universities, at the Congress of Universities of the Commonwealth, or at the Conference of the Universities of Western Europe held in Cambridge last July. Friendly observers from the United States at the Commonwealth Congress and in an earlier book, "Government Assistance to Universities in Great Britain" (see *Nature*, 171, 273; 1953), have openly expressed their doubts as to the universities of Britain being able to preserve their traditional independence. Notwithstanding the reassurances on this point given by successive Chancellors of the Exchequer, and the way in which the Treasury has hitherto consistently rejected proposals from the Committee on Public Accounts or the Select Committee on Estimates for methods of financial control which appear to endanger that autonomy, there is clearly apprehension on the subject within the universities themselves.

To such misgivings Sir Hector Hetherington gave frank expression in his P. J. Anderson Memorial Lecture to the University of Aberdeen last November[*]. Looking at the increasingly continuous and closer government and parliamentary intervention in university affairs, he displayed the reasons for this livelier interest and the agencies by which the present situation has been reached. Factually he concerned himself more particularly with the Scottish universities; but nevertheless his lecture is a most penetrating and critical survey of the British university system as a whole over the past forty years.

Sir Hector brings out at the start two interesting points. He does not expect government policy to achieve its declared objective of doubling the pre-war student numbers by about 1956, and suggests that the present increase of about 66 per cent may exaggerate the effective inflow of new students. The entry of graduating students, he notes, increased between 1938 and 1952 by only 55 per cent. Secondly, he notes that in Scotland, but not in England, there has been some quantitative shift away from the arts, and qualitatively too, as regards Glasgow, there is evidence that more of the abler students are studying science and medicine. The Scottish universities, drawing primarily on a home population of 10 per cent of that of Great Britain, contain 17·5 per cent of the university students, and while they contribute 13 per cent of all students in pure science, in medicine they provide 23 per cent, in technology 21 per cent, in agriculture 22 per cent, and in veterinary science 38 per cent. This response of the universities to the needs and challenges of a changed world has, he points out, been effected largely by the influence of government and public opinion, exercised, for example, through the royal commissions, of which at least six universities have been the subject in the past forty years, and the various committees, to which such names as Goodenough, Hankey, Barlow, Clapham, Scarborough, Teviot and Loveday are attached, that have surveyed different phases of university activity. Each university, moreover, is now normally closely in touch with half-a-dozen major Ministries, the needs and policies of which are reflected in its own work. Again, there are inter-relationships with the Department of Scientific and Industrial Research and the research stations and research associations sponsored by that Department, as well as with the other research councils concerned with medicine and agriculture.

Sir Hector does not pursue in any detail the relations of universities to the national organization for research in pure and applied science. He recognizes that they form an essential part of that structure and while, from a passing reference to the Atomic Energy Authority, he is aware of the dangers of sponsored research or of such devices as the earmarked grant, he is content to leave their implications to be considered in the light of the general principles which he lays down. Prof. W. H. G. Armytage in his "Civic University"[*] has to some extent rectified this omission. In this connexion he refers pointedly to the extent to which the Advisory Council on Scientific Policy is concerned with university development from the point of view of scientific research as well as from that of education.

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[*] The British University System 1914–1954. By Sir Hector Hetherington. (P. J. Anderson Memorial Lecture, 1954. Aberdeen University Studies, No. 33.) Pp. 13. (Edinburgh and London: Oliver and Boyd, Ltd., 1955.) 1s.

[*] Civic University: Aspects of a British Tradition. By W. H. G. Armytage. Pp. 328+8 plates. (London: Ernest Benn, Ltd., 1955.) 30s. net.

Both Prof. Armytage and Sir Hector Hetherington, in reviewing the development of the University Grants Committee over its first twenty-five years, stress the revised terms of reference, which in 1946 placed on the Committee, besides the responsibility for advising on the financial needs of the universities and the distribution of the sums voted by Parliament, the functions of collecting and making available information about British universities and of assisting "in consultation with the universities and other bodies concerned the preparation and execution of such plans for the development of the universities as may from time to time be required in order to ensure that they are fully adequate to national needs". Both again recognize that this implies the possibility of planned expansion under government rather than local initiative, and a definite move towards the development of a national system of university education. Both recognize that it was inevitable that this large responsibility should be laid upon the University Grants Committee, and that the time had come when the Government was bound to assure itself that somewhere in the university system provision was made for every field of learning which is necessary to the national interest. Nor do they suggest that this is not the right way to achieve that purpose.

Whereas, however, Prof. Armytage's analysis of the situation is concerned rather with the professional aspects and the ability of the universities to meet the needs of Britain for vocational education at that level and for research institutions, Sir Hector probes further into the working of the system, and emphasizes the special relation of the universities to the Treasury. With other Departments and organizations, the relations are those of collaborators, competitors or consumers in one or other form, and influence, though important, is indirect. With the Treasury, however, the relation is continuous, and, but for the intermediary University Grants Committee, direct. In so far as there is a Minister answerable in Parliament for the universities of Britain, it is neither the Minister of Education nor the Lord President of the Council but the Chancellor of the Exchequer; and by one of those curious touches of the British constitution, the Minister who watches most closely over the expenditure of other Ministers has in the universities a little spending department of his own, the autonomy of which he has in recent years stoutly defended in Parliament.

In discussing the implications of this situation, Prof. Armytage and Sir Hector are again complementary. The former, in considering the ways in which pressure may be brought to bear on the universities in the direction of vocational studies, sponsored research or the detailed control of expenditure, directs attention to certain intangible assets in the community which help the universities to resist such pressures. Against, for example, extreme calls for an externally imposed planned system of university education, the British universities can count on the fact that the limited size of the university population in the country greatly restricts the area of popular interest in the universities and the possible political pressures which could thus arise. This is reinforced by the fact that the universities are still severely professional, as can be seen in the persistent prejudices against the employment of university graduates in positions for which the changed educational pattern has greatly reduced the chances of recruiting the necessary talent in other ways. Still more potent is the sympathetic relationship between the universities, the University Grants Committee and the Treasury departments, which arises from the common outlook and origins of their personnel. That community of outlook and interests not only promotes co-operation but also an understanding that ensures that proposals which threaten to disturb the traditional autonomy of the universities will require to demonstrate a very clear public advantage if they are to pass the scrutiny even of the Government side.

Sir Hector takes this for granted. He examines rather the way British universities have drawn together—not so much deliberately in self-defence—for example, by joint consultation between an impressive range of specialist societies in which scholars and scientists take counsel about their several studies and the policies by which those studies may be advanced, or between less formal groups within and without the universities. He notes, too, the way in which circumstances have forced such a body as the Committee of Vice-Chancellors and Principals not merely to consider matters of common interest to the universities, but also to make commitments for the universities and to influence significantly university and even government policy; and he notes also the way in which university individualism is further circumscribed by external influences, even in regard to rates of pay.

Sir Hector is concerned rather to show how the Committee of Vice-Chancellors and Principals has come, somewhat against the wishes of its members, to function as it does as a body to the views of which both university courts and government departments attend with some care, notwithstanding that the Committee neither possesses nor desires executive authority. In his judgment something of the sort must have been created during the past twenty years if it had not already existed. But while he admits that, in this and in other ways, we have come a good deal nearer a university system, and that government influence is strong, Sir Hector gives no support to the idea canvassed during and since the War by, for example, the British Association Committee on Post-War University Education, the Parliamentary and Scientific Committee and the Association of University Teachers, for a fully representative Universities' Advisory Council. By implication rather than explicit statement, he suggests that the universities' defences are still sufficiently strong and that the existing organization provides effective means for formulating common policy where desirable, or on the other hand for representing common views to the Government.

Sir Hector's chief concern appears to be that British university structure may become too rigid in its internal and informal aspects, and that a certain consequential change of mood may be detrimental to the outlook and to the spirit of adventure in which a university does its best work. A university is a living corporation or society—not an institution—the members of which are bound together to promote sound learning and the advancement of knowledge, to follow inquiry wherever it leads. If the growth of organization confuses that issue and leads to disregard of the freedoms essential for such a community or even to uncertainty as to their nature, university independence is endangered, no matter how carefully the Government itself may respect the right and duty of the university for final decision as to the organization of its courses and for the character and standards of the instruction given within its walls.

Sir Hector is not blind to the dangers of the present situation and trends. He recognizes that an unlucky appointment in any one of three or four key posts could easily work great mischief. He acknowledges that Parliament can rightly expect of the universities an account of their expenditure of the large sums of money they now receive, and that the universities should be ready to listen to criticisms of their activities. He recognizes, too, that this is an essential part of the task of building up an instructed public opinion and that, in the last resort, this is the only defence of the universities, though to him the pervasive influence of the mass mind seems to be a less formidable menace than it appeared to be to Sir Walter Moberly.

The next decade will show whether or not Sir Hector is too optimistic in this respect, but the evidence would suggest that the mass mind is a more formidable menace than when Sir Walter Moberly wrote six years or more ago, and that it would be unwise to rely unduly on the level of enlightenment in government circles. Indeed, there is already evidence of surrender on the part of the Ministry of Education to sectional pressures, and it could well be that the real threat to the full responsibility of the universities in academic affairs may in future come not from the Chancellor of the Exchequer or the Lord President of the Council, but from the Minister of Education, in spite of the absence of any formal responsibility on his part for the universities. Unless, indeed, educational policy as a whole is shaped with clear conceptions as to the purpose and functions of a university and of the over-riding importance of quality rather than numbers, decisions may be taken elsewhere which adversely affect the work of the universities or the resources at their disposal.

The education of public opinion as to the work of the universities and their essential place in the community thus involves much more than the purely factual accounting to Parliament or public opinion generally for the expenditure of the funds received from public sources. It means that the purpose and nature of a university should be widely and clearly understood, and also the way in which a university works and the vital relation of academic freedom to the achievement of its purposes and the service it renders to the community. It is not enough that this should be understood in government departments or in Parliament, though this is essential if plans for university expansion and for the development of technological or technical education are to be conceived soundly and kept in balance with national needs and resources. It means that, as Dr. Eric Ashby emphasized in a broadcast talk early this year on the British universities, a determined effort must be made to enlighten the man in the street, who is now the effective patron of the universities. The real threat to academic freedom is from public ignorance of what the universities are and what they are doing. The continuance of the effective functioning of the British university system depends in large measure on the extent to which the universities themselves and their alumni, whether in government office or department, in industry or in public or private life, seek and use every opportunity in Parliament, in the schools, in adult education and other extra-mural work and in every possible way to interpret to the public the purpose and method of university life and work.

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# BABYLONIAN ASTRONOMY

### Astronomical Cuneiform Texts

Babylonian Ephemerides of the Seleucid Period for the Motion of the Sun, the Moon, and the Planets. Edited by O. Neugebauer. Vol. 1: Introduction, The Moon. Pp. xvi+278. Vol. 2: The Planets. Indices. Pp. xii+279–512. Vol. 3: Plates. Pp. v+255. (London: Percy Lund Humphries and Co., Ltd. Published for the Institute for Advanced Study, Princeton, New Jersey, U.S.A.) 105*s*. the set.

THE publication of these three volumes, containing the source material of our present knowledge of Babylonian astronomy, has placed all students of the history of mathematics and astronomy under a deep obligation to Prof. O. Neugebauer, whose earlier work, "The Exact Sciences in Antiquity" (1951), contains a brief summary (see *Nature*, 169, 854; 1952).

In the first of the two clearly marked periods in Babylonian science—the Old Babylonian, *c*. 1800–1600 B.C.—mathematics reached a high level, but astronomical knowledge was crude and merely qualitative. One group of documents contains the earliest records of actual observations in Mesopotamia. For several years the appearances and disappearances of the planet Venus were recorded, the dates being given in the contemporary lunar calendar, and have proved useful in determining the chronology of the Hammurapi period. Two texts dating from about 700 B.C., but undoubtedly based on older material, contain a summary of the astronomical knowledge of the day. One is concerned mainly with the fixed stars arranged in three 'roads', of which the middle one is an equatorial belt of about thirty degrees in width. The other deals with the Moon, the planets, the seasons, shadow-lengths and other related phenomena.

In the second period—the Seleucid—which is datable to the last three centuries B.C., the introduction of a sign for zero led to a complete mastery of arithmetical calculations immediately available for application to the problems of astronomy. The predominantly mathematical character of Babylonian astronomy was not realized by early investigators, who stressed the observational side and failed to appreciate the difficulties of observations near the horizon in areas subject to desert sand-storms. It is a remarkable fact that not a single text of this period can be called wholly observational.

The most important step in the development of scientific astronomy was the adoption of the ecliptic (the apparent path of the Sun among the fixed stars in the course of the year) as a reference-line for all lunar and planetary phenomena—perhaps as early as 500 B.C. The calendar in use was essentially lunar. The day began in the evening (cf. *Genesis*, i, 13) and the month began on the evening of the day of first visibility of the new crescent Moon shortly after sunset. To predict this day accurately was the primary concern of the early astronomers, but the real problem for them was to fix the exact moment of conjunction of the Sun and Moon. The Babylonians solved it by considering the velocities of the Sun and Moon and their variations. How this scheme was evolved we do not know. We meet with it already fully developed in the "Ephemerides" and "Procedure Texts", more than three hundred of which have now been published in the volumes under consideration.

The "Ephemerides" are tables showing the position of the Sun, Moon and planets computed for regular time-intervals, comparable with those in our modern "Nautical Almanac", and used to predict the times of astronomical phenomena. Most of these tables were carefully written out in columns with details such as the date, the velocities of the Sun and Moon, and the various corrections required by the computer. On some tablets we find details frequently computed for several years in advance. The so-called "Procedure Texts" give rules for determining an ephemeris step by step. The tables are 'final copies', omitting intermediate steps in the calculations, and some of the columns give only the rounded-off values. These methods of computing lunar and planetary phenomena were certainly in use *c.* 250 B.C. Two slightly differing variants of the lunar theory were in use. One assumed the Sun to move with constant velocities on two complementary arcs of the ecliptic; the other assumed a linear zig-zag function for the Sun's velocity as a function of the time. The results are amazingly good and could scarcely be improved upon with elementary mathematics. The determination of eclipses was not so successful, since parallax of both the Sun and the Moon was completely disregarded. The Babylonian procedure shows a remarkably abstract attitude and unhesitatingly introduces quantities for purely mathematical convenience on the same principle as complex numbers are employed in modern mechanics.

Planetary theory was not developed to the same degree as that of the Moon. The method of time reckoning was independent of the civil calendar and was based on a special unit, the one-thirtieth of a lunar month, corresponding to the Hindu *tithi*. The use of this unit implies that the accuracy aimed at was less than that considered necessary in the case of the lunar theory. Several different systems were used, and interpolation schemes were ingeniously devised and skilfully applied to describe the daily motion of the planets.

We derive little of our knowledge of Babylonian astronomy from Greek sources. Pliny mentions the existence of astronomical schools at Uruk, Babylon and Sippar. Ptolemy refers to lists of eclipses dating back to 747 B.C. and complains of the lack in Babylonia of reliable planetary observations—a very fair estimate of the position.

Among units used, it is interesting to find the 'barleycorn' (the 1/180 part of a larger unit) used for the latitude. The degree was the fundamental unit for measurement of arc as it was for time. The day was divided into six parts, each divided again sexagesimally. This system was transferred to the sky and survives in our modern reckoning of right ascension and time. Water clocks were employed in connexion with measurements of the daily increase or decrease in the length of daylight or night.

The main incentive for the study of astronomy seems to have been the attempt to introduce some measure of regularity in the intercalations of the lunar calendar. Astronomy did not originate in astrology as has so often been stated; but the very widespread belief in astrology as the one science which gave insight into the causes of events on earth influenced the transmission of astronomical knowledge from one nation to another. The technique of Hellenistic astrology demanded knowledge of the position of the Sun, Moon and planets in the zodiacal signs at the moment under consideration, and this information was not immediately available from the Babylonian ephemerides, of which the elements played no part whatever in the practice of astrology. Magic, number-mysticism and astrology can no longer be regarded as the guiding forces in Babylonian science.

The texts considered in this new publication represent but a small fraction of the total available, most of which still remain unexamined. Few scholars are as competent as Prof. Neugebauer to deal with these, and perhaps in time he may be able to throw some light on the interesting problem of how the methods of computation were arrived at—quite possibly in a relatively short period, by some Newton or Einstein of the day. The three volumes are admirably printed, of handy size and include a full bibliography, a useful concordance of texts, glossaries and index.

R. W. Sloley

# BIOLOGY IN SCHOOLS

**The Teaching and Learning of Biology in Secondary Schools, with Special Reference to Grammar Schools**

By Prof. L. T. Green. Second, revised edition. Pp. ix+248+6 plates. (London: Allman and Son (Publishers), Ltd., 1955.) 12*s.* 6*d.* net.

THIS new edition of Prof. L. T. Green's book is timely and useful. The author combines theory and practice in a skilful manner. Most books on science teaching neglect the problems of learning as distinct from those of teaching. There is a considerable bulk of research papers on science teaching, and these are relatively inaccessible to most teachers. There is, as Prof. Green remarks, a curious British tradition that objective techniques cannot be applied to educational problems. Nevertheless, he has made a careful digest of all such work relevant to his book, and the documentation is complete.

Prof. Green writes that the two generally accepted points in biology teaching are: first, that the study of biological science in schools should present a picture of biology as a whole and not consist of two quite separate courses of botany and zoology; secondly, that biology should be studied in terms of its general principles and functional aspects. Generally speaking, the universities do not know biology as a subject and maintain a rigid distinction between its several divisions. This has influenced the work of grammar schools and in general has rendered general science courses in schools an unsafe preparation for the university award and entrance examinations.

Prof. Green is an enthusiastic and efficient photographer, and this is reflected in his book. Every useful method of producing visual material, including models and their use in the work of teaching, is dealt with in a thorough and practical manner.

The author has examined the whole field, and while he makes a plea for a wider public attention to the problems of human biology, particularly in relation to population changes and family life, he is prepared to show how the best can be got from the more formal botany and zoology. There are chapters on museums and gardens, agricultural and economic botany, sylviculture, ecology, dissection, evolution, physiology and sex education.

The recent British Association report, "Biological Sciences in British Schools", is an important and realistic but rather depressing document. It stresses "the alarming deterioration in Biology teaching in schools". There are difficulties due to large classes, lack of laboratory assistance and teachers inadequate both in numbers and qualifications. There is also the widespread neglect of field-work at all levels in many schools. The teacher must have an interest in, and knowledge of, natural history and an ecological approach to the subject. Good biology teaching and, indeed, good science teaching in all its branches, are more than ever necessary at the present time; and the pressing problems concerning the provision of adequate human and material facilities for this work must be a first priority in national schemes, not only in education but in the field of economics also.

The book is not only a safe guide for the young teacher but will, in addition, stimulate and encourage the practised worker. It is a very valuable contribution to a subject of primary importance.

W. L. Sumner

## THE GREAT BARRIER REEF

### The Romance of the Great Barrier Reef

By Frank Reid. Pp. xiii+191. (Sydney and London: Angus and Robertson, Ltd., 1954.) 18*s*.

ANYONE interested in Australia will be glad to have this book, especially if, like the reviewer, he knows the Barrier Reef waters. It is not in any sense a scientific work—and for that reason may be somewhat out of the ordinary run of books noted in *Nature*. It consists of twenty-six chapters of murder, piracy, cannibalism, escapes, 'blackbirding', wrecks, storms, and everything that goes to make the successful adventure book. The difference is that all these incidents are vouched for, and the sum total of frightfulness is far worse than any ordinary tale. It is, indeed, an example of fact being stranger than fiction.

Frank Reid is well known in Australia and he has collected the material in this book very largely from people who took part in the adventures, or were at any rate very closely concerned with them. The earlier events are based on historical records, and A. W. L. Russell, who was for some years honorary secretary of the Queensland Royal Geographical Society, states in his foreword, and the author in his preface, that all the events related, fantastic though some of them may be, are entirely factual. Many of them relate to the islands in Torres Straits—one of the most dangerous pieces of water in the world. Several others are based on the Palm Islands—now a large native reserve.

Apart from man's brutality, the book does bring out very clearly indeed the dangers of navigation in reef waters. Great care is always necessary, and it is difficult now to appreciate the dangers that Cook and his successors overcame in vessels which were entirely dependent upon wind and current. Anyone who has been to Lizard Island and seen the line of the outer barrier, the passes, the breakers, and the innumerable inner reefs gains a far greater respect for those who sailed the sea before the advent of power than can possibly be obtained from reading, however vivid the accounts may be.

To all who now travel in these waters, and especially to those who visit them in good weather for a holiday, I would recommend this book. Those who sail regularly in these waters, and those who have worked there scientifically and otherwise, will want to read it. I think one or two chapters might be added to a further edition to include the scientific 'romance' of the reefs. While it may be commended to all, I cannot but think its title should have been "The Tragedy of the Great Barrier Reef".

J. A. Steers

## MECHANICAL PROPERTIES OF METALS

### Strength and Resistance of Metals

By Prof. John M. Lessells. Pp. xiv+450. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 80*s*. net.

THIS book, which is primarily directed to engineers, covers that field, within the purlieus of engineering and metallurgy, concerned with the resistance of metals to deformation and fracture. Here, the theory of elasticity, which frequently masquerades under the misnomer 'strength of materials', has a limited application, and considerations of plasticity and fracture are essential for a complete description of the behaviour which is observed in practice. The tenuous understanding of these factors at the turn of the century precipitated an experimental approach in which such properties as hardness and notched-bar value were measured to assess the suitability of a metal for a particular engineering application. In this development little regard was paid to the real meaning of the tests; but the metallurgical engineer to-day feels that information of fundamental significance is implicit in the copious legacy of these mechanical test results which have been handed down to him. This suspicion receives support from recent progress in the understanding of plastic flow and fracture, and the time is now ripe to incorporate some of these ideas in text-books on 'mechanical testing', which too often concern themselves almost exclusively with standardized testing procedure and results. Although the efforts of the author of the book under review are a welcome step in this direction, it must be admitted that he could have availed himself more fully of the opportunity to fill this palpable gap in the literature.

The observational features of tensile, hardness, notched bar, wear, hysteresis and fatigue testing are well presented, with a text liberally garnished with tables of typical results by way of illustration. Fatigue, which is clearly close to the author's heart, receives a particularly generous coverage. A commendable feature is a chapter on the effects of overstrain in the early part of the tensile stress – strain curve, which, although known for at least fifty years, seldom finds its way into books of this kind. A realistic preference for proof stress rather than elastic limit permeates the text, along with a recognition of the importance of hysteresis. Those interested to learn more about the neglected factor of spurious energy loss in notched-bar testing, to which the author properly directs attention, would do well to consult reference 1, which is given on p. 287 for a different purpose.

The substantial section devoted to engineering resilience calculations, in the chapter on impact tests, appears a little out of place in this work, and the inclusion of notched-bar tests under the same general heading is misleading in view of the secondary importance of the rate of deformation here. In the interspersed sections of the text on interpretation of the tests, the author does not always get completely to grips with the problems. For example, no mention is made of Tabor's illuminating, but admittedly approximate, application of plane strain plasticity to the analysis of the hardness test; and the treatment of the yield point in iron and its associated recovery from overstrain would make more convincing reading if related to Cottrell's basically simple picture of solute atom migration.

Briefly, the book, which is handsomely printed and illustrated, gives a competent account of the experimental features of the mechanical properties of metals, but the senior and graduate student to whom the work is commended in the preface will probably find its attempts at interpretation inadequately stimulating.
K. M. ENTWISTLE

# GEOLOGY OF THE ICE AGE

## Das Eiszeitalter

Grundlinien einer Geologie des Quartärs. Von Dr. Paul Woldstedt. Erster Band: Die Allgemeinen Erscheinungen des Eiszeitalters. Zweite, völlig neu bearbeitete Auflage. Pp. vii+374. (Stuttgart: Ferdinand Enke Verlag, 1954.) 41 D. marks.

THE study of Pleistocene deposits is often more difficult than that of some older rocks because of the diversity of facies which is found. In dating Pleistocene beds it is therefore safer, where possible, to rely on more than one kind of 'zonal fossil'. In the present volume, as in past work, Prof. P. Woldstedt has proved himself to be a believer in this principle and shows an admirable all-round approach to the problems of the Ice Age. I understand from a statement at the end of the first chapter that this is only the first volume of a more comprehensive work and that a second is to be written dealing with separate regions.

After one introductory chapter, Chapters 2–9 are devoted to comparative glaciology: a full description is given of the world's existing ice-sheets, and depositional forms, including various kinds of moraines, outwash gravels and loess, as well as the processes of erosion, are discussed as effects of the Pleistocene ice-sheets. Interesting details are also given of the work by Milthers and others on the erratics carried by the various Baltic glaciers. The author's treatment of these subjects is in harmony with his long experience in the field, and the illustrations, some of which are exceptionally clear, are partly from his own photographs.

Prof. Woldstedt then turns his attention to fossil plants and animals, dealing at some length with the interglacial plant beds (Chapter 12) and tracing the evolution of the flora through the succession from the Reuverian up to the Holocene. Pollen diagrams are shown for the Cromer Forest Bed, which is considered to be Pre-Elster, also for the Elster–Saale and Last Interglacials in Northern and Central Europe, with detailed descriptions of the forest histories. No attention is paid to the plant remains at Hoxne, but now that this site has been freshly described by West and Donner, presumably it will be included in the forthcoming second volume. Examples are also given (Chapter 10) of marine interglacial deposits. The Eem marine beds of Holland and Germany are placed in the Last Interglacial, and the earlier Holstein deposits in the Elster–Saale Interglacial; and in Table 1, p. 215, the Holstein horizon is correlated with the Tyrrhenian, and the Eem with the Monastirian. This table summarizes the author's ideas on long-distance correlations and emphasizes a major problem which has been evident in his earlier publications, namely, the difficulty of fitting in the three known glaciations of Northern Germany with the four (or five) recognized elsewhere.

Chapters 13 and 14 then summarize the kinds of fossil man and his implements, maintaining that the Heidelberg jaw and the earliest *Pithecanthropus* remains belong to the Gunz-Mindel Interglacial, and Peking man is placed with the Swanscombe and Steinheim fossils in the Mindel-Riss stage. The Fontéchevade and Ehringsdorf remains are placed with the Neanderthal man in the Last Interglacial. Dating of the Palaeolithic implements is conventionally related to the Alpine glacial sequence.

The last three chapters (15–17) are given up to the problems of isostatic and eustatic changes of level, to a discussion of changes of climate and finally to a summary of the theories which have been formed to account for these changes. The theoretical aspect of these questions is sometimes overstressed, as in the discussion of eustatic changes of sea-level, and Fig. 121 on p. 294 represents these changes according to an ideal which does not entirely agree with the facts discovered by Gignoux, Deperet and later workers; for example, the Sicilian stage is placed in an interglacial episode in spite of the fact that it has a notably cold fauna. Apart from some of these details, most interesting climatic reconstructions are attempted, one of the most successful showing the position of the ice-sheets, tree-line and temperate forests during the Last Glaciation (Fig. 129, p. 320). The discussion of the causes of climatic change is very detailed.

The list of references at the end is comprehensive, considering the complexity of the subject, but certain omissions will perhaps be put right in the next volume; the main work of James Geikie, F. W. Harmer and Prof. P. G. H. Boswell, for example, receives little or no attention. In general, however, this book is particularly well indexed and is a most useful and well-balanced introduction to a very intricate subject.
D. F. W. BADEN-POWELL

## Thunderstorm Electricity

Edited by Horace R. Byers. Pp. viii + 344. (Chicago: University of Chicago Press; London: Cambridge University Press, 1953.) 45*s*. net.

THE volume under review is a compendium based on contributions to a conference held in Chicago in 1950, some of which have been brought up to date, together with a few chapters from other workers. The chapters deal in turn with general results of atmospheric electricity, thunderstorm dynamics, cloud physics and charge generation, followed by chapters dealing more directly with thunderstorm electricity and finishing with lightning and its effects on aircraft and power lines. As a collection of separate contributions, the book naturally suffers from a lack of coherence, and as a volume on "Thunderstorm Electricity" it may be criticized in that a great many of the chapters are not directly connected with that subject, but contain background information; for example, in the longest chapter, Chapter 5, by H. Weickmann, a mere three pages out of seventy-three are concerned with electrical phenomena.

But every chapter is of considerable interest to those whose work is at all connected with thunderstorms, though the chapters themselves are uneven in content: for example, Chapter 3, by L. Koenigsfeld, describes new work, perhaps more suitable for publication in a journal than in such a volume; Chapter 8, by R. Gunn, is a useful summary of his previously published work; and Chapter 14, by H. Norinder, combines a historical survey with an account of recent work.

The volume is attractively produced, and the large numbers of diagrams and plates are very clear. The nature of the volume has made cross-references impossible, but an index would have greatly added to its value.

J. ALAN CHALMERS

## Infinite Abelian Groups

By Irving Kaplansky. (University of Michigan Publications in Mathematics—No. 2.) Pp. v + 91. (Ann Arbor: University of Michigan Press; London: Oxford University Press, 1954.) 16*s*. net.

A REMARKABLE amount of material has been compressed into this monograph. After some examples of Abelian groups, definitions follow, together with some properties, of torsion groups and divisible groups. Then pure subgroups (*Servanzuntergruppe*) and groups of bounded order are studied, and the important notion of height is introduced. This leads up to Ulm's theorem, which, involving both cardinal and ordinal numbers, gives a complete classification of countable torsion groups. The next part is concerned with the extension of preceding results to modules over principal ideal rings and an application to the theory of linear transformations. Then the ring is restricted to a discrete valuation ring $R$, and a study is made of a complete $R$-module (that is, complete in its $p$-adic topology). A partial classification of the submodules of a given module is made in terms of the characteristic submodules, and the account ends with a review of recent literature.

The material presented is part of a course of lectures given in 1950 in the University of Chicago. Prof. I. Kaplansky has a crisp, vivid style, and a pleasant feature is the interruption of the text at various points to ask a pertinent question such as "What is our goal in studying Abelian groups?", or "How do we know when we have a satisfactory theorem?". The general atmosphere of the book is one of freshness and vigour, and the reader has the satisfaction of knowing that he is being led right up to the edge of our knowledge of a branch of modern infinite algebra.

L. S. GODDARD

## Applied X-rays

By Prof. George L. Clark. Fourth edition. (International Series in Pure and Applied Physics.) Pp. ix + 843. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 89*s*. 6*d*.

THE previous edition of this book—one of the McGraw-Hill International Series—was published thirteen years ago. In that time a great deal of development has taken place in the application of X-rays to almost all branches of science, and the attempt to cover all these applications has produced a work that is generally unsatisfactory.

It must now be accepted that the subject of X-rays and their applications is too large to be covered by a single text-book, and the present book can only be regarded as a rather poor patchwork; it covers instrumentation, radiography, biological applications, X-ray diffraction and crystal chemistry. The author seems at his best in the earlier sections, the later sections being much too condensed and not distinguished by any originality of the point of view.

The presentation of much of the material seems hurried and careless. Several tables are reproduced from other works, sometimes without adequate explanation, sometimes with mistakes, and sometimes without acknowledgment. There are numerous mis-spellings of names in the references, and there is no author index. Altogether, the book must be regarded as a rather unworthy companion to the other members of this important series. Finally, I would like to ask why, in general, American books are printed on such heavy paper; this one weighs 3 lb. and is most uncomfortable to handle for prolonged periods.

H. LIPSON

## Organic Syntheses—Collective Volume 3

Edited by E. C. Horning. (A Revised edition of Annual Volumes 20–29.) Pp. x + 890. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1955.) 120*s*. net.

THIS work, begun as an annual publication in 1921 under the original editorship of Prof. Roger Adams, has proved from the first to be a practical aid of very high value to students and research workers in organic chemistry and biochemistry. It is a thoroughly reliable, accurate and comprehensive *vade mecum* for all who are actively engaged in these great and expanding fields of science. It was a happy thought of the editors to issue a collective volume at intervals, and the third volume of this kind includes the classified and revised material of annual Vols. 20–29.

In all, particulars are here given for the preparation of more than three hundred and fifty organic compounds and reagents, and there are details of new procedures for acenaphthenequinone, aminoacetal, α-tetralone, and several other substances. References have been brought up to date and linked with *Chemical Abstracts* in order to facilitate a complete search of the literature. The vast amount of material in the book has been made readily accessible by means of indexes of reactions, types of compounds, formulæ, solvents and reagents, and illustrations, in addition to a comprehensive general index. Altogether, this collective volume, like its two predecessors, is a time-saver of the first order.

JOHN READ

# PEACEFUL USES OF ATOMIC ENERGY

## CHEMICAL, METALLURGICAL AND GENERAL TECHNOLOGICAL SESSIONS AT GENEVA

By DR. R. SPENCE, C.B.

THE economic aspects and engineering design of nuclear power reactors naturally provided the main theme for the recent Conference on the Peaceful Uses of Atomic Energy held in Geneva; the supporting sciences and technologies were, however, adequately represented in parallel sessions which commenced on August 11 and finished on August 20. The *A* Sessions were mainly devoted to physics and reactor engineering; raw materials, chemistry, chemical technology, metallurgy and waste disposal problems were discussed in the *B* Sessions, while the *C* Sessions were concerned with medical and biological problems and with applications of radioisotopes.

Until quite recently, it would not have been possible to hold useful international discussions on some of these topics, but the situation has changed so rapidly during the past few months that the United States, Great Britain and Canada have been able to release a very substantial amount of technical information. The complete success of the Conference was assured when it also became known that there would be important contributions from the U.S.S.R. Undoubtedly, the greatest mass of information, in practically all fields, was supplied by the United States, and many very comprehensive survey papers were included. There were about as many Russian contributions as British, but they were not so evenly spread; for example, there were no Russian papers on chemical processing or on waste disposal. Contributions from other nations were sufficiently numerous and sufficiently important to give the Conference a truly international flavour.

One of the most valuable papers in the *B* Sessions, and perhaps one of the most important in the whole Conference, was that given by Mr. Jesse Johnson, head of the Raw Materials Division of the U.S. Atomic Energy Commission. He estimated that at least one million tons of uranium can be extracted at a reasonable price and that much more is obtainable. This means that there will be no shortage of uranium even for substantial natural uranium power schemes such as that recently announced by Great Britain. In the Russian exhibit there was a particularly fine display of uranium minerals, and the paper by H. Sankhoff on location of ore bodies by radiochemical analysis of ground waters was specially interesting, as no other country appears to have used this method systematically.

There were very detailed American papers on the production of heavy water, on the production of the atomic energy metals and on graphite, together with important contributions from Britain, Canada, France and the U.S.S.R. These papers, and the discussions which followed them, will allow those countries which hope to initiate an atomic energy programme of their own to make an appreciation of the feasibility of producing some of the necessary materials themselves. It was made clear in some of the economic discussions in the plenary sessions that the factors which the so-called under-developed countries would take into consideration in making their appreciations might be quite different from those ruling in the case of the technically advanced countries. Countries with local supplies of one or other of the necessary raw materials may not be deterred by purely economic considerations, therefore, from setting up their own factories or refineries.

The situation as regards the chemical processing of irradiated reactor fuel seems to be rather different. In spite of the fact that the chemical processing plant is an essential component in the industrial atomic power complex, and that the information released at the Conference was exceptionally complete, the discussion in the sessions dealing with this subject was restricted to the specialists, mainly those coming from the United States and Britain. This may have been due to the fact that the processing sessions were held on the penultimate day of the Conference, by which time delegates were visibly tiring; but it was more probably due to a general acceptance of the likelihood that such plants will have to be designed, built and perhaps operated by organizations within the technically advanced countries.

The sessions on waste disposal were most instructive, although here again the bulk of the information was provided by the United States and Britain. It was particularly interesting to hear an account of the elaborate storage system for highly active liquors which has been installed at the great Hanford works in the United States. Several speakers emphasized that the scale and cost of the highly active storage and disposal facilities are very greatly dependent on the nature of the reactor and chemical plant with which these facilities are associated. On the other hand, it was admitted that even some of the more elaborate systems would add only a small percentage to the cost of power generated. The real problem is the danger and embarrassment which would arise if there should be any accidental spread of these highly active liquids. There seemed to be general agreement on the policy to be adopted in a nuclear power scheme, namely, concentration, separation of cæsium-137 and strontium-90 and storage of the less dangerous residue for ten to fifteen years with ultimate burial or discharge to sea, perhaps after extracting some of the more useful isotopes.

In contrast to the chemical processing and waste disposal sessions, there were notable Russian contributions in those sessions dealing with laboratory facilities for handling highly radioactive materials and with the effects of radiation on materials. While nothing was disclosed which was outstandingly new, it was evident that the Russian laboratories are well equipped in this respect and that much useful work is going on there. Similarly, in the fields of inorganic chemistry and radiochemistry and in analytical chemistry, it was quite evident that Russian scientists are well advanced. They reported, for example, interesting work on elements such as ruthenium, americium and technetium, and a new application of the isotope dilution technique to the emission spectroscopic method of isotopic analysis. Very fine review papers were presented in most of these sessions by American authors and there were also certain outstanding contributions from the United Kingdom, notably the paper on the chemistry of ruthenium, which was far in advance of any other work on this element reported at the Conference. The Barker square-wave polarograph, which was shown in the United Kingdom exhibit at the Palais des Nations, also attracted considerable attention from analytical chemists as a new and original instrument of great potentiality.

The two exhibitions, one in the Palais des Nations and the other in the Salle des Expositions in Geneva, were both extremely good. The United Kingdom sections in particular received universal praise, which the hard-working organizers thoroughly deserved.

For chemists and metallurgists as well as for engineers and physicists, the Conference was a tremendous success. To discuss matters which have been kept secret for so long, in the free atmosphere of an international conference, was an exhilarating experience, and to establish personal connexions with other scientists who have been working in the same field was extraordinarily beneficial. Possibly after more sober appraisal, it may be found that the value of the Conference to the United States, Canada and Great Britain lies mainly in such intangible benefits as those just mentioned; but there can be no doubt that for the world at large the gain was a great one.

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# GOUGH ISLAND SCIENTIFIC SURVEY

By J. B. HEANEY

Organizer

AN eight-man expedition, most of whose members are graduates of Oxford or Cambridge, left the United Kingdom at the end of August to carry out a six-month scientific exploration of Gough Island. The island is one of the few high peaks of the Mid-Atlantic Ridge that pierce the ocean surface, and lies some 260 miles south-south-east of the three islands of the Tristan da Cunha group; it is a remote outpost of the Commonwealth, 1,500 miles from the Cape of Good Hope, and in the path of the 'Roaring Forties', which, by all accounts, give it an unfriendly climate with frequent ferocious storms and often cold, damp and foggy weather.

The conception and organization of the Gough Island Scientific Survey were mine, but, due to medical advice, I cannot take part in the field-work, and the leadership of the party has been handed over to Mr. Robert Chambers. The expedition is actively supported by the Royal Geographical Society, the Scott Polar Research Institute, the Mount Everest Foundation, and many other bodies and scientific institutions in Great Britain.

Uninhabited by man, Gough Island is a precipitous mass of volcanic rock rising to nearly 3,000 ft.; it measures about eight miles by four, and from its western storm-beaten beaches cliffs tower to 1,000 ft. Mountaineering techniques will be employed to enable the party to travel freely over the area.

The island has been described as a 'naturalist's paradise'; and is the only remaining sub-antarctic island which has not been thoroughly investigated. It has a luscious vegetation of small stunted trees, tree-ferns, tussock grass and mosses, and a rich bird life. It is the home of a unique species of flightless rail which has lost the use of its wings through processes of natural selection; some of the insects will probably show the same degeneration. Large numbers of albatrosses and rockhopper penguins nest on Gough Island, and every year an increasing number of fur seals and elephant seals haul out to breed on the beaches. These animals were exterminated from the island by the depredations of the sealers during the past century, and since their exploitation became unprofitable the island has been visited on very few occasions. In 1904 the expedition ship *Scotia* called, homeward bound from the Antarctic, and small collections were made on the island on one day, and again in 1922 members of Shackleton's last expedition from the *Quest* spent four days ashore. Present knowledge of the island's geology and natural history is chiefly based on collections made on these two occasions, and also on those made by a Norwegian who spent a few hours ashore in 1934. That a detailed scientific investigation of Gough Island is eminently worth while is indicated in an article by Prof. R. N. Rudmose Brown, of the *Scotia's* party, when he wrote, "No doubt looked at from an impartial standpoint, Gough Island is but a relatively insignificant rock in mid-ocean, but its very isolation makes it of great interest. It may throw light on some former continuity of land in the Southern Hemisphere, and it cannot fail to elucidate various problems of biological distribution when its fauna and flora have been thoroughly investigated. It is for these reasons that its further exploration is so much to be desired".

The members of the expedition, with the qualifications and ages, are listed below: R. J. H. Chambers (leader, surveyor), 23; J. P. Hall (cameraman), 32; M. W. Holdgate (zoologist), 24; R. W. Le Maitre (geologist), 21; P. J. Mullock (radio operator), 22; J. J. van der Merwe (meteorologist), 29; M. K. Swales (zoologist), 24; N. M. Wace (botanist), 26. Van der Merwe is a South African Government meteorologist.

Gough Island lies in the path of weather approaching South Africa, and one of the tasks of the expedition will be to transmit reports five times a day to the Weather Bureau, Pretoria. By comparing simultaneous readings from Gough and from the existing station on Tristan, it should be possible to orient fronts, and to fix more correctly the centres of passing depressions so that their time of arrival in the Union may be forecast more accurately. Dr. T. E. Schumann, director of the South African Weather Bureau, is sponsoring the programme for synoptic reports, and welcomes this opportunity of testing the value of Gough Island as a permanent meteorological station. Some research will also be carried out on the air currents and local clouds formed around the island, which behaves as a small land mass in the path of a steady prevailing wind.

The main emphasis of the field-work will be on various biological programmes. First and foremost, these will consist of making thorough collections on the island; it is to be expected that there will be several species new to science. A particular study will be made of the ecology of the flightless rail, and of the other land bird—a bunting. The populations of the fur and elephant seals will be assessed for the possible future exploitation of the two species.

The invertebrate fauna of Gough Island is almost completely unknown. The isolation of the island, the diversity of its terrain and vegetation, and its comparative freedom from human interference, will make a faunistic survey especially interesting. It is hoped to use the main plant associations as the units in this survey, although a study will be made of the fauna of particular habitats such as streams, caves, beach debris and bird nesting colonies.

The botanist will make a study of the dispersal mechanisms and agents that have brought about the distribution of some of the more interesting plants; he will also investigate systems of reproduction in a few plants. Pollen analyses of peat samples and their radiocarbon dating will give some indication of the history of plant-life on the island.

The petrological examination of the lavas of Gough may provide clues as to the nature of the Mid-Atlantic Ridge. A gneissous block of 'continental' origin has been found in the crater of Tristan, and there are rocks with similar 'continental' affinities on St. Helena and Ascension; it is hoped that the rocks of Gough will provide further hints about the nature of the Atlantic floor.

The expedition's collections will be distributed to specialists for identification after the party returns, and individual members will work on their own lines of research. Papers will be published in various scientific journals, and in addition it is hoped to collect and republish all the results in a series of papers under the name of the expedition.

# CEREBRAL ACTIVITY

A JOINT meeting of Section I (Physiology) and Section J (Psychology) of the British Association on September 2 at Bristol took the form of a symposium on cerebral activity. Without being restricted to a particular theoretical issue or to data obtained from a particular discipline, this symposium provided common ground for workers from a number of different fields of inquiry relating to the problems of cerebral mechanisms. The topic chosen by the organizers of the symposium may fairly be said to be one where interdependence of different scientific disciplines is becoming increasingly apparent, and the papers which were read on this occasion were largely focused on this point.

The symposium opened with an account by Dr. C. G. Phillips (Oxford) of the essential established facts of nerve structure and function with which any theory of cerebral activity must come to terms.

Reviewing the progress in neurophysiology since the discovery late in the nineteenth century that the nervous system is built up of independent nerve cells, Dr. Phillips described the function of nerve cells in conducting impulses inwards along the dendrites towards the cell body and outwards along the axon to other nerve cell bodies or their dendrites, or to muscles. Dr. Phillips cited the evidence for a voltage gradient across the plasma membrane of the cell body and its processes and (without committing himself to a particular theory of neurohumoral transmission) outlined the sequence of events whereby signals arriving at the specialized terminals which are applied to the dendrites and cell bodies of other nerve cells result in the secretion of chemical transmitter substances which serve either to increase or to decrease this voltage gradient. The excitatory or inhibitory effect of these terminals was discussed in relation to the critical potential difference which determines the firing of a self-propagating nervous impulse.

Dr. Phillips emphasized that, in considering the nerve cell as a unit in an information system (for example, as a relay), the complexity of this unit's function must not be overlooked. Although the firing or non-firing of a nervous impulse in accordance with a certain critical voltage difference across the plasma membrane may seem a simple and unitary function, nevertheless this is only the end result of the integration of inhibitory and excitatory effects at hundreds of dendritic contacts. The cell "may be poised near to the critical firing level or it may be 'biassed off' over a range of about twenty millivolts, by preponderating inhibitory action". On one hand, there is variability in the amount of further excitation needed if the cell is to fire at all; on the other, given adequate excitation, the frequency of firing is variable over a wide range.

Dr. Phillips then turned to the question of the organization of particular types of cerebral activity, and mentioned that repetitive activity may cause an enduring facilitation of transmission from cell to cell. In suggesting that such changes could conceivably impose fairly definite pathways on an originally diffuse system of interconnexions, he was careful to point out that particular patterns of activity occurring in a more or less restricted brain region might very well engage different populations of brain cells on different occasions, and that one cannot assume an unvarying anatomical substrate for particular types of cerebral activity. In fact, although certain reflex pathways can be traced and although there is some knowledge of the traffic of impulses in a few well-marked tracts within the central nervous system, the nervous events which subserve such functions as speech and skilled movement cannot at present be traced in detail.

Dr. W. Grey Walter (Burden Neurological Institute, Bristol) gave an account of some of his investigations into the function of the spontaneous electrical activity of the brain. He suggested that this activity has an 'administrative' function in cerebral organization and, more specifically, that this activity is concerned with the distribution in the brain of information derived from the sense organs and that this is best considered as operating on a statistical basis. He also maintained that this spontaneous activity is related to temperament and social behaviour.

After stressing the inadequacy of the tools which are available for the study of cerebral mechanisms, Dr. Grey Walter pointed out that useful information can nevertheless be gleaned provided that the information extracted by one's recording instruments bears a recognizable relation to the end result of the function under investigation. He suggested, for example, that the conventional voltage-against time record is unsatisfactory, and that frequency analysis yields more meaningful information. He illustrated this point by referring to the electrical changes which occur in the brain during word association procedures and during problem solving.

Another technique which Dr. Grey Walter believes is of particular value is the graphic representation of electrical activity from various parts of the brain. A cluster of cathode-ray tubes with revolving time-bases (intensity modulation) can assist in the analysis of the electrical activity of the brain as a whole, since it is then possible to trace functional relationships between different brain areas. Thus Dr. Grey Walter claimed that this technique shows that the alpha rhythm of the brain is not a simultaneous synchronous firing throughout the brain, but that instead the alpha rhythm picked up from different parts of the scalp is not completely in phase. Similarly, a rhythmically flashing light (when the time relations of the apparatus are adjusted to the periodicity of the stimulus) is reflected in a corresponding pattern in parts of the visual display of the apparatus. This pattern may appear in a unitary fashion in a particular part of the cortex (for example, the occipital lobes), may be broken down into components, with these components distributed to different parts of the brain, or may even be conserved (in the temporal region) for a period as long as 10 or 20 sec. after the cessation of the stimulus. The cerebral consequences of visual stimulation as measured with this technique show habituation effects with prolonged stimulation and also dishabituation when subjective monotony is relieved by the introduction of a reward.

Dr. Grey Walter carried interpretation a step further when he claimed that people with similar patterns of electrical activity of the brain tend to have temperamental affinity and are well fitted for social co-operation with each other.

Dr. D. M. Mackay (King's College, London) discussed some of the theoretical problems of cerebral organization. He pointed out that the fault with the kind of analogy which compares the brain to known mechanical or electronic devices is that it is too restricted, and he stressed the necessity for a more basic and general language. This, he urged, could first most properly be employed to describe what the brain does before attention is turned to the problem of how it does it. He suggested that, given adequate definition of what the brain does, one could proceed to consider various possible alternatives as to the mechanism involved and then refer back to the known facts of neurophysiology for guidance as to which of the postulated mechanisms occurs in the brain. The theory of information and control which has arisen from recent developments in communications and automatic control systems is framed in terms which, Dr. Mackay suggested, are of sufficient generality to meet the requirements he had referred to. This basic terminology, he maintained, could be applied to both physiological and psychological data, possessed a reasonable chance of surviving changes in engineering fashion, and lent itself particularly well to a theory concerned with units with a controllable probability of passing on signals (as described by Dr. Phillips).

Dr. Mackay raised two important issues which would necessarily have to govern any theoretical model of cerebral organization: first, such a model would need to be self-organizing; secondly, it would need to be able to take advantage of the redundancy of information which is implicit in a stable environment. It would thus be necessary to work out the general principles upon which such a system as the brain would have to function if it is to take advantage of the statistical regularities of the world with which it has to deal. Similarly, Dr. Mackay argued, the question of the time which such a system would require in order to adjust itself to these regularities is a crucial one. Thus there is no possibility of a model of restricted size which could make the necessary adjustments by simple trial, error and success in relation to each alternative with which it is confronted. A principle which would be more consistent with the observed facts of behaviour, Dr. Mackay contended, is one where the system starts with "the degrees of freedom coalesced", so that the process of self-development becomes one where the probability of any particular event occurring would be reduced rather than increased during the period of organization. Dr. Mackay's suggestion is thus nearer to Coghill's theory of differentiation through maturation than to learning in terms of conditioning or simple trial-and-error learning. Finally, Dr. Mackay suggested that such a model might find its first application and its first test in relation to the effects of brain injuries, since the types of breakdown which might occur with any particular model should be predictable.

Mr. M. F. Piercy (Bristol) discussed behavioural studies of cerebral dysfunction. He pointed out that the behaviour of a normal organism in a normal environment gives very little clue as to the changed behaviour which may result from physical interference with cerebral function. Similarly, this behaviour would not be predictable on the basis of present neuro-physiological knowledge. This situation, he suggested, provides a starting-point for studies which may eventually modify both psychological and physiological theories.

As an example of studies taking their cue from clinical neurology, he cited work on the incidence of aphasia in relation to cerebral dominance. Although, in right-handed patients, aphasia occurs almost exclusively in association with lesions of the left hemisphere, nevertheless left-handed patients may sustain an aphasia as a result of a lesion of either hemisphere. There is however, he maintained, evidence to suggest that aphasia is often less severe and more transient in left-handed people. In distinction to this evidence, Mr. Piercy referred to a study of paroxysmal dysphasia (with which he had been concerned). This showed that paroxysmal aphasia occurring in association with a short-lived unilateral cerebral disturbance was more frequent in left-handed than in right-handed patients, irrespective of the side of the focal cerebral disturbance. It may be, he argued, that if a function is more diffusely organized with respect to cerebral anatomy (for example, language in left-handers), not only is restitution of function more easily achieved when the disturbance is chronic, but also that function is more liable to disruption in the face of acute interference. Conversely, in the case of a function being organized within a more restricted cerebral area (for example, language in right-handers), Mr. Piercy suggested that the function might be more resistant to acute interference (such as paroxysmal) but less capable of recovery when breakdown occurs in association with a chronic lesion. This, he said, was a tentative theoretical position which should be amenable to experimental verification or disproof.

Mr. Piercy then directed attention to studies which produced anomalous behaviour without direct interference with cerebral function. Thus, if a person's voice is recorded and played back to him through earphones with a delay of about half a second, gross disturbances of speech are liable to occur. These disturbances are not unlike those occurring in some forms of dysphasia. Similarly, a recent study carried out in Canada has shown that if sensory stimulation is reduced to a minimum for a period of hours or days, a human subject may experience hallucinations and feelings of unreality which closely resemble those occurring under the influence of hallucinogenic drugs. Similar symptomatology from radically different experimental procedures may or may not mean that a common cerebral mechanism is disturbed; but such converging lines of evidence should, he urged, at least provide strong stimulus for further research. MALCOLM PIERCY

# PROGRESS OF CANCER RESEARCH

THE annual report of the British Empire Cancer Campaign has now expanded in its 1955 edition* to more than 500 pages; consequently, this short review can only deal with a very limited number of the researches financed and organized by the Campaign. The investigations to be described can be divided into three main groupings, namely, those concerned with carcinogenesis and other studies of that kind, clinico-pathology, and radiology.

In the editorial summary to the report there is a statement which says that "steady progress continues in our understanding of the manner in which cancer-producing substances act". Unfortunately, this happy thought verges on the over-optimistic.

Work on the fashionable cancer problem, the lung cancer – cigarette smoking relationship, continues at a number of centres. One of the main difficulties, from the experimentalist's point of view, is to find some tissue which has the same sensitivity as human lung and upon which the carcinogens present in cigarette smoke could be tested. Sir Ernest Kennaway and co-workers have found 3 : 4-benzpyrene, anthracene, pyrene and acenaphthylene in the condensate from tobacco smoke, and the same compounds have also been detected in smoke from the paper in which the cigarette tobacco is rolled. Sir Ernest has attacked the difficulty of test material by using tissue-culture technique:

"Several workers have demonstrated the carcinogenic power of tobacco condensates upon the skin of the mouse, but neither the species nor the tissue concerned in these experiments is of practical importance. Human tissue can be used thus only in tissue culture. Dr. Honor B. Fell, of the Strangeways Research Laboratory, Cambridge, has kindly allowed Dr. Ilse Lasnitzki to investigate this matter. Lung tissue obtained from an early human fœtus, and therefore sterile, was found to grow well in culture without replacement of epithelium by fibroblasts.

"Such cultures are being exposed to 3 : 4-benzpyrene, and to various fractions of tobacco condensates, in order to learn whether the nuclear changes known to be produced by carcinogens in other tissues can be induced in this instance also."

M. H. Salaman and collaborators have reported interesting developments in the study of the two stages of carcinogenesis ('initiation' and 'promotion'). They find that pre-treatment of mouse skin with urethane (initiation), followed by promotion with croton oil, yields skin tumours; however, urethane, although a highly potent carcinogen for mouse lung, does not induce cancer in mouse skin when applied alone. It has now been found that for the initiation stage in mouse skin not only urethane but TEM (triethyleneimino-3-triazine) or 1 : 2-benzanthracene or β-propiolactone are also effective. The promoter, too (croton oil), can be replaced by iodoacetic acid or by chloracetophenone.

The search for chemotherapeutic drugs for cancer is undergoing an interesting change; less emphasis is now being placed on the therapeutic results achieved, and more and more on the synthesis and preparation of the drugs and upon the mechanism of their cytotoxic action from the points of view of cytology and physical chemistry.

Dr. Percy Stocks, in a study of the influence of social factors on the incidence of breast cancer in women, states:

"The figures suggest that when marriage is delayed the risk of breast cancer is increased, whatever the number of children borne, except in the group married about 30 with long duration of married life; or, otherwise expressed, that high fertility has a protective effect provided that marriage has not been delayed too long.

"In due course larger numbers will be available to establish this but taking account also of the remarkably low breast cancer rates in Japan where fertility has been high and breast feeding usually very prolonged, sufficient justification has been found for an attempt to seek answers to the following questions:

"(1) Does the mortality excess associated with zero and low fertility indicate simply a greater frequency of breast cancer, or is there also a greater probability of high malignancy when cancer occurs (i.e. higher fatality without higher inception rates)?

"(2) Is short duration of breast feeding more important than few confinements in producing the excess?"

There are no surprises in the field of morbid anatomy this year. It is good to learn that Bloom's series of cancers of the breast approaches the thousand mark, and that its full statistical analysis is being undertaken. The extraordinary statistical difficulties which bristle about every attempt to assess the effects of different forms of treatment of this disease, and the effect of varying histology, can only be solved by study of really large and uniformly recorded series such as we can hope for in this case. D. H. Patey and A. C. Thackray provide a much-needed study of the whole gland resected in cases of parotid tumour: in none of their cases (save their only adenolymphoma) was there any evidence whatever of multicentric origin—a most important point to be settled in regard to treatment. It is, however, disappointing to find they have used only ten cases.

The review of the tumours of childhood from the Hospital for Sick Children at Great Ormond Street,

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* British Empire Cancer Campaign. Thirty-second Annual Report covering the year 1954. Pp. xxx+531. (London: British Empire Cancer Campaign, 1955.)

London, continues. There is a valuable collection of sixteen cases, seen over a period of thirty years, of Letterer–Siwe's disease, Hand–Schuller–Christian disease, and eosinophilic granuloma of bone, which demonstrates well the point that all three conditions are examples of a single entity. They range from solitary cured granuloma in older children to rapidly fatal, widely disseminated disease in the infant; but the transitions are too striking to be ignored. The prognosis in these cases seems to be better than is generally supposed. Four cases with solitary lesions were cured by local measures: of six with multiple lesions confined to bone, three are cured and none has died. Even in the disseminated disease there have been two complete cures.

There is also a review from the same source of neuroblastoma, the commonest tumour (except leukæmia) seen at this hospital. They are of especial interest as a base-line for the study of the effects of vitamin $B_{12}$ on the tumour, first mentioned in last year's report. Of ninety-four cases collected, seventy-seven are known to have died, and there have been only two spontaneous regressions. Only twenty cases were regarded as suitable for treatment by surgery or radiotherapy, and of these seven survived more than two years. Nineteen cases in all have now been treated with vitamin $B_{12}$. All were unsuitable for radical conventional treatment, though some have had incomplete surgical or radiation therapy in addition to the $B_{12}$. Substantial response seems to have been obtained in about half the cases. There has so far been only one really unexceptionable cure, lasting 4½ years. Two other survivors beyond two years have recurrences; but several other cases whose follow-up period does not yet justify their being called cures have shown most gratifying immediate responses. It must still be a matter of very great doubt whether we have in $B_{12}$ a means of cure of neuroblastoma; but it seems probable that we have a means of relief at least as effective as, say, the nitrogen mustards in chronic leukæmia. In any event, the observation throws open a new window in tumour chemotherapy.

Prof. H. N. Green, who is now director of experimental cancer research in the University of Leeds, has combined his interests in carcinogenesis and shock metabolism into a theory of carcinogenesis which has at least the merit of directing attention to some unfamiliar facts. Briefly, his main chain of reasoning is this. Many, perhaps all, chemical carcinogens have an inhibitory effect on the take of transplanted tumours. Some fractions of tar which are not carcinogenic share this inhibitory action with the carcinogens. (Tetraphene is the active agent in some of these extracts.) Use of these non-carcinogens has made it possible to show that the inhibitory action on transplanted tumours is a relatively specific one, not due to any general depression of the host's health; it has also been shown that there is inhibition of the primary induction of tumours by the carcinogens. The inhibitory action is antagonized by agents, such as cortisone, which depress the immunity to transplanted homologous tissues. These, and other arguments, lead to two hypotheses, of which the first may be readily accepted as possibly true—that the tumour-inhibitory action of carcinogens and non-carcinogens alike is due to a stimulation of the homotransplant immunity reaction. Given this, Prof. Green assumes that the action of these agents must be on the antigenic structure of the cell, and proposes in his second and major hypothesis the view that the essential action of a carcinogen on a cell consists in the alteration of its antigenic structure so that it loses its individuality and becomes antigenically neutral. That loss of antigenic specificity is an important characteristic of some tumour cells—of all transplantable tumours, in fact—is a proposition that few would deny; that it is a fundamental characteristic of all tumours is harder to accept. But the hypothesis is at least fruitful of experiments.

There is a tantalizingly brief reference to work in the cytogenetics department at Manchester on the sex chromosomes in transplanted tumours in *Microtus*, suggesting that the host contributes chromosomes to the tumour cell, of which one hopes to hear more in the future.

The range of the physicist in the realms of cancer research and treatment grows wider and more diverse year by year. Basic physical studies continue, and from them are developed new methods of instrumentation and measurement. The use of radioactive isotopes is now an everyday matter in a very large number of departments; but work is still going on, and is needed, on increasing the sensitivity and scope of present-day methods of measurement. The construction of automatic devices for the measurement and localization of radioactive material within the human body and on chromatograms is reported from several centres, and the co-operation of the physicist is being sought more and more by his colleagues in their biochemical and biophysical investigations, as well as in the more accustomed radiotherapeutic uses of radiation.

The commercial development of equipment capable of producing beams of radiation of 1 MeV. and greater has necessitated increased study of the radiation effects occurring at these levels, and also the production of methods of measurement more suitable for these energies. A calorimetric method of dosimetry seems to offer a very good alternative to the more standard ionization methods for beams of X-rays of quanta 3 MeV. and greater. The use of a 1,000-curie source of cobalt-60 has also led to the study of the dose distribution obtained in the beam, and consideration of the best use of the beam for radiotherapy.

With the increasing use of radioactive materials, and wider range of radiations now in current use, the study of health physics achieves greater prominence each year. In this report, as well as the more usually considered radiation hazards, studies are reported on the possibility of the protection of bronchitics and asthmatics against 'smog', both indoors and out.

At the same centre the radon content of the atmosphere under conditions of fog or excessive smoke is being measured with the aid of specially built apparatus which permits the measurement of small amounts of radioactive gases.

The effect of whole-body radiation is being studied at a number of centres with particular reference to protective materials and to the result of partial shielding. The use of iron-59 as an indicator of the effect of various dosage-levels on the erythropoietic system, and also of the effect of changes in dosage-rate and of the comparative effect of X- and neutron-irradiation, continues. This should be of considerable value in assessing the total amount of whole radiation received either by design, after radiotherapy, or by chance after an occupational accident or thermonuclear explosion.

# JAMES PARKINSON (1755–1824)

By JOAN M. EYLES

THE incidence of Parkinson's disease, or paralysis agitans, is sufficiently high for most people to know something of its nature, or at least to have heard of it. Yet the story of the life and activities of the man who gave this crippling disease his name is not widely known, and it may surprise many to learn that in his day he attained distinction, not only as a physician, but also as a geologist and as a social reformer.

On September 17, an inscribed marble tablet was unveiled in St. Leonard's Church, Shoreditch, to commemorate the memory of "James Parkinson, of Hoxton, Surgeon and Apotheoary". A short service preceded the ceremony, and the Rev. Meredith Davies, in an address to the congregation, described Parkinson's close association with the parish and his wide humanitarian interests. He also mentioned the "untiring efforts and tenacity" of Dr. A. D. Morris, formerly medical superintendent of St. Leonard's Hospital, who for a number of years had not only interested himself in Parkinson, but also had been instrumental in inspiring local interest in this remarkable man.

The tablet, the funds for which had been provided by the generous efforts of the nursing staff of St. Leonard's Hospital, was then unveiled by Dr. Morris, who pointed out that it commemorated Parkinson's geological as well as his medical achievements. Among those present in the church were two direct descendants of Parkinson, Dr. Robert Tringham and Mr. Herman Saunders, while local interest was marked by the presence of the Mayor of Shoreditch. Members of the medical profession who attended the ceremony included Sir Zachary Cope, president of the History of Medicine Section of the Royal Society of Medicine, Mr. Macdonald Critchley, Sir Allen Daley, Dr. Donald Hunter, Mr. T. B. Layton and Mr. A. Dickson Wright. After the service Miss Bell, matron of St. Leonard's Hospital, and her staff entertained the visitors to tea at the hospital, where interested glances were directed to the plaque recording the fact that Nurse Edith Cavell had once been assistant matron there.

Earlier in the week Parkinson's name had been to the fore at the meeting of the Second International Congress of Neuropathologists, held at the Royal College of Surgeons of England during September 12–17. The president of the congress, Dr. J. G. Greenfield, referred to him in his opening address on "Historical Landmarks in the Pathology of Involuntary Movement", and several papers read during the week were concerned with Parkinsonism and Parkinson's disease. Very appropriately, as 1955 is the bi-centenary of Parkinson's birth, an exhibition was arranged at the College by the librarian and Dr. Morris to illustrate the many facets of Parkinson's life. A portrait, however, could not be discovered, and one is still being sought.

James Parkinson was born in Hoxton on April 11, 1755, and spent all his life in the parish. The son of a surgeon, he himself qualified in 1784, and in 1785 attended the surgical lectures of John Hunter, and took full notes in shorthand. Many years later these were transcribed and published by Parkinson's son, James Keys Parkinson, who was also a surgeon.

Little is known of Parkinson's early life, except that as a pacifist and political reformer he was the author of many pamphlets written either anonymously under the pseudonym of "Old Hubert", including "Revolutions without Bloodshed; or Reformation Preferable to Revolt", which appeared in 1794. He was a member of various secret societies, including the London Corresponding Society, and when some members of the latter were arrested and charged with complicity in what became known as the "Pop-Gun Plot", Parkinson gave evidence before the Privy Council in their favour and published pamphlets maintaining their innocence.

Parkinson then seems to have directed his activities into rather more innocuous channels, issuing in 1799 "Medical Admonitions for Families", which went into five editions in the next ten years, followed by the "Villager's Friend and Physician" and "Dangerous Sports" in 1800. In the latter year he also published another best-seller, his "Chemical Pocket-Book", which was "calculated, as well for the occasional reference of the Professional Student, as to supply others with a general knowledge of Chemistry". It had a good reception, and was reprinted in the United States, with notes by James Woodhouse, professor of chemistry in the University of Pennsylvania. In this book, as in other of his works, Parkinson showed he had read widely, much of the "Pocket-Book" being a digest of recently published work in chemistry.

His first geological work, a large quarto with many illustrations, appeared in 1804, with the impressive title "Organic Remains of a Former World: Volume I, The Vegetable Kingdom". This volume includes a useful historical review of early books about fossils. Two more volumes appeared in 1808 and 1811 respectively, and were concerned with vertebrate and invertebrate fossils. In the histories of geology, Parkinson's work has received less notice than it deserves, although it has recently been stated that "its appearance was the outstanding event in the history of our scientific knowledge of British fossils"[1]. There is little doubt that Parkinson, who was an original member of the Geological Society of London, was highly esteemed by his contemporaries for his scientific knowledge of fossils at a time when most people were content merely to collect them. In several papers published in the *Transactions of the Geological Society of London*, he assisted in naming the fossils. Parkinson himself had a paper in the first volume of the *Transactions*, entitled "Observations on some Strata in the Neighbourhood of London, and the Fossil Remains contained in them", which is noteworthy as the first detailed account of the strata of the London basin. In this paper he refers to the discovery of William Smith, that strata could be identified by their contained fossils. Elsewhere Parkinson mentions his friendship with the Rev. Joseph Townsend, who was the first to appreciate the value of Smith's discovery.

Parkinson wrote many articles for medical journals which indicate he was a careful observer; and he published several tracts which show his zeal as a social reformer. It was in 1817 that he published the "Essay on the Shaking Palsy" which has brought him eponymous immortality. In 1822 he received recognition from the Royal College of Surgeons of England with the award of its Honorary Gold Medal. This is of greater interest when one learns that he was the first to receive the award, which had been instituted in 1802, and that it has only been bestowed fifteen times in the past hundred and twenty years. It is stated in the minutes (a copy of which was included in the College exhibition) that the award was made "in consideration of his useful labours for the Promotion of Natural Knowledge particularly expressed by his splendid Work on Organic Remains".

Parkinson died in 1824 and was buried in the graveyard of St. Leonard's Church, though the exact location of his grave is unknown. His fine collection of fossils was sold at public auction in 1827, some being acquired by Sedgwick for the museum in Cambridge, others passing to Oxford, Haslemere, and into private hands. Some now rest in the British Museum (Natural History). His name is preserved in geological as well as medical circles, for the ammonite *Parkinsonia parkinsoni* and the crinoid *Apiocrinus parkinsoni* are both well-known fossils from the Inferior Oolite. It is satisfactory to learn that medical historians are now busy rescuing Parkinson from undeserved obscurity[2].

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[1] Challinor, J., *Ann. of Sci.*, 6, 46 (1950).

[2] *Lancet*, 1, 761 (April 9, 1955).

# OBITUARIES

## Prof. F. Blakemore

The sudden death on August 7 of Prof. Frederick Blakemore at the early age of forty-nine comes as a great shock to his friends and colleagues both within and without university circles. He qualified at the Veterinary School, University of Liverpool, in 1927, and then spent three years in general practice. In 1931 he moved to Cambridge as veterinary investigation officer for the eastern counties, where he remained until 1948. This was a period of intense activity demanding the closest collaboration with veterinary surgeons, agriculturalists and research workers, in a variety of fields. He would leave early in the morning to visit veterinary surgeons and farmers in the wide district which he covered, and his reputation as a sound adviser on all problems of animal health and disease was unrivalled. On his return he would plunge himself into his laboratory investigations, for which his enthusiasm was unbounded. The volume and high quality of his work during this period were an example to the younger men with whom he was associated. He had an uncanny knack of selecting the problems in the field which were worthy of intensive laboratory study. The impact of his scientific mind on a problem was shown by his unusually clear exposition of a subject. The extensive researches which he completed at Cambridge could not have been undertaken without the help of collaborators, many younger than himself, who owe much to his kind guidance and stimulating encouragement. His distinction in the research field was recognized by the award of the Dalrymple-Champneys Cup by the British Veterinary Association.

The high qualities which emerged during this period marked Blakemore as a man of sound judgment, and it was no surprise to his friends that he was appointed superintending investigation officer for England and Wales. This branch of the Ministry of Agriculture had reached a critical stage in its development. The absorption of the county veterinary officers had been completed, but the service had not been moulded into a closely knit unit. To this task Blakemore brought his gifts of dogged persistence, persuasion and foresight, so that with the help of his colleagues he was able to build up an independent service complementary to the field officers of the Animal Health Division.

In 1948 he was appointed to the newly established chair of veterinary studies in the University of Bristol. He found in university circles, particularly in the person of the Vice-Chancellor, a keen interest in veterinary science and a desire to fashion a school on lines differing possibly from those of the older veterinary schools. Blakemore tackled with enthusiasm and sound common sense the problem of utilizing the resources of existing University departments, but at the same time developing an independent veterinary school with ramifications in Bristol and at the field station at Langford. The buildings which have been erected are a tribute to his sound planning; but, of themselves, they would never have created a flourishing school. The measure of his success was his ability to attract from the profession young men who were fired with his own ideals. The University of Liverpool recognized his outstanding merits by awarding him an honorary degree of doctor of veterinary science.

The high standing of the Bristol School is a collective victory; but it owes much to the knowledge which Blakemore brought of the practical side of his profession, as well as to his ability to take firm decisions and his clear-sighted judgment of men. Undoubtedly by his untiring efforts he spent himself to the limit. He will be sadly missed by his professional colleagues. The deepest sympathy is extended to his widow, who loyally supported him, and to his family.

R. E. Glover

## Mr. E. T. Leeds

Edward Thurlow Leeds, who died at his home, 88 Woodstock Road, Oxford, on August 17 at the age of seventy-eight, was successively assistant keeper and keeper of the Ashmolean Museum, Oxford, and was an archæologist of outstanding ability.

As assistant keeper of the Department of Antiquities in the Ashmolean during 1908–27, Leeds was responsible for much of the day-to-day work in the Department. His systematic mind and studious attention to detail, as well as his strong sense of custody, made him remarkably well fitted for such a post in a great and growing museum, and his flair for rapidly assimilating new knowledge soon gave him a mastery over all the material under his charge. From 1928 until 1945, when he retired, Leeds was keeper both of his Department and of the Ashmolean. Though he never neglected his Department and never failed to keep a firm daily grip on its working, administrative duties, which fell to him as keeper of the Museum, came to occupy more and more of his time, involving, as they did, the planning of no less than four major additions to the fabric (the Weldon wing, the Griffith Institute, the Drapers' wing and the Beaumont Street wing) as well as several internal reconstructions of fabric or fittings. His flair for attention to detail ensured that all this work took place with but the minimum interference with day-to-day duties and with practically no interruption of the Museum's service to the public.

That Leeds, as a busy and successful museum official, did not neglect the claims of scholarship is shown by the many excavations on local sites which he undertook (notably those of the Neolithic causeway and settlement at Abingdon, Berks, the Iron Age camps at Chastleton, Oxon, and Chun Castle, Cornwall, and of the Anglo-Saxon village at Sutton Courtenay, Berks) and by the list of six books and more than ninety smaller papers which appear in the bibliography of his writings in the forthcoming volume of essays entitled "Dark-Age Britain" offered to him by a group of his friends and pupils. His chief work lay in Anglo-Saxon studies. His book, "The Archæology of the Anglo-Saxon Settlements", published in 1913, can fitly claim to have been epoch-making, as it laid the foundation of all the more recent work on the subject, and showed, once for all, how great a contribution archæology could make to a study which had previously seemed to be almost solely the prerogative of the historian. He followed this with two more books and numerous papers, which showed how, though his views may have been modified in detail as the years passed, his main arguments stood firm in his own mind and have, indeed, now won general acceptance. Besides his work for Anglo-Saxon studies, Leeds also made major contributions to scholarship in several other fields, notably with his book "Celtic Ornament" (1933), and with his work on numismatics (Roman and Chinese) and his several papers connected with Oxford inns and traders.

Leeds was Fellow, and later honorary Fellow, of Brasenose College, Oxford, and was also elected this year to an honorary fellowship of Magdalene College, Cambridge, where he had been an undergraduate. He was a Fellow of the Society of Antiquaries and a vice-president during 1929–32, and an honorary associate of the Royal Institute of British Architects.

D. B. Harden

## Prof. Haakon Shetelig

Haakon Shetelig, formerly director of the Bergen Museum and professor of archæology there, who died on July 23 at the age of seventy-eight, was a distinguished authority on Scandinavian prehistory and on the archæology of the Vikings. He was particularly well known in Britain, both for the admirable account in his "Scandinavian Archæology" (Oxford, 1937), written in conjunction with the philologist Hjalmar Falk, and for his interest in the archæological traces of the Vikings in the British Isles, of which he left a permanent memorial in the six parts of "Viking Antiquities in Great Britain and Ireland", published in 1940 (pts. I–IV) and 1954 (pt. VI) on behalf of the Norwegian Scientific Research Fund of 1919. Much of the writing was contributed by British and Norwegian scholars, but Shetelig edited the whole work and himself contributed a masterly introduction to the history of the Vikings in Western Europe.

Shetelig was a genial and hospitable as well as a learned man, and he had an abiding love and respect for Britain. He had a particularly warm place in his heart for the amateur scholar, whom he regarded as the fine flower of our society in the days of its prime. It must have given him peculiar pleasure to be awarded the Gold Medal of the Society of Antiquaries of London, a recognition which came to him in 1939.

Grahame Clark

## Dr. C. H. N. Jackson, O.B.E.

Dr. C. H. N. Jackson, chief entomologist of the East African Tsetse Research Organization, died in hospital in England on July 28. His whole career was devoted to research in East Africa, his first appointment being in 1927 as zoologist to the Department of Game Preservation in Tanganyika. C. F. M. Swynnerton was the head of the Department, and Jackson was one of the team of able young men who Swynnerton inspired to work on the tsetse fly which then, as now, was one of the major problems of East Africa. Swynnerton persuaded his Government and the Colonial Office to set up a separate Department of Tsetse Research, and Jackson was appointed as survey entomologist to it in 1932. He became senior entomologist in 1936. In 1948 tsetse research became the responsibility of the East African High Commission, and Jackson was appointed research officer in the Tsetse Research Organization, becoming chief entomologist in 1951. He held the degree of D.Sc. of the University of London, and was appointed O.B.E. in the Queen's Birthday Honours List this year.

Jackson was, like Swynnerton, an excellent field-worker, and spent much of his time almost completely isolated from the amenities of civilization and even from his colleagues. His work, carried out over so many years at Kakoma in Central Tanganyika under difficult and uncomfortable conditions, provides data on the tsetse of continuing value to all concerned with similar problems. But Jackson was not only a field-worker; he combined this with rigorous academic standards, and an ability to keep up to date with theoretical and laboratory work in his own and allied subjects. He will be particularly remembered for his work on natural populations. This applied primarily to the tsetse fly, but is accepted by others as applying much more generally to other ecological problems. A particular contribution was his development of the 'marking' technique, by which tsetse flies were marked with spots of paint in such a way that the date and place of release could be indicated and recaptures could also be recorded. He spent much of his leave analysing his data, and was among the first field-workers to apply the methods of Sir Ronald Fisher to his results. He had a real enthusiasm for his subject which he communicated to those who discussed his work with him either in the laboratory in Britain or in the field in East Africa. His work, though individual, was also part of the work of a team of scientists who have done much to make tsetse control over large areas a possibility.

Kenneth Mellanby

## Mr. R. L. Collett, M.B.E.

Ronald Leslie Collett, who died on August 15, will be remembered for the devoted service he gave to the profession of chemistry as assistant secretary (1925–44) and as registrar (1945–51) of the Institute of Chemistry of Great Britain and Ireland, now the Royal Institute of Chemistry. Throughout that period he was always available for consultation by students and members of the Institute on matters affecting their careers, and there were few who at some time or other did not benefit from his advice and help in resolving professional or personal difficulties. Even those who at first were overawed by the luxuriance of his eyebrows or his somewhat didactic manner soon came to regard him as a friend and confidant. His obvious sincerity and complete honesty of purpose won for him the esteem and affection, not only of innumerable chemists, but also of many government officials, fellow bird-watchers and members of the Savage Club—and, not least, of those whose opinions he combated most vigorously.

Born in 1886, Collett was educated at St. Paul's School, London, and, after graduating in natural sciences from Trinity College, Cambridge, he specialized in the chemistry of food, drugs and water at King's College, London. He was elected a Fellow of the Institute of Chemistry in 1913. During the First World War he was first commissioned in the Middlesex Regiment, but was later transferred for specialist duties in connexion with water supplies and served for three years in France as a captain in the R.A.M.C. After the War he was successively chemist to a brewery and a member of the scientific staff of the newly formed British Leather Manufacturers Research Association.

He took a close interest in the work of several scientific societies and had been a vice-president of the Society of Public Analysts, now the Society for Analytical Chemistry. Before his appointment as a salaried officer of the Institute of Chemistry, Collett had been a member of its council and had served as honorary secretary and honorary treasurer of its London Section. During the Second World War he gave valuable assistance to government departments in connexion with the utilization of the services of qualified chemists and was afterwards appointed M.B.E. After his retirement he was attached in an advisory capacity to the Association of University Teachers, and continued to act as a consultant on the engagement and conditions of service of chemists in industry.

H. J. T. ELLINGHAM

# NEWS and VIEWS

## Chemical Technology at the University of Edinburgh : Prof. K. G. Denbigh

THE first occupant of the recently instituted chair of chemical technology in the University of Edinburgh is to be Dr. K. G. Denbigh, who will take up his duties there in October. Dr. Denbigh is at present a University lecturer in the Department of Chemical Engineering, Cambridge. He is forty-four years of age, and was educated at Queen Elizabeth's Grammar School, Wakefield, and at the University of Leeds, where he graduated with first-class honours in chemistry in 1932. He continued his studies by research on the fluorides of sulphur and was awarded the degree of Ph.D. His old University has recently recognized his distinguished contributions to a wide field of scientific subjects by conferring upon him the degree of D.Sc. Dr. Denbigh's career has been almost equally divided between chemical industry and university teaching. He has held appointments with Imperial Chemical Industries, Ltd., and with the Ministry of Supply Royal Ordnance Factories and was for a time a lecturer in the University of Southampton. In 1948 he was appointed to a University lectureship in the then newly-established Department of Chemical Engineering at Cambridge, and from the start he has been largely responsible for the teaching of chemical thermodynamics and associated subjects. His researches have been mainly concerned with the kinetics of reactions between gases and liquids and between gases and solids, and he has published a number of papers on these topics and in the general field of chemical kinetics and thermodynamics. His monograph "The Thermodynamics of the Steady State" (Methuen, 1951) has become very well known, and a text-book, "The Principles of Chemical Equilibrium", has been announced by the Cambridge University Press for the autumn. Dr. Denbigh is a Fellow of the Royal Institute of Chemistry and a member of the Institution of Chemical Engineers, and he is a member of the Education Committee of the latter organization.

## The Animal Health Trust : Dr. K. C. Sellers

THE Animal Health Trust has appointed Dr. Kenneth Charles Sellers to be director of its new Farm Livestock Research Station at Stock, Essex. Dr. Sellers, who is thirty-nine, is at present in the service of the Ministry of Agriculture as veterinary investigation officer in Yorkshire. He was trained at the Royal Veterinary College, London, and then went to the University of Cambridge, after which he was appointed to the staff of the Institute of Animal Pathology at Cambridge. He remained at the Institute, with the exception of war service, until joining the Ministry of Agriculture. Dr. Sellers has already contributed some thirty papers on widely varying aspects of disease problems, including a survey of losses during pregnancy and parturition in sheep, vitamin deficiencies in livestock, bovine mastitis, ketosis in pregnant ewes, and various nutritional problems. Pending completion towards the end of the year of a new range of laboratories at the Farm Livestock Research Station at Stock, temporary laboratory accommodation has been provided at Lilystone Hall, where alterations have been made to meet library, lecture hall and reception room requirements and for provision of residential flats for various members of the staff. The nucleus staff from the old Farm Livestock Station at Houghton Grange in Huntingdonshire have moved to Stock.

## Perkin Centenary Celebration in 1956

IN 1856, William Henry Perkin, then aged eighteen, discovered the first synthetic dyestuff, later called 'mauve', and from this discovery have developed the modern dyestuffs industry and the greater part of the world's organic chemical industries. It is planned to celebrate in London, during May next year, the centenary of this discovery, and six bodies are co-operating in making the arrangements: the Royal Society; Chemical Society; Society of Chemical Industry; Society of Dyers and Colourists; Royal Institute of Chemistry; and the Association of British Chemical Manufacturers. Under the patronage of H.R.H. the Duke of Edinburgh, the president of the celebration is the president of the Royal Society, with the presidents of the sponsoring societies as vice-presidents. An organizing committee has been set up under the chairmanship of Sir Robert Robinson, and four sub-committees have been formed to deal with the following aspects: technical and scientific; social; finance; and publicity. It is intended to appeal for a fund of £100,000 and with this money to set up a trust fund which will finance Perkin Centenary Scholarships designed to promote, advance and encourage technical education in relation to all aspects of the fabrication or application of colouring matters. The main part of the celebration will take the form of a series of five lectures dealing with the effects of Perkin's discovery on life and industry during the past hundred years. There will also be a conversazione at which an opportunity will be given for overseas delegates to meet one another and the delegates from Britain. The general secretary for the celebration is J. W. Nicholls, c/o Society of Dyers and Colourists, 19 Piccadilly, Bradford 1, Yorks.

### Independent Television Authority: Croydon Transmitting Station

The first station of the Independent Television Authority, to be known as the Croydon Station, was officially opened by the Mayor of Croydon on September 13, and full-scale programmes started on September 22. This is also the first television station in Great Britain to operate in Band III (174–216 Mc./s.), the frequency of the vision carrier being 194·75 Mc./s. and that of the sound carrier 191·27 Mc./s. The British standard 405-line system is used, in common with the existing B.B.C. Band I service. The station is situated on high ground, 375 ft. above sea-level, at Beulah Hill, and the mean height of the aerial above ground-level is 175 ft. The aerial consists of a vertical array of eight stacks, each stack containing four half-wavelength dipoles set at the corners of a square: the two top and two bottom stacks are rotated 11° with respect to the remaining four stacks in order to achieve as nearly as possible a circular radiation pattern in the horizontal plane, and the array has a gain of six relative to a half-wavelength dipole. The radio-frequency power outputs of the vision and sound transmitters are 10 and 2·5 kW., respectively, and the corresponding effective radiated powers are thus 60 and 15 kW. It has been estimated that, with these radiated powers, the primary service area, which is included within the 2 mV./m. field-strength contour, extends roughly thirty miles to the north and west from the transmitter, and some twenty miles to the east and south, though there is a narrow belt of shadow a few miles wide, and with field strengths between 0·5 and 2 mV./m., running just to the south of the North Downs. Within this area there are about 9·5 million potential viewers. The 0·5 mV./m. field-strength contour, defining the limit of the secondary-service area, lies five to ten miles beyond the 2 mV./m. contour, the greatest ranges being in a north-easterly direction from the transmitter, and a further million potential viewers are contained within this belt. Such measurements of field strength as have been made agree well with the predicted values. It is the intention of the Authority to increase in the near future the effective radiated power of the Croydon station to 120 kW.; and it is anticipated that the second station of the Authority, near Lichfield, will be ready to radiate programmes, also in Band III, early in 1956.

### International Fisheries Convention: Meeting of the Permanent Commission

The fourth meeting of the Permanent Commission set up at the International Fisheries Convention, 1946, was held in London during September 13–16. Delegations attended from all the thirteen Member States—Belgium, Denmark, Federal Republic of Germany, France, Great Britain, Iceland, Ireland, The Netherlands, Norway, Poland, Portugal, Spain and Sweden—and observers from the International Council for the Exploration of the Sea, the United Nations Food and Agriculture Organization, and the International Commission for the North-West Atlantic Fisheries. The discussions at the meeting centred mainly upon the 'industrial fisheries', the minimum size of mesh of trawl nets, and the arrangements for enforcing the provisions of the Convention. The provision whereby any catch not destined for human consumption (that is, 'industrial fisheries') may contain up to 10 per cent of undersized fish of species which the Convention protects was extended until May 1958 in order to allow further time for the International Council for the Exploration of the Sea to report on the problem. In view of the considerable 'industrial fishery' for sand eels (*Ammodytes*) that has developed during the past two years in Denmark, the Commission agreed to include sand eels in the species which are exempted from provisions relating to the minimum size of mesh. As a result of experiments on the relative selectivity of light and heavy trawls and the effects of the prescribed minimum mesh size for trawls in the southern part of the Convention area, two interim measures were decided upon: first, that the 75-mm. minimum mesh should remain unchanged for a further year; secondly, that trawl nets made of single twine and containing no manila or sisal might have a minimum mesh size of 5 mm. less than that applicable to other trawl nets. The International Council for the Exploration of the Sea was asked to advise on a more detailed definition of a light trawl. The Commission will hold its next meeting in London, starting on May 8, 1956.

### Paint Testing Laboratory at the Borough Polytechnic, London

On September 16, Lord McCorquodale opened the new Paint Testing Laboratory at the Borough Polytechnic, London, and presented to Mr. Hubert Secretan, the chairman of the Governors, testing equipment purchased from funds subscribed by industry, through a committee consisting of representatives of the Society of British Paint Manufacturers; the London Colour, Paint and Varnish Manufacturers' Association; and the London Sections of the Paint Manufacturers and Allied Trades Association and the Oil and Colour Chemists' Association. The testing equipment installed is similar to that used extensively in government and other laboratories for the examination of the properties of paints; for example, resistance to humidity and other atmospheric conditions. The Borough Polytechnic, which is one of the twenty-five institutions in England and Wales recognized by the Ministry of Education as senior colleges of technology, has for sixty years provided courses in paint technology. Lord McCorquodale congratulated the Polytechnic on its pioneer work and appealed to industry to make the fullest use of the facilities provided, at a time in the history of Britain when all industries—and the nation as a whole—require technologists of high calibre and sound training. Industry, he said, must not only be concerned with present and immediate needs, but should attempt also to forecast the changes likely to come about in the next decade.

## Journal of Electronics

THE first issue of the *Journal of Electronics*, a new scientific publication, appeared in July (London: Taylor and Francis, Ltd. 20*s*. each part; subscription, £5 10*s*. for 6 parts). Sir Edward Appleton welcomes the new journal in a foreword to the first issue, and the editor, Dr. J. Thomson, explains and discusses the title, to which different readers might otherwise attach very different meanings. Prof. N. F. Mott will be consultant editor on the new journal. The *Journal of Electronics* is to cover any behaviour of electrons when they are nominally free or only loosely bound. The chemistry and metallurgy of any materials the properties of which contribute to, or are affected by, the behaviour, design and properties of new electronic devices are included; but descriptions of equipments using electronic devices, already well catered for elsewhere, are excluded. Several of the papers in the first issue deal with electron dynamics; but one of the longer papers deals with the structure and magnetic properties of ferrites, and another with a mass spectrometer. The second issue will, according to its table of contents announced in the first issue, be devoted almost entirely to the intermetallic semiconductors. The new journal will appear every two months. Its progress will be watched with much interest. Comparisons with the *Philosophical Magazine* (also published by Messrs. Taylor and Francis), the size and layout of which are used, may be inevitable; but they could act as a powerful spur, particularly to the many young scientists engaged in the fields now specially catered for, to set and maintain a high standard of scientific writing and hence to justify fully the new venture.

## U.S. Geological Survey Technical Files in Palæontology

A TECHNICAL file concerning the Cambrian fossils of the world has been prepared by personnel of the Paleontology and Stratigraphy Branch of the U.S. Geological Survey from an earlier file compiled by Dr. C. E. Resser, of the U.S. National Museum. This is now available as an 'open file report' of the U.S. Geological Survey, and positive microfilm or paper facsimile copies may be purchased at cost of reproduction by filing a prepaid order with the Map Information Office, U.S. Geological Survey, Washington 25, D.C. Charges are based on current materials and labour costs. As in previous releases of technical files, no guarantee of the accuracy of the file is made. It consists primarily of uncritical compilations in large part brought together by clerical help, and commonly not checked as to accuracy or consistency of usage; on the other hand, the file is a useful research tool in judicious hands, and it is being made available to the profession at large. The nature of the material and the amount of professional time that would still be required to prepare it for publication has determined the form of release. The technical files of the Paleontology and Stratigraphy Branch that are now available are: objective synonymy catalogue of the Cambrian fossils of the world (5 microfilm rolls; more than 14,000 images); compendium of palæobotanical species (28 microfilm rolls; 135,490 images); palæobotanical bibliographical index (5 microfilm rolls; 17,356 images); Mesozoic species index—North and Central America, including the Caribbean (8 microfilm rolls; 25,459 images); Mesozoic species index—South America (3 microfilm rolls; 8,345 images); Cushman catalogue of Foraminifera (33 microfilm rolls; 118,967 images). The original records and subsequent additions to them remain available in the Survey's offices in the U.S. National Museum, and with the Museum's "Cushman Collection".

## Wild Life Preservation in Burma

U. TUN YIN, formerly of the Burma Civil Service, reports that the Wild Life Protection Act of 1936 is still in force in Burma (*Oryx*, 3, No. 2; August 1955). The only blot appears in section 6, which, *inter alia*, gives protection to the rhinoceros. Unfortunately the section contains the phrase "provided that it shall not be an offence for any physician or druggist to possess or sell, or for any person to possess for private medical purposes rhinoceros blood or any preparation thereof". This exception was essential or the Act would not have been passed; many people in Burma have implicit faith in the efficacy of rhinoceros blood for medicinal purposes. U. Tun Yin writes that the Forest Law Amendment Committee has recommended the deletion of the proviso and this should lead to greater conservation of the rhinoceros. A further difficulty arising from the Act is that its application to the States comprising the Union of Burma is complicated and obscure. It does not apply, for example, to the Kachin State. The few Sumatran rhinoceros which survive there are wholly unprotected, as are also, in that State, takin, musk-deer, panda, goral, serow and other rare animals. If these are to be saved, not only must the Act be extended to the Kachin State, but also the Kachin Hill Tribes Regulation and the Hkamti Long Administration Order must be amended. There should be a uniform wild-life protection law throughout the Union of Burma. At present the law is almost ineffective, for there is no central authority directly responsible for its enforcement.

## New Ammonites

SOME new and little-known ammonites in South Africa have recently been described by E. C. N. van Hoepen (*South African J. Sci.*, 51, No. 12; July 1955). One, an unusually large form of *Pervinquieria* (*Styphloceras*) *multicostata* from Zululand, is described as the biggest *Pervinquieria* yet discovered. From the Umsinene River come some large specimens which represent a new species that has been named *Puzosia willemventeri*; a new genus of *Scaphites*, represented by a new species, is described under the name *Zuluscaphites orycteropusi*. A new genus, *Collignoniceras*, of the family Acanthoceratidæ, is established for two species, *C. hammersleyi* and *C. peregrinator*, and for a species previously described by Venzo as *Mortoniceras vinassai*. In the family Pachydiscidæ, a new species of the genus *Lewisiceras* is introduced and compared with four similar-looking species from Madagascar. This is the first record of this genus in South Africa. A new family, Gauthiericeratidae, is established for the two genera *Peroniceras* de Gross. and *Gauthiericeras* de Gross. Two new species of *Peroniceras*, *P. platycostatum* and *P. undulato-carinatum*, and three new species of *Gauthiericeras*, *G. libertas*, *G. obesum* and *G. planulatum*, are described. A family, Erioliceratidae, has been created for three new genera of keeled *Albian ammonites*, which lose their keel at a late stage; they have parallel flanks and their ribs are more or less overhanging backwards on the shoulder.

## The Starfish

THE eighth number of *The Starfish*, the journal of the Association of School Natural History Societies, is, like its predecessors, a tribute to the vitality and enthusiasm of natural history students and their teachers in British grammar schools. Mr. A. R. P. Hayden contributes the main article, which describes the work of the Nature Conservancy; David Spires, of Bishop's Stortford College, writes on observations he has made on the ecology of the house-sparrow during 1953–54; and R. J. Cryer, of St. Paul's School, gives an account of his investigation into a shaker mutant in mice. The usual reports from member schools are included, as are the yearly observations on mammals, birds, butterflies and moths, and plants. The report on the annual essay competition describes the number of entries as being particularly disappointing. A charge of 2*s.* for the journal is made to non-members of the Association. Each year the Society holds an exhibition which, in 1955, will be held in London at the British Museum (Natural History) on October 15; it is open to the public.

## Fat Accumulation by Algae

ON the basis of extensive analyses, D. M. Collyer and G. E. Fogg have come to the conclusion that the generally held view that fat accumulation is characteristic of certain classes of algae stands in need of revision (*J. Exp. Bot.*, 6, 17, 256; 1955). In the investigations now reported, the fatty acid, unsaponifiable lipoid, total cell nitrogen and polysaccharide contents of representative algae from different classes have been ascertained at different stages during their growth in pure culture. Species belonging to the same class have been found to resemble each other in the relative amounts of crude protein, fats and hydrolysable polysaccharide which they contain. Marked differences in composition between species belonging to different classes have been found; but it is concluded that there are no fundamental differences in the physiological relations of fat accumulation in the algae belonging to the Chlorophyceae, Eugleninеae, Xanthophyceae and Bacillariophyceae. Representatives of the Rhodophyceae and Myxophyceae, although they may in certain circumstances have moderately high fat contents, appear to differ in that in them fat accumulation is not associated with low cell nitrogen contents as it is in the other algae examined. No well-defined correlations between the unsaponifiable lipoid and either the fatty acid or total cell nitrogen contents of the algae have been found. *Euglena gracilis* var. *bacillaris* has been found to have a rather higher content of unsaponifiable lipoid than the other algae.

## Zoological Nomenclature

As from January 7, 1956, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full particulars of these cases have already been published (*Bull. Zool. Nom.*, 11, Parts 7 and 8; 1955). (1) *Gnathophyllum* Latreille, 1814 (Cl. Crustacea, Order Decapoda), validation of emendation from *Gnatophyllum*; Hippolytidae Bate, 1888, and Eugonatonotidae Chace, 1937, validation of; (2) Mayaitidae Spath (L.F.), 1928 (Cl. Cephalopoda, Order Ammonoidea), validation of; (3) *Lernaeocera* Blainville, 1822 (Cl. Crustacea, Order Copepoda), validation of emendation from *Lerneocera*, and designation of a type species for; (4) proposed grant to the International Commission of authority to prescribe for generic names a gender different from that grammatically appropriate where such action is needed in the interests of nomenclatorial stability; (5) determination of a gender for (*a*) generic names in the Class Aves having the termination -rhynchus; (*b*) generic names in the Order Decapoda (Cl. Crustacea) having the terminations -opsis and -gnathus; (*c*) for the following names—*Gigantorhynchus* Hamann, 1892 (Cl. Acanthocephala); *Desmognathus* Baird, 1850 (Cl. Amphibia); *Nephrops* Leach, [1814] (Cl. Crustacea, Order Decapoda); *Syngnathus* Linnaeus, 1758 (Cl. Pisces); (6) *Varuna* Milne Edwards, 1830 (Cl. Crustacea, Order Decapoda), validation of currently accepted gender for. Proposals are also made for the adoption of the following Declarations: (*a*) Article 21: clarification of the authorship to be attributed in certain circumstances to zoological names and to actions affecting the status of such names; (*b*) Article 25: clarification of the status of names published only in the indexes of books. Comments should be sent as soon as possible to the secretary to the Commission, Mr. Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

## Announcements

THE fourth Coal Science Lecture of the British Coal Utilization Research Association is to be delivered by Sir Cyril Hinshelwood on October 19 at 5.30 p.m. in the lecture theatre of the Institution of Civil Engineers. He will speak on "The Carbon of Coal". Tickets are available from the Secretary of the Association (B.C.U.R.A., Randalls Road, Leatherhead, Surrey).

THE Bedson Club, King's College, Newcastle upon Tyne, will be holding its hundredth lecture on October 26, when Prof. M. Calvin (University of California, Berkeley) will speak on "The Photosynthetic Carbon Cycle". Two further lectures will be given as follows: November 25, Prof. E. A. Guggenheim (University of Reading), "The Relation between Theory and Experiment in Physical Chemistry"; and January 27, Dr. F. Sanger (King's College, Cambridge), "The Chemistry of Insulin".

THE Council of the International Union of Pure and Applied Chemistry has approved the recommendation of the Union's Commission on Nomenclature in Inorganic Chemistry that element 101 be named Mendelevium, symbol Mv. The original recommendation for this move was made at the eighteenth conference of the Union at Zurich during July 20–28, and was based on the claims of A. Ghiorso, B. G. Harvey, G. R. Choppin, S. G. Thompson and G. T. Seaborg, of the University of California, as announced in a report printed for the United States Atomic Energy Commission, *UCRL*-2943 (contract No. *W*-7405-eng-48), "The New Element Mendelevium", dated April 4, 1955.

ERRATUM. In *Nature* of August 27, p. 379, in the paragraph on super-voltage machines for X-ray therapy in the Science Museum, the misleading impression is given that betatrons and synchrotrons are widely used for hospital radiotherapy in Great Britain. They are, in fact, used for research purposes; for radiotherapy the travelling-wave linear electron-accelerator is being installed in a number of hospitals.

# INTERNATIONAL UNION OF LEATHER CHEMISTS' SOCIETIES

## FOURTH CONFERENCE

NEARLY four hundred members and guests from twenty-five countries took part in the fourth biennial conference of the International Union of Leather Chemists' Societies held in Stockholm during July 31–August 4. The official opening of the conference took place at the Kungl. Tekniska Högskolan, when in the presence of representatives from the Swedish Tanners' Federation, the Swedish Chemical Society and the University of Uppsala the president of the conference, Dr. K. H. Gustavson, called upon the veteran Swedish leather chemist, Dr. Edmund Stiasny, to declare the congress open. In the presidential address that followed, Dr. Gustavson dealt with the researches of the little-known Swedish chemist of the early nineteenth century, Carl Hyltén-Cavallius, who in the space of a short life of thirty-six years published several papers on tanning processes and also on the conversion of collagen to gelatin. His pioneer work did much to pave the way for subsequent investigations into mineral tannages.

There then followed the Max Bergmann Memorial Lecture delivered by his successor, Prof. Dr. Wo. Grassmann, of the Max Planck Institut für Eiweiss- u. Leder-Forschung in Regensburg. The subject, "Our Present Knowledge of Collagen", provided occasion for a comprehensive and lucid review of the progress of collagen research from the early days of Emil Fischer, through the work of Astbury to the modern concepts of the helical configuration proposed by Pauling and Corey. He also dealt with the many precursors and congeners of collagen that are now being widely investigated.

One novel feature of this congress was the holding of two symposia devoted to "The Properties of Leather" and "The Fundamentals of the Chemistry of Tanning Processes". In this way the organizers of the conference largely avoided one of the dangers that are apt to beset all large scientific meetings, namely, that of loading the programme with a host of unrelated papers. In these two symposia a number of invited speakers presented various aspects of the subjects which were afterwards discussed.

The symposium on "The Properties of Leather" included papers by Drs. R. G. Mitton (British Leather Manufacturers' Research Association and president of the Society of Leather Trades' Chemists), J. R. Kanagy (U.S. National Bureau of Standards), E. Baumann (Bally Experimental Station, Switzerland) and Prof. P. Chambard (École de Tannerie, Lyon). Mitton, in surveying the main physical properties of leather, emphasized the importance of the inter-fibrillary air spaces and showed how their relative magnitude affected such properties as water vapour and air transmission, thermal insulation, etc. Kanagy dealt mainly with the steps being taken in the United States by the government and by industry to establish standards by which the behaviour and reputation of leather could be safeguarded. Baumann presented the problem of leather properties from the point of view of the shoe-making industry and classified the desirable properties under three headings: (i) properties such as tear- and abrasion-resistance, and plasticity, that are important in manufacturing processes and in wear; (ii) properties such as flexibility of sole and upper leather and their permeability to water vapour, which are important for comfort; and (iii) properties such as colour stability, freedom from spue, etc., which are æsthetically important. Chambard's contribution mainly concerned methods of testing leathers in current use in France, such as sand-blast abrasion and the softening of leather in contact with water. He also outlined some recent service trials. Largely as a result of this symposium, it was agreed to set up an International Commission on Physical Testing of Leather, of which Dr. Mitton was invited to become chairman.

A whole day was devoted to the symposium on "The Fundamentals of the Chemistry of Tanning Processes", with lectures by Drs. K. G. A. Pankhurst (British Leather Manufacturers' Research Association), D. Balányi (Klippan), Th. White (Forestal Central Laboratories), A. Küntzel (Darmstadt), G. Otto (Badische Anilin- u. Soda-Fabrik), H. G. Turley (Rohm and Haas) and Mr. N. L. Holmes (R. Hodgson and Sons, Ltd.). Pankhurst outlined the work of his department on monolayer studies of tanning reactions and gave evidence of the predominant role of hydrogen bonding between phenolic groups in the tannin molecule and carbonyl groups in the protein 'backbone' in vegetable tanning. The use of model substances had provided confirmatory evidence of this. Otto, in a paper on the interaction of skin with aromatic tanning agents, dyestuffs and auxiliaries, also gave attention to this aspect and outlined the various types of chemical and physical linkage that could occur, from the strongest coulombic binding to the weakest van der Waals – London attractions. A review of the theories of vegetable tannage was given by White, who showed how modern concepts of the collagen molecule have helped in the interpretation of vegetable tanning processes. Küntzel's contribution, which was concerned with synthetic tannages, showed how modern syntan manufacturers had tended to depart from the original object of simulating vegetable tannins, having realized the immense versatility that could be achieved by concentrating on ionic types. Balányi gave a very full summary of the chemistry of chrome compounds and their reaction with hide. The papers of Holmes and Turley were essentially practical, the former dealing with modern sole leather manufacture, and the latter tracing the influence of the pre-tanning processes on the final properties of the leather. Prof. D. Burton provided a concluding résumé.

In addition to the papers presented at these two symposia, fifteen other communications were read. It is impossible to summarize all these here, but mention may be made of the following, which provoked some useful discussion. In "Studies of Leather by means of a Sonic Technique", J. R. Kanagy and M. Robinson described the propagation of sound waves through various types of leather in different directions, showing that the velocity of the waves is correlated with such physical properties as tensile strength. R. G. Mitton, in "The Diffusion of Water Vapour in Leather", provided conclusive proof that the transfer process is almost exclusively by diffusion through the interfibrillary air spaces and that diffusion through the fibres themselves is negligible. In "Tanning as a Rate Process", N. L. Holmes and H. G. Wollenberg described the use of buoyancy measurements for following the uptake of tannin by skin. Equilibrium values agreed well with chemical analysis. The uptake was exponential, with half-periods varying from several days with dilute solutions to 18 hr. for strong solutions. "The Examination of the Fastness Properties of Leather Dyestuffs", by W. Weber, put forward a proposal, eventually agreed in a plenary session of the conference, that an international commission be set up to co-ordinate the activities of the various national committees interested in this subject. Other papers dealing with dyeing were: "The Colouring of Suede Leather" (C. Alabouvette and C. Rouanet) and "The Measurement of the Colour of Leather" (J. A. Sagoschen). The problem of effluent disposal, which is becoming increasingly pressing in the leather industry, was discussed in two papers: "The Problem of Sewage in the Leather Industry" (H. Scholz) and "Financing Waste Disposal Installations" (E. B. Thorstensen). The impregnation of sole leather with synthetic resins, with the view of improving wearing properties, was discussed by P. Chambard.

In addition to the scientific and technological communications, useful committee work was carried out by the two existing International Commissions dealing with Leather Analysis and Tannin Analysis.

Social events included a visit to Skansen, where a replica of an ancient tannery and of many other craftsmen's shops attracted much attention, a sea trip to part of the Stockholm Archipelago, a reception by the Stockholm City Council and the closing banquet in the famous Gyllene Salen of the City Hall.

The conference attracted a good deal of attention in Stockholm, and besides the usual news conferences, Radio-Tjanst relayed an account of the proceedings given by the retiring president, Dr. K. H. Gustavson, and his successor, Dr. H. G. Turley. At the final meeting of the conference it was decided to accept the invitation of the Italian Society of Leather Trades' Chemists to hold the 1957 Conference in Rome.

K. G. A. Pankhurst

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# CANADIAN COLLOQUIUM ON THEORETICAL PHYSICS

A COLLOQUIUM on theoretical physics was held at the Canadian National Research Council, Ottawa, during June 9–17, arranged by the Division of Pure Physics of the Council in honour of Prof. P. A. M. Dirac. Owing to a prolonged illness, Prof. Dirac was unable to attend the colloquium, but he was to visit the National Research Council later. The colloquium was attended by a hundred and twenty-one physicists from Canada and forty-one from the United States. At the opening session, Dr. E. W. R. Steacie, president of the National Research Council, welcomed the speakers and visitors, and Dr. G. Herzberg, director of the Division of Pure Physics, explained the general scope and purpose of the colloquium; he said that there would be twenty-one invited papers and twenty-four contributed papers covering a wide range of subjects in theoretical physics, and he hoped that sufficient time would be available for the speakers to give an account of their subjects which would be of value both to the non-specialists and to the specialists. This purpose was admirably achieved, and the colloquium was a valuable contribution both to theoretical physics in general and, more particularly, to physics in Canada.

The opening lecture was the first of three lectures by H. A. Bethe on the scattering of $\pi$-mesons. Dr. Bethe gave an account of the experimental evidence and showed how the main properties of the meson–nucleon system could be deduced. The dominance of the $p_{3,3}$ state in $\pi$-meson scattering and the energy dependence and sign of the principal phase shifts were shown to follow from the scattering data independent of any perturbation method or detailed use of theory. His second talk gave an account of Goldberger's proof based on causality that the real part of the forward-scattering amplitude changes sign at a resonance, and then described the successes of the Chew–Low theory of meson scattering, and of the Cornell calculations based on the Tamm–Dancoff equation. Dr. Bethe's third talk gave Wick's derivation of the Low equation in meson theory and noted that Low and Chew had now shown that this equation followed from causality rather than from any detailed structure of meson theory.

S. Chandrasekhar gave a series of five lectures on problems of stability and turbulence in hydrodynamics and hydromagnetics. In his lectures on stability he concentrated principally on the manner of the onset of thermal instability in a layer of fluid heated below when it is subject to rotation and/or a magnetic field. He showed that, when subject to rotation, instability can set in either as convection and a stationary pattern of motions, or as over-stability and a purely oscillatory pattern of motions, depending on the ratio $K/\nu$ of the thermometric conductivity to kinematic viscosity. The dependence on this ratio is such that, for a layer of water subject to rotation, instability should set in as ordinary convection, while for mercury it should set in as oscillations of increasing amplitude. In these instances the experiments by D. Fultz and Y. Nakagawa confirm all aspects of the theoretical predictions. Similarly, Prof. Chandrasekhar showed that an external magnetic field should inhibit the onset of convection by thermal instability in an electrically conducting fluid such as mercury; and that the extent of the inhibition should depend on the strength of the impressed magnetic field and the electrical conductivity in a determinate way. Here again the theoretical predictions have been confirmed by experiments. In his lectures on turbulence, Prof. Chandrasekhar described his recent efforts to develop a deductive theory of turbulence. He suggested that the similarity principles of Kolmogoroff (and their extensions) provide boundary conditions at infinity for the basic equations he has derived (*Proc. Roy. Soc.*, **229**, 1 (1955), equation 32). In this way he has been able to determine in a unique manner the function and the constant which are left unspecified by the dimensional arguments. In his last lecture he outlined an elementary theory of hydromagnetic turbulence and showed that two distinct modes of turbulence exist. He distinguished these as the velocity mode and the magnetic mode, respectively. In both modes, equipartition between the two forms of energy (kinetic and magnetic) prevail among the largest eddies present; however, in the velocity mode the magnetic energy (relative to the kinetic energy) tends to zero in the small-scale Fourier components, whereas in the magnetic mode the magnetic energy tends to about two and a half times the kinetic energy. He described the bearing of these results on the possible character of the interstellar magnetic field and on Fermi's ideas on the origin of the cosmic rays.

Collective motion in nuclei and nuclear moments was discussed by G. M. Volkoff in two lectures, the first of which described the main ideas of the Bohr–Mottelson model of the nucleus. In his second lecture, Dr. Volkoff referred to recent work at the Massachusetts Institute of Technology and at Columbia University on nuclear magnetic octopole moments, and indicated briefly some features of the Bohr–Mottelson model relevant to nuclear moments. He concluded with an outline of the nuclear moment aspects of the work of his own research group at the University of British Columbia on radio-frequency spectra of nuclei in crystals, which has been reported in a series of papers in the *Canadian Journal of Physics*. In particular, a new method of measuring nuclear spin was described.

W. H. Watson gave a review of the experimental work on mechanical properties of helium II carried out at the University of Toronto and discussed their interpretation on the two-fluid theory. He pointed out that a hydrodynamical explanation cannot be given for the experimental results for the viscosity measured by the rotating cylinder method and for the relation of the zero shift of the inner cylinder, and he suggested that a better understanding of the kinetic theory of classical liquids would promote our understanding of the behaviour of a quantum liquid like helium II.

A description of the many-body problem in nuclear structure was given by R. J. Eden, the account being based on recent work by Brueckner and others at Indiana University. The simplicity of certain nuclear models gives hope that corresponding simple features can be derived by considering a system of many nucleons in strong interaction. The many-body method was illustrated by applications to the problem of nuclear saturation and to the theory of low-energy neutron reactions with nuclei.

G. Breit gave three lectures on nucleon–nucleon scattering. The first of these gave a historical survey of the subject and explained the general features of the experimental evidence and its mathematical interpretation in terms of partial waves and phase shifts. It was shown that a careful analysis of experiments at low energy is insufficient to determine the nucleon–nucleon potential, and it was indicated how high-energy data can be interpreted by a boundary condition which corresponds to a repulsive core potential between nucleons. In his second lecture, Dr. Breit discussed the limitations of potential theory in nucleon–nucleon scattering, and he described difficulties which arise when one tries to interpret meson field effects in a wave equation. Dr. Breit's third lecture was primarily concerned with high-energy data; he discussed the successes and failures of various potentials in the high-energy region and indicated the importance of relating the data for pion–nucleon and nucleon–nucleon interactions.

G. Wentzel gave two lectures on hyperon–nucleon interactions and one on rotational states of deformed nuclei. His first lecture classified the experimental information on hyperons by interpreting it in terms of their masses, spins, isotopic spins, and decay schemes. He showed that the $Q$-values indicate that very strong selection rules must operate to slow down the decay of hyperons, and described Gell-Mann's interpretation of the data by isotopic spin-selection rules. In his second lecture, Dr. Wentzel showed how some information can be deduced about $\Lambda^0$ if one assumes that the observed binding in a hyperfragment comes about by coupling to nucleons via $\theta$-particles. In his lecture on deformed nuclei, he considered the discrepancy between nuclear distortion deduced from quadrupole moments and rotational energy-levels using the Bohr–Mottelson theory. He concluded that this discrepancy cannot be removed by refining calculations and that the theory, in its present form, is untenable.

V. F. Weisskopf lectured on nuclear reactions, on the shell theory of deformed nuclei and on the proton–neutron mass difference. His first lecture described the relation between the resonance fine-structure for low-energy neutron reactions with nuclei and the broad structure obtained by averaging over resonances. It was shown that the latter can be described by neutron scattering on a complex potential having a mean absorption similar to that of a neutron in a Fermi gas. In a discussion of detailed reaction cross-sections, significant departures from the statistical theory of Niels Bohr were noted, particularly in the medium-energy range. Dr. Weisskopf's second topic was an account of the work of K. Gottfried at the Massachusetts Institute of Technology, who has calculated the ground-state energies of a deformed independent particle model of nuclei. These predict a distortion giving a minimum energy for each nucleus which agrees well with observed quadrupole moments. Dr. Weisskopf's third talk described the work of Feynman and Speisman on the electromagnetic origin of the proton–neutron mass difference and showed how an analogous mass difference also exists in a classical theory.

In addition to the invited papers described above, papers were contributed covering topics ranging from the Dirac equation in Finsler space to thermal conduction in solids. These papers were read by P. Havas and C. R. Mehl, F. A. Kaempffer, R. H. Good, C. O. Hines, H. Jehle, H. Feshbach and E. Lomon, I. Kay and H. E. Moses, D. K. C. MacDonald, Y. Takahashi, R. J. Eden, D. R. Inglis, U. Ingard and D. C. Pridmore-Brown, A. B. Bhatia, S. Gasiorowicz, R. Jastrow, H. Yilmaz, F. R. Tangherlini, F. H. J. Cornish, A. E. S. Green and K. Lee, T. Y. Wu, S. Shanmugadhasan, T. F. Morris, A. Klein, and O. Theimer. After a dinner on June 16, given by the Royal Society of Canada, Dr. D. C. Rose gave a talk on the recent cosmic-ray expedition to the Arctic and Antarctic of members of the National Research Council.

The colloquium was the first of its kind in Canada, and, judging from the comments of the principal speakers and other visitors, it was both enjoyable and useful. The distinction of the visitors from the United States indicated the great interest of American scientists in Canadian physics, and it should perhaps be noted that a fault of the meeting was the small number of papers read by Canadians. It is to be hoped that the success of the colloquium will encourage the organizers to provide further opportunities for Canadian theoretical physicists, usually so widely dispersed, to gather together and talk with each other and with visitors from the United States and elsewhere.

R. J. Eden

# LOCUST RESEARCH

## DISCUSSIONS IN LONDON

IT became apparent early this year that a number of workers engaged on locust research abroad would be on leave in England during the summer, and the Anti-Locust Research Centre, taking advantage of this fact, organized a series of informal discussions on various aspects of current research. It may be taken as an indication of the magnitude of the locust problem, and of the importance now attached to it all over the world, that from such a modest beginning grew the virtually international meetings on locust research held in London during July 18–23 in the rooms of the Royal Meteorological Society. Locust workers attended from Canada, Cyprus, East Africa, France, French Sudan, Israel, Jugoslavia, Northern Rhodesia, South Africa and Syria, and they included representatives from the survey and control organizations concerned with the major locust pests of Africa and the Middle East, namely, the desert locust, the red locust, the African migratory locust, the brown locust and the Moroccan locust. Universities and other institutions in the United Kingdom where research on locusts or related problems is conducted were also well represented.

The keynote of the meetings was informality, and although the period of fifteen minutes allotted to each speaker was too short to allow of more than a brief outline of current problems and research, the good chairmanship shown at all sessions ensured that the maximum amount of factual evidence was put before the meeting in order to provoke discussion. That this was stimulating to all was shown by the fact that almost every person who attended spoke at least once.

The meetings were arranged as a series of sessions each relating to a particular aspect of locust research. The first session, on "Aggregation and Gregarious Behaviour", was marked by the presentation of evidence which allowed gregariousness to be approached on a quantitative basis instead of by the rather vague qualitative methods used hitherto. R. C. Rainey (Desert Locust Survey), Z. Waloff (Anti-Locust Research Centre) and H. J. Sayer (Desert Locust Survey) showed that in spite of random flight orientation, and also of convective turbulence in the air and the dispersal to be expected from wind, swarms of the desert locust traverse hundreds of miles as discrete entities. They have been led by these observations to postulate reactions having the effect of keeping the swarm together, and have observed various behaviour patterns in flying swarms which may have been relevant. P. T. Haskell (Imperial College, London) spoke on the possible sensory mechanisms related to gregarious behaviour, with particular reference to auditory and visual reactions. P. E. Ellis (Anti-Locust Research Centre), W. J. Stower (Desert Locust Survey) and G. B. Popov (Desert Locust Survey) spoke on aggregation in hopper bands and in ovipositing swarms of the desert locust. It was most interesting to hear from L. D. Vesey-Fitzgerald (International Red Locust Control Service) a preliminary theory relating outbreak areas to vegetation pattern in the case of the red locust.

The second session, with Prof. O. W. Richards (Imperial College, London) in the chair, consisted of papers on the "Estimation of Numbers". J. G. Skellam (Nature Conservancy) and D. L. Gunn (International Red Locust Control Service) spoke about estimations of populations of the red locust, the latter dealing with the figures obtained by the practical method of flushing the insects by means of a motor vehicle. Z. Waloff and R. C. Rainey dealt respectively with numbers in solitary populations and in swarms. J. P. Dempster (Moroccan Locust Research Team) spoke on estimation of populations of various stages of the Moroccan locust, and W. J. Stower and C. Ashall (Desert Locust Survey) on estimations of hopper bands of the desert locust. The latter gave figures showing estimates of the number of hoppers in bands based on experienced visual observation and on various other techniques, and it was interesting to find that the former gave far more accurate results; unfortunately, it is not a teachable technique. G. Popov spoke on egg-pod distribution, a problem which is complicated by the fact that often the extent of the egg-field is difficult to establish. One important point made in the discussion was that the accuracy desired depends on the purpose for which the estimate is required; for control campaigns, figures relating to orders of magnitude of populations are generally sufficient, enabling fairly quick practical methods to be used, but for research, more accurate methods must be found.

The subject of the third session, "Factors in the Fluctuations of Populations", followed naturally that of the preceding one, and M. J. Richards (Anti-Locust Research Centre) and N. Waloff (Imperial College, London) gave papers on the fecundity and fertility of various Orthoptera under laboratory and field conditions; these papers focused attention on the great gaps in our knowledge relating the effect of environment and the physiological state of the insect to its reproductive capacity. J. P. Dempster spoke on variations in a population of the Moroccan locust relative to the changing habitat. No more than a start has been made in studying natural enemies of the desert locust (D. J. Greathead, Anti-Locust Research Centre) and other factors of natural mortality in this species (J. Roffey, Desert Locust Survey).

The session on "The Distribution and Movements of Populations", with P. R. Stephenson (Desert Locust Survey) in the chair, was marked by the interesting papers relating to movements of scattered populations presented by J. T. Davey (International African Migratory Locust Control Organization) for the migratory locust and by Z. Waloff for the desert locust. The former outlined experimental work which suggests a closed-circuit migration by night related to the seasonal rains and floods in the Niger Basin; although there were criticisms of some of the inferences on physiological grounds, nevertheless the theory is most attractive in explaining the appearance of hopper bands in approximately the same parts of the region year after year and the cyclical changes in population densities that occur over parts of the area. The results presented by Z. Waloff demonstrated that movement of scattered adults of the desert locust occurs at night. R. C. Rainey and Z. Waloff spoke on the theory that swarms of the desert locust move down-wind towards zones of convergence of air flow; this conception has the virtue of explaining the observed displacements of flying swarms and the general migration cycle demonstrated by swarm mapping. Again, some aspects of the theory were challenged, and it clearly needs much more work before it can be accepted as a complete basis for the movement of swarms, but no alternative theories were offered. The papers of P. E. Ellis and W. J. Stower on movements of hopper bands of the desert locust showed that there may be some common features in the behaviour of adults and that of hoppers.

A session on "Locust Phases" began with a review by J. S. Kennedy (Cambridge) of the recent approaches to the problem with emphasis on the endocrinological and behavioural aspects of phase variation. Papers by F. O. Albrecht (Laboratoire de Biologie Animale, Paris), P. E. Ellis and P. Hunter-Jones (Anti-Locust Research Centre) illustrated the great amount of laboratory work that is being done on many aspects of the biology, morphology, physiology and behaviour of the phases. Perhaps the greatest need suggested by these papers and the subsequent discussion of them is for basic physiological knowledge to link together the results of widely separated experimental approaches to the problem. R. E. Blackith (Imperial College, London) and D. E. Davies (Anti-Locust Research Centre) spoke on the application of statistical methods, in particular the generalized-distance method, to the analysis of phase variation in locust populations.

The research that is being done on control methods was described and discussed under the heading "Control Development", with Dr. D. L. Gunn (International Red Locust Control Service) in the chair. It ranges from field investigation of the use of aircraft against swarms, hopper bands and egg-fields to laboratory work on problems such as the cumulative effect of sub-lethal doses of insecticides, the comparative toxicity of different materials and formulations, and the comparative susceptibility of species and stages of locusts. The principal speakers included R. D. MacCuaig (Anti-Locust Research Centre) and J. H. Lloyd (International Red Locust Control Service), the former dealing with laboratory research and the latter with the various methods, including spraying adult locusts from light aircraft, used for controlling the red locust in its outbreak areas near Lake Tanganyika.

Papers by Z. Waloff, R. Skaf (Syria), R. C. Rainey, G. B. Popov and W. J. Stower, on "The Desert Locust Problem", emphasized a fact suggested at many of the previous talks, that the desert locust remains the most difficult of the plague locusts from the point of view of both research and control. The lack of clearly definable outbreak areas, the very long-range migrations of which the insect is capable, the possibility of continued nomadic existence of swarms in small numbers during interplague periods, and the large number and diversity of countries affected by it, all conspire to complicate the problem, but also to make it most challenging to research workers. B. Zolotarevsky (International African Migratory Locust Control Organization) spoke on some unusual seasonal movements of swarms of the desert locust in West Africa.

The final session, on "Trends and Needs in Locust Research", was introduced by T. H. C. Taylor (Anti-Locust Research Centre) in a talk designed to illustrate the gaps in present-day knowledge revealed by the preceding sessions. In the discussion which followed, two main trends were apparent. These were, on one hand, a call for more physiological research relating to sensory physiology, internal physiological states and the relation of such states to behaviour and to phases; and on the other hand, the treatment of the problem quantitatively from the point of view of population dynamics and ecology.

This gathering was the first for which locust research workers assembled solely to exchange views and discuss current work, previous locust conferences having been largely concerned with matters of international co-operation and control arrangements. Its success was undoubtedly due to the informal atmosphere, which encouraged the airing of unconventional and tentative proposals, and thus helped to enliven the discussions. Perhaps the emergence of several tentative and controversial theories may reduce the empiricism which has perforce formed such a large part of locust research hitherto. The Anti-Locust Research Centre, under its director, Dr. B. P. Uvarov, who took the chair at most of the sessions, is to be congratulated on initiating this stimulating review of current research on locusts.

P. T. HASKELL

# COLONIAL STUDENTS IN GREAT BRITAIN

THE inquiry conducted by Political and Economic Planning (PEP) into Colonial students in Great Britain[*] had as its practical aim to discover whether any changes in approach or organization on the part of the authorities concerned might lead to a more effective use of the resources devoted to the education and training of men and women from the Colonial territories, and to make constructive suggestions where necessary. The general implications have been discussed elsewhere in *Nature*, but the inquiry, supplemented by questionnaire, interview and field work, and the detailed information about scholarship holders kept by the Colonial Office, brought to light concrete facts and figures which are not otherwise easily available. These facts, on which the main recommendations are based, are presented in one chapter of the report and in the appendixes, and in their collection PEP was guided by four main considerations: the interest which the student or his sponsors has in the use to be made of his education; the possible wish for him to acquire more than a qualification or purely professional skill; the requirements of the society from which the student comes; and the effect which the education of Colonial students in Britain may have upon relations between Britain and the Colonial territories.

The grand total of Colonial students in the United Kingdom and the Republic of Ireland on January 1, 1955, was 10,200, but this includes 2,040 student nurses who are otherwise excluded from these statistics. In 1939 there were about four hundred Colonial students at British universities with an unknown number at other institutions. Ten years later the combined total was 3,300, of whom 1,745 were university students. For the academic year 1954–55, there were 8,160 students, of whom 2,915 were university students; but although in 1953 nearly a tenth of university students in Britain were overseas students, only one-fifth of these, or about 2 per cent of the total, were from the Colonial territories. While, however, the number of university students in Britain is slightly decreasing, the number of students coming from the Colonial territories is increasing, and, since 1950, the number of post-graduate Colonial students has become significant. During the academic year 1954–55 nearly one-third of Colonial students in Britain were Nigerians, about one-tenth came from the Gold Coast, and a small group from Sierra Leone and Gambia. More than one-fifth came from the Far East—Malaya, Singapore, Hong Kong, Sarawak and North Borneo—about one-eighth from East and Central Africa, and another eighth from the West Indies, the remaining one-tenth coming from Cyprus, Malta, Gibraltar, Mauritius, Fiji, the Seychelles and the other Colonies of the British Commonwealth. Every Colony has to-day more students in Britain than it had six years ago, but since 1949 Nigeria has replaced the West Indies as the largest single group and, with the Far East territories, has outstripped all the others in the rate of growth.

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[*] Colonial Students in Britain: a Report by PEP. Pp. ix+257. (London: Political and Economic Planning, 1955.) 21s.

By far the greatest number of Colonial students who go abroad from their homeland go to the United Kingdom, but many go to other Commonwealth countries, including India, Australia, New Zealand and Canada. The last-named has more than six hundred Colonial students in its universities, and more than four hundred Nigerians are now studying in the United States. Some have gone to the Netherlands, and the Gold Coast Cocoa Marketing Board in 1953–54 placed about forty medical students in Germany. Colonial students are mostly older than their British fellow-students, usually between twenty and thirty, about 10 per cent of those interviewed being thirty-one years of age or more; most African students are between twenty-five and thirty. About a quarter of those interviewed were married, and nearly half of them had their wives or husbands with them in Britain; these figures are regarded as typical. About one-half had reached School Certificate standard, a quarter had taken Higher Certificate, an Intermediate degree or a first M.B.; about one-twentieth had graduated, and one-tenth had some form of professional or trade qualification. The gap between the date of their last examination at home and the commencement of their studies in Britain is often considerable, sometimes several years. About one-third of the Colonial students hold scholarships, although the proportion is much smaller than in 1949. For Gold Coast students the proportion in the academic year 1954–55 was two-fifths.

Scholars outnumber private Colonial students in agriculture, forestry, veterinary science, education, teaching diploma, social sciences, public administration, railway training and Post Office training courses, and they account for about a third of those taking architecture, medicine, pharmacy, printing and science. Three-quarters of all Colonial students take one of eight courses: law (18 per cent); engineering (14 per cent); medicine (12 per cent); allied medical subjects like dentistry (3 per cent); arts subjects (6 per cent); preliminary studies to qualify for the desired course (10 per cent); education and teacher training (10 per cent); and science (5 per cent). The largest group (law) has 1,451 students, and the smallest (science) 378. Except for nursing, law is the course with the largest number of registrations, but although a much higher proportion of West Africans study law at a university than of any other group of Colonial students, there are, relative to their numbers, fewer West Africans at the Inns of Court than any other group. The percentage of Colonial students who take a further degree appears to be slightly higher than that of British students. Little is known about the part-time students (probably several hundred in number); but the inquiry suggests that, while this group occasionally throws up a first-rate scholar, such students generally experience great difficulties with their studies and sometimes lose heart and abandon them. Just over a third of Colonial students are at universities and university colleges, about one-eighth are at the Inns of Court, and the rest mainly at polytechnics, and technical and training colleges. In 1955 more than a half were in London, only about 3 per cent at Oxford and Cambridge, about 27 per cent in the English provinces, 7 per cent in Scotland, 2 per cent in Wales and 7 per cent in Northern Ireland and the Republic of Ireland. Most of the women are student nurses; but excluding nurses, women students constitute just over one-sixth of all Colonial students, and about one-third are at universities.

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# COMMONWEALTH OBSERVATORY, CANBERRA

## REPORT FOR 1954

The report for 1954 of the Commonwealth Observatory, Canberra*, follows the usual course, dealing with the work of the Observatory under eleven main headings, the first of which includes time service and positional astronomy, described under five sub-sections. Time signals were sent out from the Observatory four times each day, the average correction for the transmitted signal being 21 m.sec. and the average daily change in these corrections 2·2 m.sec. Under astrophysical investigations are included magnitude sequences, variable stars, nebulæ and clusters, stellar atmospheres, stellar spectroscopy and Mars. With regard to nebulæ and clusters, it is announced that the photographic survey of both the Magellanic Clouds has been completed with an Ektar camera. Star counts in and around the Small Cloud to magnitude 14 and 16 provide new evidence on the structure and population characteristics of the Cloud. It has been established that the cepheids in the Large Cloud, as in the Small Cloud, are much bluer than the galactic cepheids. The survey of bright southern galaxies with the Reynolds reflector is about 90 per cent complete and about 110 plates were obtained on twenty-eight nights, bringing the total to 270, of which 170 have been measured for types and diameters, and a few for luminosity distribution in some large spirals.

Under the heading of telescopes and equipment, it is satisfactory to know that the major components of the 74-in. reflector have been erected, the final assembly only awaiting the completion of the dome which, with the optical parts, arrived early in the year. The erection of the Yale–Columbia 26-in. refractor has been commenced and will be completed as soon as the dome is finished. The old clock-drive will be replaced by an electronic diurnal drive, and provision has been made for a Selsyn repeater which will indicate declination settings to 2′ of arc. The Munich zenith telescope, installed in May, has since been in constant use by the Munich observers. An iris diaphragm photometer is in operation, and preliminary trials are being made on plates obtained with the Zeiss instrument.

In the account of buildings, it is mentioned that the assembly for the 74-in. and Yale–Columbia telescopes, which was commenced during the year, is now nearing completion, but unfortunately the 50-in. dome, although new, has given a lot of trouble, and substantial improvements will be made. The figuring of the aspherical secondary for the 50-in reflector was successfully achieved in the optical shop, and this will enable the telescope to be used as a Gregorian instrument for stellar spectroscopy prior to its conversion to a Schmidt type; preliminary work for this purpose has already been carried out on a 36-in. corrector plate. Under the heading of ionospheric prediction services, reference is made to the extension and completion in some sections of the atmospheric dynamo theory. An investigation of oblique incidence propagation has been commenced by recording field strengths of inter-station communication equipment. A report has been prepared on the investigation of triple splitting, which provides new information on the mechanism of 'Spread *F*' ionospheric echoes at high latitudes. Work has been carried out on *Z* echoes.

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* Commonwealth Observatory, Canberra. Report of the Commonwealth Astronomer for the Year 1954. Pp. 8. (Canberra: Commonwealth Observatory, 1955.)

Among the reports on liaison with other observatories may be mentioned the use of the Reynolds reflector for about a quarter of the time by the Yale–Columbia observer for the completion of a survey of the brighter southern galaxies. The Munich observers, Drs. Schmiedler and Heintz, have been working since May on a programme of absolute declinations of *FK3* stars, and, in addition, Dr. Heintz has collaborated with the Observatory staff members in working with the slit spectrograph and also with the Farnham slitless spectrograph.

Two research scholars and one instrument-maker are attached to the Observatory, and one of the scholars, Dr. A. Przybylski, received the Ph.D. of the Australian National University (where the Commonwealth Astronomer has continued to act as honorary professor of astronomy), which was the first such degree to be awarded. Prof. O. Struvè, during a short visit to Australia, spent two weeks at the Observatory, holding a number of valuable discussions, chiefly on spectroscopic problems, with members of the staff. He also presided at a symposium in Canberra at which three members of the staff presented papers under the title "Structure and Composition of the Galaxy".

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# STRUCTURE OF COLLAGEN

By Prof. G. N. RAMACHANDRAN and Dr GOPINATH KARTHA
**Department of Physics, University of Madras, Madras 25**

A STRUCTURE was proposed for collagen by us about a year ago[1]. Although it explains the features of the infra-red spectrum and the chemical composition of collagen, it appears to be defective in that it disagrees with the X-ray data for stretched collagen[2] and in having too large an angle between the NH and N . . . O directions in hydrogen bonds (Pauling, L., personal communication). It is found that a small modification of the earlier structure, which preserves many of its features, fits the above evidence on collagen quite well. In addition, it also explains a number of other properties of collagen, in particular, the important role of hydroxyproline in this protein and the periodicity of 640 A. along the fibre axis.

The new structure (the projection of which along the fibre axis is shown in Fig. 1) is topologically very similar to the earlier one in that it consists of triple chains of amino-acid residues, each chain being itself a helix. However, the chains now form coiled coils, instead of being arranged with their axes parallel to the fibre axis. Thus, every third α-carbon atom (corresponding to the *G*-type of carbon atom of the earlier structure) is placed on the surface of a cylinder of radius 1·0 A., the successive ones being displaced (in unstretched collagen) by 8·58 A. along the axis of the cylinder and rotated through an angle of 36° about the axis. The single coiled coil repeats itself after thirty residues, and the repeat distance along the fibre axis is 85·8 A. The two other chains occur in such a manner that the three chains are symmetrically disposed with respect to one another. Their configuration is most easily described by saying that they are displaced along the fibre axis by + 28·6 A. and − 28·6 A. with respect to the first chain. They are also related to the latter by a rotation of ± 108° about the axis of the cylinder and a translation of ± 2·86 A. parallel to the axis. For the mathematical discussion of the structure, each chain may be described as consisting of a minor helix (following the nomenclature of Crick[3]) having ten residues in three turns, with a projection of 2·91 A. per residue along its axis, wound to form a major helix of radius 2·5 A., there being thirty residues per turn of the major helix. The major

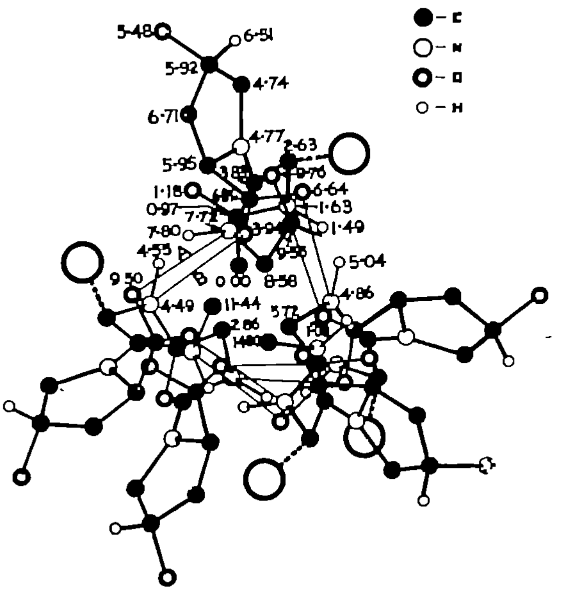

Fig. 1. Projection of the proposed structure along the fibre axis. The numbers denote the heights of the atoms above the plane of projection. Only a part of each of the three individual chains is shown. The thin lines indicate the N . . . O directions in the hydrogen bonds

helix is wound in a direction opposite to that of the minor helix, the latter being a left-handed screw if all the residues are of the *L*-type. Thus, while the thirty residues make nine turns in the co-ordinate system of the minor helix, they make ten turns in the fixed co-ordinate system of the major helix; this ensures that every third residue is similarly situated with respect to the fibre axis.

Because of the above relationships, there are only two types of inter-chain hydrogen bonds, marked *A* and *B* in Fig. 1, which are repeated by screw symmetry. In both bonds, the N . . . O distance is close to 2·9 A. and the angle between NH and N . . . O directions is about 30°. This angle would be less if the NH-bond were not coplanar with the rest of the amino-acid residue.

As in the earlier structure, two of every three NH groups are hydrogen bonded to an O of a CO group, but unlike it, the two oxygens to which they are linked are different. Thus, of every three carbonyl oxygens, only one does not take part in internal hydrogen bonding in the triple-chain cylindrical rods. This oxygen points outward from the rod and plays an important part in the cross-linking of the rods by side-chains, as shown below. As before, every third residue must be a glycine residue, and similarly a maximum of one-third of the residues may be proline or hydroxyproline.

The essential difference introduced in the structure, so far as its X-ray pattern is concerned, is that the 2·86 A. reflexion is meridional, and is the only meridional reflexion apart from its higher orders. Further, the exact repetitive unit along the fibres axis is ten residues (28·6 A.), which agrees well with the observed layer-line spacings[4]. The intensity distribution among the spots on the layer lines has been found to agree with the structure qualitatively. The distribution of intensity along the equator has been worked out in detail and is shown in Fig. 2. This is in good agreement with observations (Ramachandran, G. N., and Ambady, G. K., unpublished results), particularly with regard to the large peak at 4·7 A. and the minimum at 7·4 A. The absence of the expected spot at 7 A. is thus explained. In wet collagen, the water would be expected to occur between the cylindrical rods and, under these conditions, the minimum shifts towards smaller angles and continues to occur in the region of the unobserved reflexion of 7–8·5 A., even though the lattice expands. Further, the three-dimensional cylindrical Patterson diagram for collagen published recently by Yakel and Schatz[5] is in excellent agreement with the structure. The peak at about 1 A. in the level $z = 0$ is due to the projected component of bonds joining neighbouring atoms perpendicular to the fibre axis; that at 2·7 A. is due to the component of the almost horizontal hydrogen bond interactions; the strong one at 4·5 A. is due to the distances between the three approximately parallel amino-acid residues at the same level.

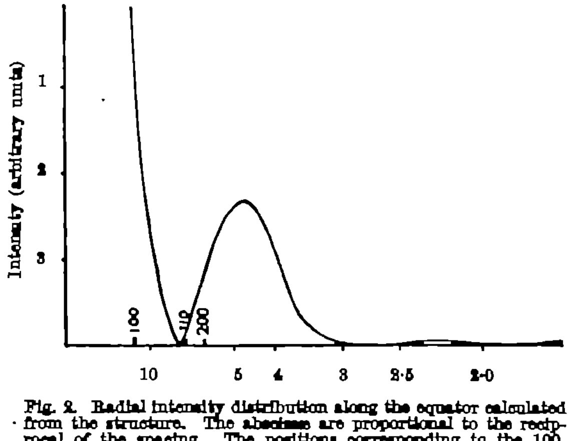

Fig. 2. Radial intensity distribution along the equator calculated from the structure. The abscissae are proportional to the reciprocal of the spacing. The positions corresponding to the 100, 110 and 200 reflexions of the hexagonal unit cell with $a$ = 12 A. are also marked

The recent infra-red data[6] of Sutherland *et al.* are also in agreement with the present structure. The expected dichroism of the non-coiled 3–10 helix agrees with the observed data[7], and the further coiling of this helix produces only small changes and the results are not materially different.

The distribution of the proline and hydroxyproline rings can be calculated exactly, and they are found to be such that the oxygen of hydroxyproline is nearly as far away from the axis of the cylinder as is possible. Thus internal hydrogen bonding of the OH in hydroxyproline is ruled out. Rather, these groups take part in linking the cylindrical rods with one another; the hydroxyproline OH group in one rod is nearly at the same level as the exposed non-hydrogen-bonded carbonyl oxygen of the neighbouring rod, so that they could readily be linked by a hydrogen bond. This is in agreement with the results of Gustavson[8] on the nature of the hydroxyproline OH . . . O bond. Assuming these bonds are 2·7 A. long, the distance between the centres of neighbouring rods works out to be 11·6 A., which is close to 12 A. (10·4/0·866) found for well-dried collagen[8]. The theoretical value is not precise, for it would change if the bond angles in the amino-acid residue and the α-carbon atoms are altered by even a small amount.

If the coiled coils described above are simply put together in a hexagonal array, then only some of the hydroxyproline OH groups are bonded to carbonyl oxygens of neighbouring rods. However, it is found that a very slight change in the pitch of the major helix is sufficient to make the number of hydroxyproline–carbonyl hydrogen bonds a maximum. Instead of a rotation angle (say φ) of 36° per three residues about the axis of the major helix, the angle must be changed to 35°. This immediately introduces a $6_1$ symmetry for the major helix, which now repeats after 216 residues (618 A.). The spacing 618 A. is highly suggestive of the 640 A. spacing found in the small-angle X-ray pattern and in electron micrographs of collagen. The condition for stabilization of the structure by forming the maximum number of hydroxyproline cross-links thus automatically leads to the long spacing of collagen. Further, on working out the number of hydroxyproline residues which occur in such a position that the hydrogen bonds are fairly short, the number is found to be twelve for every thirty-six of the *P* type residues. The percentage of hydroxyproline residues occurring in collagen is variable with the source of the material[9]; but if we assume that the hydroxyproline residues which actually occur are all hydrogen-bonded, then the maximum proportion of hydroxyproline residues should be 11 per cent. It is noteworthy that the maximum observed (namely, in bovine collagen) is about 10 per cent. Further, the correlation of the shrinkage temperature with hydroxyproline content reported by Gustavson[8] is also to be expected if hydroxyproline is mainly responsible for the cross-linking of the cylindrical rods. When collagen shrinks, the individual chains in the triple chain are not likely to be separated, but the triple chain itself would take up a highly folded configuration. The X-ray pattern of gelatin, in fact, supports this. The detailed evidence will be discussed elsewhere.

Having fixed the configuration of the rods with reference to hydroxyproline cross-linkages, a consideration of the length of the *R* side-chain of the third residue needed to form hydrogen-bonded linkages between one rod and another shows that it is variable from 5·5 to 7·5 A. In view of this, there must be a periodic distribution of the *R*-type residues. The details are not easy to work out, but an interesting result emerges, namely, that the distribution of *R*-groups along the fibre axis will not have a period of 618 A., but one-sixth of this. It is indeed noteworthy that electron micrographs of collagen stained with phosphotungstic acid exhibit[10] such a six-fold subdivision of the gross period of 640 A.

The agreement of 618 A. with 640 A. observed for dry collagen is not close enough, nor is the six-fold subdivision exact[11]. However, it must be mentioned that it is not at all certain that the unit cell of collagen is hexagonal. It is probably monoclinic even in the dry state with slightly differing *a* and *b* (taking *c* as monoclinic axis), as is found to be the case with wet collagen[12]. The subdivision of 618 A. would then not be exactly into six equal parts, and further the angle φ may be different from 35° and the macro-period may also differ from 618 A. The variation of the long spacing with moisture[9] is to be attributed to the changes in the angle of the monoclinic cell.

Further details of this work are reserved for a separate communication. [June 3

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# ECOLOGY OF SNOWDONIA

## Ecology of Livestock Productivity

PHILLIPS *et al.*[1–3] have shown how climatic factors have a marked influence on livestock productivity in Wales. In Snowdonia[3], the mean estimated deadweights of ewes and lambs reaching the livestock collecting centres of the high-rainfall western section (precipitation generally greater than 100 in. mean annual rainfall) are less than those reaching Conway in the drier east (precipitation less than 100 in. mean annual rainfall).

A study[4] of summer grazing intensity over fifty-five sheepwalks (mainly enclosed) in Snowdonia (for the years 1945, 1948, 1949 and 1950) has shown that a significant difference, which can be attributed to rainfall differences, exists between eastern and western sheepwalks in the region. Western Snowdon sheepwalks (twelve in number) bear a mean grazing intensity of 1·27, while the eastern Conway Valley sheepwalks (forty-three in number) bear 1·94 ewe units to the acre[5].

It is, however, evident that factors other than those of climate do affect sheep grazing intensity in Snowdonia. The fifty-five sheepwalks have been classified into nine ecological groups. Some of these ecological groups are differentiated from each other by local climate, and others by soil and vegetational factors. An analysis of variance of the sheep grazing intensity over these sheepwalks shows that the main source of variation is due to ecological factors (variance ratio of 36·09 derived from ecological group and residual variances, based on 8 and 161 degrees of freedom)[4].

*Lower rainfall, Eastern Snowdonia* (Conway Valley section). Here soil and related vegetation have a major influence on sheep grazing intensity (see also refs. 6, 7). The highest sheep grazing intensity is found where (*a*) precipitation is less than 70–80 in. mean annual rainfall; (*b*) the soil parent material is either a basic Ordovician dolerite or pumice tuff, and the derived soil is akin to a brown earth; (*c*) soil drainage is free; (*d*) the vegetation is basically a *prato-Agrostideto-Festucetum* (an agrostis-fescue grassland in which *Trifolium repens*, *Dactylis glomerata*, *Plantago lanceolata*, *Achillea millefolium*, *Poa pratensis*, etc., are prevalent), typically distributed between 800 ft. and 1,450 ft. and locally 1,800 ft. O.D. Accruing from these investigations, much is known about the floristic composition of this kind of plant community; it varies much with local rainfall, soil properties (particularly exchangeable calcium) and grazing intensity[4,8].

Eleven such sheepwalks at the lower altitudes have a mean grazing intensity of 2·84 and three at higher altitudes 2·46 ewe units per acre.

Blanket peat areas, as would be expected, bear a much lower sheep grazing intensity (1·36 ewe units to the acre, a mean of five sheepwalks).

Acidic terrains with more podsolic soils derived from rhyolite and bearing a heathy vegetation are not prevalent in the Conway Valley. Only one major sheepwalk of this kind occurs there, and this bears a sheep grazing intensity of 1·70 ewe units per acre. It is difficult to assess the statistical significance of this, but the level of grazing intensity is according to expectation.

Glacial Drift, containing much basic igneous and volcanic materials (dolerites and pumice tuffs) under conditions of free drainage, gives rise to similar soils and vegetation, as do the dolerites and pumice tuffs *in situ*[3]. Impeded drainage abounds, however, and various *Nardus*, *Molinia*, *Juncus* and bog communities are prevalent. Such terrains on the average carry 1 ewe unit per acre less than the better kind of basic terrain (one group of eight such sheepwalks carried a mean of 1·70 and another group of thirteen 2·02 ewe units per acre). This contrast in sheep grazing intensity gives a measure of the possible increase in productivity following drainage.

*Higher rainfall, Western Snowdonia* (Snowdon section). In the Snowdon section it is possible to compare directly a number of sheepwalks on basic (pumice tuff and dolerite) and acidic (rhyolite) terrains. No statistical difference in grazing intensity exists between such terrains (basic terrains, mean of four walks, 1·39; acidic terrains, mean of eight walks, 1·21 ewe units per acre). Under the prevailing high rainfall conditions, the properties of soils derived from different parent rocks tend to merge, though vegetational differences persist[9]. Here, therefore, climatic factors are of paramount importance, and vegetational differences appear to have little influence on sheep grazing intensity.

The general conclusions that emerge from this study are:

(1) For the Snowdonia region as a whole, though environmentally complex, climatic factors, in particular rainfall, are the major influence determining livestock productivity estimated in terms of the number of stock per acre. These conclusions are similar to those of Phillips[3], who has considered productivity in terms of estimated dead-weight.

(2) Within the lower-rainfall Conway Valley area, geological and physiographical complexity affecting soil and vegetation have, however, an important bearing on livestock productivity, so that over a major part of Snowdonia, where precipitation is less than 70–80 in. mean annual rainfall, the basic igneous and volcanic terrains are of first importance to its livestock economy. Locally, even at higher rainfalls, these terrains are important grazing foci.

(3) The arctic–alpine element in the flora of Snowdonia is found mainly on these basic rocks. It is of interest to the problem of the conservation of this flora that it survives locally in the face of considerable grazing pressure. This needs detailed investigation.

(4) Environmental variations in an area like Snowdonia are of an extreme and complex kind. They are available within a single compact region and can provide a fruitful field of inquiry into fundamental ecological problems and also into animal productivity and health in relation to environment[4].

I am indebted to the Agricultural Research Council for financial help, and to Prof. R. Alun Roberts for his encouragement and facilities placed at my disposal. Part of the work outlined here was carried out at the School of Agriculture, Cambridge, and thanks are also due to Sir Frank Engledow for the facilities provided there for part of this investigation. A more detailed account of this work will appear elsewhere. A statistical appraisal of the results has already been given[4].

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## Wild White Clover in Natural Mountain Grassland

IN the course of ecological investigations from Bangor, it has been found that there is a considerable number of outcrops of soft base-rich rocks distributed throughout Snowdonia which have a marked effect on the natural vegetation. The cliffs and crevices harbour an Arctic–Alpine flora and have been well described. On the slopes, however, there is an extremely different distinctive vegetation, a grassland scarcely distinguishable from lowland base rich grassland, about which little is known[1].

Cwm Llefrith, which is situated between Moel Hebog and Moel yr Ogof in South Caernarvonshire, is being investigated. This is related to a more general study of mountain grasslands by R. E. Hughes, preliminary details of which are given in the preceding communication. The upper reaches of this Cwm carry a very rich pasture in which wild white clover features prominently, though at 1,600–1,800 ft. in a rainfall of 100 in. The soil is a well-drained brown-earth type with a good crumb structure and very little undecayed organic matter, similar to those described in East Snowdonia by Hughes[2], the underlying rock being a magnesium-rich soft volcanic ash.

In pastoral Snowdonia, Cwm Llefrith is outstanding for the record of its productivity (Cwm Llefrith means milky cwm). Summer milk production used to be a prominent feature of its economy to the close of the past century. Every autumn about three tons of salted butter was taken from a single farm and sold at the slate-quarrying district of Blaenau Festiniog for winter use. Now under sheep, its carrying capacity is about two ewes to the acre, a capacity well above that of the surrounding districts. Hughes[1] reports a similar state of affairs elsewhere in Snowdonia. The basis of this remarkable productivity at such a high altitude seems to a great extent to be due to the abundance of wild white clover and the fertility of the accompanying sward.

From preliminary transplant experiments, a distinctive ecological race of wild white clover seems to have been differentiated, characterized by small size but extreme persistence, adapted to upland conditions of grazing and climate. Such a race is capable of enduring successfully the rigour of climatic conditions at high altitudes while lowland races are not. At the same time, it is likely that the mountain race shows some adaptation to low base content and low *p*H, since the soil in Cwm Llefrith, while it approaches that of lowland soil, is by no means identical with it.

The implications of such a situation are far-reaching in the economics of the reclamation and improvement of hill regions at the present state of our national economy, and make investigations on the ecology and genetics of wild white clover paramount in such regions.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Role of Nucleic Acid and Enzymes in Peptide Chain Synthesis

RECENTLY, there has been much discussion of possible mechanisms whereby the order of the nucleotide sequence in a polynucleotide chain might determine the order of the amino-acid sequence in a peptide chain. The polynucleotide molecule is assumed to be the template or pattern for the peptide chain. In a mechanism proposed by one of us[1], enzymes were assumed to play an important part in attaching the amino-acids to the polynucleotide chain; as many enzymes would be required for this purpose as there are nucleotide combinations corresponding to amino-acids. In a system where a nucleotide triad is assumed to correspond to a given amino-acid, there must be as many enzymes as there are triads, and it can be shown that more than one triad would have to correspond to a given amino-acid in order to permit the occurrence of a reasonably large number of possible neighbours on either side of a given amino-acid in a peptide chain (unless it is postulated that there is to be no overlapping of the triads).

Since there are forty possible nucleotide triads, assuming direction along the polynucleotide chain to have no effect, or sixty-four triads if direction is important, there would have to be somewhere between forty and sixty-four specific enzymes to make the scheme in question function. While a synthesizing mechanism such as the one outlined could, once established, in theory produce these enzymes along with all the others for which nucleic acid templates existed, it is hard to understand how the mechanism could develop in evolution without the pre-existence of the forty to sixty-four operating enzymes just mentioned. Therefore it would seem of interest to explore possible mechanisms not involving the use of enzymes to attach the amino-acids to the nucleic acid template.

If enzymes do not attach the amino-acids to the template, the amino-acids apparently must be held by functional groups on the nucleic acid itself. An enzyme may function chiefly because of the exact geometrical relationships among its substrate-binding and catalytic groups, and hence it does not seem entirely unreasonable to assume that nucleic acid might act in a similar manner, especially since it possesses some of the same types of functional groups as are found on protein molecules. Such an idea has already in fact been advocated[2], although without much consideration of detail. The geometry of the ribonucleic acid molecule is not yet sufficiently known for one to decide whether the amino-acids could be bound by the functional groups of the purines and pyrimidines in the proper positions for attachment to phosphate groups, but one point in this connexion does seem fairly clear. This is that nucleotide triads could scarcely be expected to bind or determine the location of a given amino-acid in the absence of enzymes catalysing the process of attachment. This is because too long a segment of the polynucleotide chain is involved. On the other hand, it can be shown that too little information is stored in pairs of nucleotides, or diads, to account for the complexity of arrangement already observed in peptide chains, if one considers such diads in the way that has been customary up to the present time.

There is, however, one possible consideration which seems to have been overlooked, and in theory it could make possible the storage of enough information in nucleotide diads to account for the observed complexities of composition of peptide chains. This is that the rings of adjacent nucleotides (sugar, purine, pyrimidine) may lie close enough together to prevent free rotation about the bond connecting the sugar to the base. In this case a given base might have either one side or the other 'up' but not both, so that a new kind of geometrical isomerism would arise in the polynucleotide chain; this would greatly simplify the problem of information transfer from a polynucleotide to a polypeptide chain. This situation means that we would set up sixty-four different nucleotide diads, if direction along the polynucleotide chain were of importance. For example, we can start with diads containing adenine, with the ring 'up'. ('Up' and 'down' have no real meaning in this sense except to distinguish the two possible positions of the ring.) Let $A_u$ be adenine with ring up, $G_u$ guanine with ring up, $C_d$ cytosine with ring down, etc. The diad pairs are:

$$\begin{array}{ll} A_u—A_u & A_u—C_u \\ A_u—A_d & A_u—C_d \\ A_u—G_u & A_u—U_u \\ A_u—G_d & A_u—U_d \end{array}$$

It should be noted that this system would not function if the nitrogen of the purine or pyrimidine which is also attached to the sugar were of fixed optical configuration; but such a nitrogen usually does not maintain optical asymmetry. Coiling of the polynucleotide chain should not interfere greatly unless extreme.

With these sixty-four possible diads, it is in theory possible to assign three diad pairs to a given amino-acid and still have four left over. Since each assignment permits of eight possible neighbours for a given amino-acid on one side, the three assignments permit twenty-four possible neighbours, and the 'neighbour problem' disappears.

Such a system might require very few or possibly no enzymes, and would lend itself to attempts to explain the evolutionary development of protein synthesis. The system of assignments of nucleotide diads to given amino-acids might depend almost entirely on molecular geometry, and therefore should be the same throughout Nature as advocated by Dr. G. Gamow and collaborators (personal communication). The assignments should be susceptible of solution by an advanced study of the possible structures for ribonucleic acid. The most difficult aspect of the scheme seems to be to make it select from among the amino-acids glycine, alanine, valine, leucine, isoleucine and perhaps phenyl alanine, which do not have functional groups other than one carboxyl and an α-amino group; but any scheme would seem to face this problem. The scheme is very flexible, however, and could account for the change of a single amino-acid in a peptide chain or the transposition of two amino-acids only, whereas a scheme involving nucleotide triads presents difficulties in this respect. It is true that the system would require the presence of a polynucleotide-synthesizing mechanism that could distinguish and reproduce the 'up' and 'down' configurations of the bases, but such a system does not seem impossible to imagine. It should be noted that if the type of isomerism in question should be preserved in oligo-nucleotides produced by the action of ribonuclease on ribonucleic acid, it might be possible experimentally to find oligo-nucleotides of identical nucleotide sequences but with slightly different physical or chemical properties; although this might be difficult because of the large number of theoretically possible isomers even for a very short polynucleotide.

The senior author is indebted to Drs. G. Gamow, M. Ycas and A. Rich for the free communication of much of their thinking, which has been extremely helpful in bringing him up to date on the problem of the transfer of information.

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## Role of Pantothenic Acid in the Reproductive Cycle of Ovaries in Fish

IN the course of an investigation of the vitamin contents of different organs of the tunny (*Thunnus thynnus*) caught off the coast of Norway, very high values were found for pantothenic acid in the ovaries, up to 245 μgm. per gm. of fresh tissue[1]. The tunny spawns in the Mediterranean and nearby waters in June and early July, whereupon shoals of the fish move in search for food and arrive off the coast of Norway in July–October. At this time the ovaries are small and in the first stages of a new reproductive cycle. Earlier observations in ovaries (hard roes) from different species of fish had indicated differences in the pantothenic acid content in relation to their degree of 'ripening', the values being lowest at the time of spawning. The findings in the ovaries from the tunny indicated a relation between the pantothenic acid in the ovaries and the sexual cycle of the fish. As cod (*Gadus morrhua*) of all sizes are brought alive to the fish market in Bergen all the year round, it was chosen as a suitable species for the further investigations.

Sivertsen[2] has investigated the spawning of the cod especially with regard to the yearly cycles of the regeneration of the reproductive organs. Based on his findings, ovaries from cod were collected during the period September–April, thus giving samples covering all stages of the development. The pantothenic acid concentrations were determined by the microbiological method using *Lactobacillus arabinosus* as test organism. The results are plotted logarithmically in Fig. 1, which gives the following general picture. In the ovaries of juvenile fish and of mature fish in the first stages of regeneration the pantothenic acid contents were high. Values up to 375 μgm. per gm. of fresh weight, 2,320 μgm. per gm. of dry weight were found, with an average of respectively 250 and 1,650 μgm. These values are in themselves of great interest as the highest reported pantothenic acid content found in natural sources. Pearson and Burgin[3] found that royal jelly, the special food given to those bee larvæ that are destined to become queens, contained an average of 183 μgm. pantothenic acid per gm. of fresh weight or 511 μgm. per gm. of dry weight. These values were the highest reported in Nature up to the present investigation. During the regenerative or reproductive growth of the ovaries in mature fish, the pantothenic acid content decreases, and finally it reaches values of approximately 10–30 μgm. per gm. of fresh weight shortly before spawning. In the very last stage of the reproductive cycle the ovaries take up considerable amounts of water, and after spawning the eggs contain only 5–10 μgm. pantothenic acid per gm. of fresh weight. The findings indicate that pantothenic acid may play an important part in the metamorphosis of the ovaries in fish.

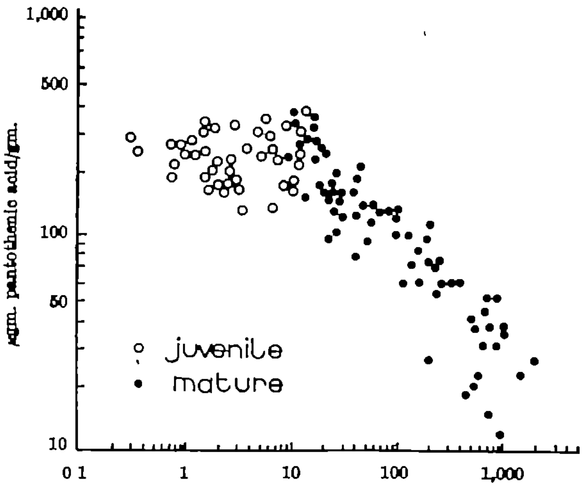

Fig. 1. Relation between pantothenic acid content and size of ovaries in juvenile and mature cod (*Gadus morrhua*)

Investigation of the contents of other factors of the vitamin B complex are in progress. Riboflavin and niacin did not show similar changes, while vitamin $B_{12}$ showed values decreasing from an average of 0·25 to 0·11 μgm. per gm. of fresh weight. Thus, of the factors so far investigated, only pantothenic acid shows the unique relation to the reproductive cycle reported above. The total dry matter of the ovaries increased from approximately 15 to 20 or 25 per cent during the growth of the ovaries; thus simple dilution effects are excluded. The results will be published in detail elsewhere.

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## A Technique for studying the *In vitro* Effect of Serum on Activated Taeniid Hexacanth Embryos

THE *in vitro* effects of normal and immune serum on various nematode larvæ and on schistosome cercariæ have been described by a number of workers[1]. The use of helminth larvæ for the detection of natural and acquired immune responses has proved to be a very useful immunological tool, and some progress has been made towards using this method in the diagnosis of some nematode and blood-fluke infections.

The problem of applying this technique to the study of the host–parasite relations in cestode helminth infections is complicated by several factors. The penetrating larvæ of cestodes, the hexacanth embryos, particularly those belonging to the family Taeniidae, are contained within the several membranes of the tapeworm egg and are not readily available in a free and active state. The process of hatching and activating mature taeniid hexacanth embryos may be brought about under certain conditions by the use of appropriate enzymes and bile constituents[2]. The success of the hatching technique depends upon the selection of mature tapeworm eggs. It has been shown that naturally expelled tapeworm ova vary in their state of maturity[3], and for this reason, freshly obtained taeniid tapeworm eggs are stored in normal saline until hatching tests reveal that at least 30 per cent of the ova may be activated.

Only one previous worker has reported attempts to study the effects of sera on the penetrating larvæ of a cestode helminth. Chen[4], working with *Taenia taeniaeformis*, was not able to demonstrate any effect of rat immune serum on the hexacanth embryos. It appears from the description of his hatching technique that although he had obtained disintegration of the embryophores, the embryos contained within the oncospheral membrane had not been stimulated to activity and in consequence had not freed themselves from the oncospheral membrane. We have been studying the effects of calf and rabbit sera on the hexacanth embryos of *Taenia saginata* and *T. pisiformis* which have freed themselves from their membranes after activation, and have observed several types of serum reactions.

Our technique of hatching and activating the embryos has been previously described[2]. All operations are carried out in centrifuge tubes which are kept in a water-bath (38°–40° C.). Precautions are taken throughout to minimize the introduction of bacteria. After 30 min. treatment in the final activating solution, the embryos are sedimented by gentle centrifugation (1,500 r.p.m. for 1 min., centrifuge radius 5¼ in.), and the supernatant solution replaced with warmed (38° C.) normal saline. The embryos are rinsed in saline, sedimented and the saline replaced with 0·1–0·5 c.c. of the test serum. The serum and activated embryos are allowed to stand in the water-bath for 1 hr. before observations are made. Some reactions have been noted after only 15 min. Observation counts have been made at 1-, 2-, 3-, 4-, 5- and 6-hr. intervals as well as after overnight standing. Positive reactions are usually visible by one hour. Warmed ringed slides are used with a microscope stage warmer designed to keep the slide temperature at between 38° and 40° C. Only those embryos which have been successfully activated are counted in the observations.

Free activated hexacanth embryos may show several types of reactions. (1) Precipitates may form around the secretions of the penetrating gland and at other points on the embryos (Figs. 1 and 2). (2) A membrane may form enclosing the entire embryo and its secretions. (3) A lethal and lytic effect has been noted in inactivated immune sera and in some active and inactivated normal sera, particularly at the 3-hr. and later readings.

Oncospheral membranes that contain activated embryos which have not succeeded in freeing themselves may show a thickening precipitate on the inner surface of the membrane. This may be a result of the serum reaction to the embryo's secretions, and would appear to indicate that the serum-precipitating factor can pass through the semipermeable oncospheral membrane.

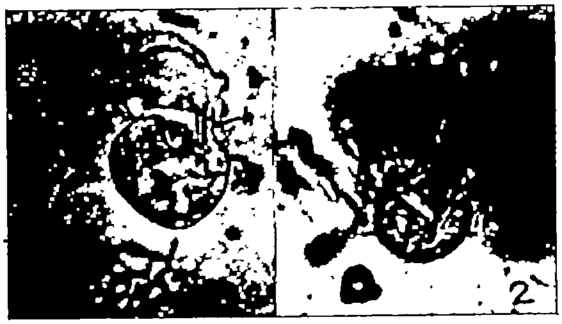

Fig. 1. A free and active taeniid hexacanth embryo in non-reacting serum which demonstrates the normal appearance of the gland secretions (*gs*) and hooks (*h*)

Fig. 2. A free and active taeniid hexacanth embryo in a reacting serum which demonstrates the thick precipitate reaction to the gland secretion (*gsp*) and the precipitates which form at the base of the hooks (*hp*)

Inactive oncospheres show a tendency to clump. This clumping occurs in all sera, however, and no other visible effects have been observed.

It is of interest to note the remarkable effect of serum in sustaining hexacanth embryos in an active state. Embryos may remain in a state of constant activity in sera for three hours or more, whereas in other solutions, such as intestinal juice or normal saline, activity usually ceases within one hour. Embryos kept on the bench overnight in normal inactivated serum may be reheated and reactivated again on the following day.

Studies are in progress using the technique described above to follow the development of immune responses in animals at various ages and at different stages of infection.

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Liverpool 3. May 3.

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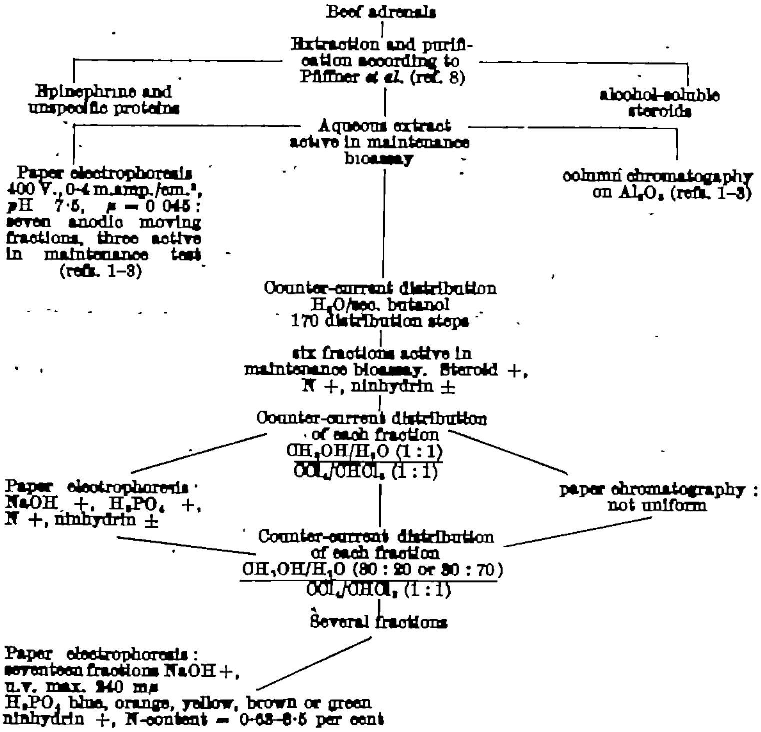
## Nitrogen-containing Steroids in Aqueous Adrenal Cortical Extracts

Previous investigations on the nature of aqueous adrenal cortical extracts led to the isolation of potent fractions as assessed in the golden hamster maintenance test. A preliminary analysis of the crude fractions suggested the presence of nitrogen[1–3], and on further separation the potent mixtures yielded substances which according to our criteria possessed steroidal properties besides containing nitrogen. The course of the separation is outlined in Table 1.

A number of these substances could be isolated by combining various fractionation procedures such as counter-current distribution, paper electrophoresis, and paper chromatography. 13·0–36·5 per cent of the material gave a positive Zimmermann reaction in an early separation step; 18·4–43·9 per cent

Table 1


Beef adrenals
Extraction and purification according to Pfiffner *et al.* (ref. 8)
Epinephrine and unspecific proteins
alcohol-soluble steroids
Aqueous extract active in maintenance bioassay
Paper electrophoresis 400 V., 0·4 m.amp./cm.², pH 7·5, μ = 0 045: seven anodic moving fractions, three active in maintenance test (refs. 1–3)
column chromatography on $Al_2O_3$ (refs. 1–3)
Counter-current distribution $H_2O$/sec. butanol 170 distribution steps
six fractions active in maintenance bioassay. Steroid +, N +, ninhydrin ±
Counter-current distribution of each fraction $\frac{CH_3OH/H_2O\ (1:1)}{CCl_4/CHCl_3\ (1:1)}$
Paper electrophoresis: NaOH +, $H_3PO_4$ +, N +, ninhydrin ±
paper chromatography: not uniform
Counter-current distribution of each fraction $\frac{CH_3OH/H_2O\ (80:20\ or\ 30:70)}{CCl_4/CHCl_3\ (1:1)}$
Several fractions
Paper electrophoresis: seventeen fractions NaOH +, u.v. max. 240 mμ $H_3PO_4$ blue, orange, yellow, brown or green ninhydrin +, N-content = 0·63–3·5 per cent

reacted as total neutral reducing lipids (Heard and Sobel). The nitrogen content varied between 0·8 and 4·5 per cent. The biuret and sometimes the ninhydrin reactions were negative, in contrast to the final fractions, which reacted strongly with ninhydrin. After electrophoretic separation most of the ninhydrin-positive bands also exhibited fluorescence with sodium hydroxide and phosphoric acid. Only a small number of ninhydrin-positive bands moved to the cathode; the rest, moving to the anode, did not always correspond to the steroid bands usually found here under our experimental conditions. Some of these bands were ninhydrin-negative.

A more detailed description will be given of six fractions which, out of a total of seventeen ninhydrin-positive fractions, have been assayed in the golden hamster maintenance test. All these fractions fluoresced with sodium hydroxide and phosphoric acid. Their nitrogen-content ranged from 0·63 to 3·5 per cent; in four of them it amounted to 2·59 – 3·50 per cent. If the mean molecular weight of the steroid component is taken as 300, this would agree with the theoretically calculated amount assuming that nitrogen is bound to the steroid nucleus in the form of an amino-acid or at most of an oligopeptide. According to the positive ninhydrin reaction and the anodic movement of the compounds, the carboxyl group as well as the α-amino-group should be present in a free state. Ultra-violet spectrophotometric analysis of the steroidal component showed an absorption maximum at about 240 mμ. This, together with the sodium hydroxide fluorescence, strongly indicates the presence of a $\Delta^4$-3-keto configuration. The fluorescing colours produced with phosphoric acid were equal to those shown by the biologically active corticosteroids[4].

Taking this evidence into account, it can be assumed that these substances are α,β-unsaturated 3-keto corticoids possessing an exocyclic additional amino-acid component. The presence of similar compounds in urine was recently reported by Eades *et al.*[5], and by Hudson and Lombardo[6]. The latter also suggested their presence in adrenal cortical extracts and adrenal vein blood. Nothing definite can as yet be said on the nature of the binding, though there is a possibility that a mechanism is involved comparable to the binding of steroids to protein as discussed by Areshkina *et al.*[7].

The large number of fractions isolated may be explained by supposing that these consist of different steroids and/or amino-acid components, though there is no doubt that in part the methods applied are involved, as the counter-current distribution in particular tends to show overlapping in closely adjacent fractions.

Whereas the total extract shows a strong activity in the life-maintaining assay, which is still present in the early fractions, no such activity was detectable with certainty in the six purified bands examined. It should be understood that by this bioassay only one property of certain steroids can be demonstrated, therefore no conclusions can be drawn from this test on the biological significance of our substances. Investigations are in progress to find out whether these substances represent a special hormone-group or merely a transport form, or whether they are intermediates in the biosynthesis of corticosteroids.

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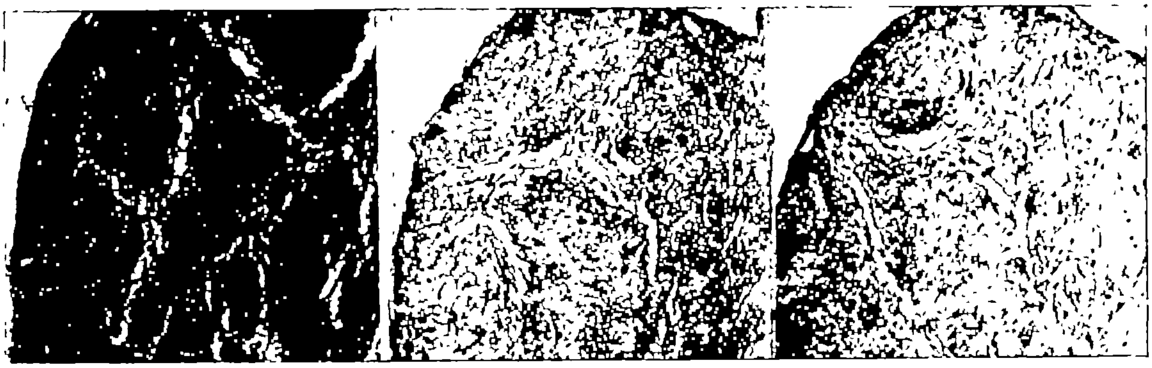
# Selective Digestion of the Neurosecretory Material of the Hypothalamus and of the Neurohypophysis by Tissue Homogenates

VARIOUS authors[1,2] claim, mostly on indirect evidence, that the neurosecretory colloid material present in histological preparations of the hypothalamus and in the neurohypophysis is related to the hormones of the posterior lobe of the hypophysis, probably to the antidiuretic hormone. However, Hild and Zetler[3] reported that some solvents extract the neurosecretory colloid material without modifying the antidiuretic activity.



(a) (b) (c)

Fig. 1. Neurohypophysis of *Bufo ictericus*; Gomori's chromalum hæmatoxylin stain (× 150): (a) incubated with distilled water; (b) incubated with liver homogenate, not heated; (c) incubated with liver homogenate, heated at 80° C. for 10 min.

Since various tissue homogenates were found to inactivate the antidiuretic action of posterior pituitary extracts[4,5], it appeared interesting to try the action of such homogenates on the neurosecretory colloid material.

We investigated the action of homogenates of various rat tissues—liver, spleen, lung, kidney, striated muscle—on histological sections of the hypothalamus and the hypophysis from dog, cat and from several species of *Bufo* (*B. arenarum*, *B. marinus*, *B. ictericus*).

One volume of the organ was homogenized with four volumes of distilled water in a Waring blender, and the solution centrifuged for 10 min. at 1,800 *g*. The *p*H of the supernatant was adjusted to *p*H 6·0–7·0 with *N*/4 sodium hydroxide and the solution was used either immediately or after heating for 10–15 min. at 80° C. or at 98° C.

The hypothalami and hypophysis were fixed for twenty-four hours in a saturated mercuric chloride solution containing 10 per cent formalin, embedded in paraffin and cut at 8μ. After removal of the paraffin, the sections were incubated with the homogenates for 4–5 hr. at 37° C. Control preparations were incubated in distilled water. After the incubation, both the control and the treated preparations were rinsed in running tap water for 5–10 min. and stained by one of the following techniques, which are known to stain the neurosecretory material: (*a*) chromic hæmatoxylin–phloxin method[6]; (*b*) Gomori paraldehyde–fuchsin as modified by Gastaldi[7]; (*c*) periodic–Schiff reaction[8].

In these conditions, we found that the colloid material cannot be demonstrated in the sections treated by the homogenates, although it remains unaltered in the control preparations.

According to Birnie[5], the homogenates which destroy the antidiuretic activity of posterior hypophysis extracts contain an enzymatic system that is inactivated by heating at 80° C. for 10 min. However, the homogenates heated at 80° C. and at 98° C. for 10 min. have the same action on the neurosecretory colloid material as untreated ones. Thus the action on the neurosecretory material appears to be different from the antidiuretic hormone-inactivating system previously described by Birnie.

Attempts to purify and to identify the active substance are in progress.

We tried the action of the homogenates on various organs of the rat (kidney, pancreas, intestine, stomach, adrenal, salivary glands, testicle, thymus) in the same conditions as those of the previous experiments. We found that no other histological element that stains by the Gomori methods is altered by this treatment. An exception is the beta cell granules of the islets of Langerhans of the pancreas, which can no longer be stained after this treatment. The significance of this finding will be studied elsewhere.

Thus the action of the homogenates on the Gomori-positive neurosecretory material appears to be specific. It is hoped that these properties may be used in order to provide a histochemical method to identify this substance.

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## Glutamine as an Accelerator of Chondroitin Sulphate Synthesis

The sulphate exchange of chondroitin sulphuric acid can easily be studied *in vitro* in surviving slices of cartilage suspended in a Krebs–Ringer-bicarbonate solution containing $^{35}$S-labelled sulphate[1,2]. The influence of various factors on this reaction, which is of an enzymatic nature, has been studied in this department. In the course of the work, it was noted that small amounts of a liver homogenate added to the suspending medium produced a remarkable stimulation of the sulphate incorporation into chondroitin sulphuric acid. As reported in a preliminary paper[3], this effect was found to be due to the presence in the liver of a thermostable, dialysable factor.

In a subsequent study[4], it was found that this 'sulphate-exchange stimulating factor' is present not only in the liver, but also in several other organs and tissues, for example, brain, muscles and lung. It is also present in the serum of various animals. The sulphate-exchange stimulating factor from calf liver could be purified by means of fractional precipitation of boiled liver extract with mercuric acetate, and subsequent preparative paper electrophoresis. When subjected to two-dimensional paper chromatography, the final product showed seven ninhydrin-positive spots, one of which contained the whole sulphate-exchange stimulating activity.

In the course of the aforementioned investigation[2], our attention was directed to a recent paper by Lowther and Rogers[4] concerning the influence of glutamine on the synthesis of hyaluronic acid by bacteria. In it they also referred to the work of Leloir and Cardini[5] on the action of glutamine in the biosynthesis of glucosamine by *Neurospora crassa*. When we added glutamine to the series of compounds studied in the previous paper[3], it was found to have a five times greater sulphate-exchange stimulating activity per mgm. of dry substance than that of the electrophoretically purified sulphate-exchange stimulating factor from calf liver.

The evidence supporting the conclusion that the sulphate-exchange stimulating factor is probably identical with glutamine is as follows:

1. The sulphate-exchange stimulating – active ninhydrin-positive spot and L-glutamine have the same $R_F$ value in the solvents used for two-dimensional paper chromatography (80 per cent ethanol in water; *sec*-butanol–90 per cent formic acid–water: 75+15+10 parts, respectively).

2. In chromatography on the cation exchange resin 'Dowex 50', L-glutamine and the sulphate-exchange stimulating factor have the same effluent volume when tested separately as well as in mixed chromatography. The recovery of glutamine is not quantitative[6]; this also applies to the sulphate-exchange stimulating factor.

On the basis of the observations reported above, it seems likely that glutamine plays a part in the biosynthesis of mammalian mucopolysaccharides.

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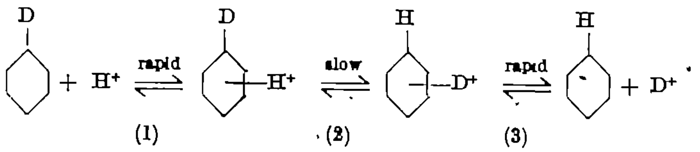
## Hydrogen Isotope Exchange between Aromatic Molecules and Aqueous Acids

THE hydrogen isotope exchange between an aromatic compound and aqueous acid without the intervention of heterogeneous catalysts can be regarded as an electrophilic aromatic substitution reaction[1]. It is also known qualitatively that the kinetic efficiency of the acid increases with its strength[2]. We have now examined quantitatively the nature of this dependence upon acidity in homogeneous solution at 25° and have drawn some more specific conclusions about the mechanism of the reaction.

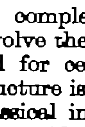
The compounds investigated were *ortho*-deutero derivatives of *p*-cresol, *p*-chlorophenol and *p*-nitrophenol, and monodeuterobenzene. The difference in reactivity of these compounds was such that exchange-rates could be measured in aqueous sulphuric acid over the whole composition range 9·2–97·6 weight per cent without a disturbing amount of sulphonation. Two of the compounds were also studied in aqueous hydrochloric and phosphoric acids.

The measurements indicate that, for each of the compounds, the logarithm of the rate-constant is linearly related to Hammett's acidity function[3] $H_0$, except at the highest acidities (higher than 85 per cent) where the increase of rate is less steep. There are minor discrepancies between the slopes of the log $k$ vs. $H_0$ lines and the ideal slope of $-1$, but these discrepancies are no greater than those found in the cases of other reactions which are held to satisfy this relation and they can be interpreted qualitatively[4]. We have also attempted to correlate the reaction velocities with the concentrations of the different proton donors present in concentrated aqueous acids, using results derived from the intensities of Raman spectra[5], but this alternative analysis of the data was unsatisfactory.

If we accept the usual interpretation of a linear relation between the logarithm of a rate-constant and $H_0$, our results point to the existence of a rapidly attained pre-equilibrium in which the aromatic molecule accepts a proton to form a conjugate acid in which the entering atom and the isotopic atom being replaced occupy non-equivalent positions. The rate-controlling step is then a rearrangement of this molecule, without intervention of the solvent:



By analogy with the case of aromatic nitration[6], it seems likely that step (2) proceeds via an intermediate in which deuterium and hydrogen occupy equivalent positions, that is,



Since the dependence of the reaction velocity on acidity is the same for benzene as for the substituted phenols, the proton attachment in the intermediate is probably of a non-classical kind, which we like to describe as 'outer complex'[7] formation. This outer complex may involve the same kind of bonding as has been suggested for certain of the so-called 'π-complexes'[8]. Its structure is likely to be analogous to that of the non-classical intermediate which has been postulated for the acid-catalysed hydration of isobutylene[9].

It must be left undecided for the present whether the reaction scheme put forward for the hydrogen isotope exchange will find a necessary place in the general theory of electrophilic substitution reactions or whether its applicability is to remain confined to substitution by protons.

A fuller presentation of the results and of the arguments leading to the conclusions outlined in this communication is being submitted for publication elsewhere.

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## Mechanism of the Reduction of Tetrazolium Salts

INVESTIGATIONS undertaken since our previous publication[1] seem to permit of the following additional statements on the reduction and photochemical properties, respectively, of tetrazolium salts used as dehydrogenase indicators.

Alkalinity of the medium accelerates not only the disproportionation and chemical reduction of triphenyltetrazolium chloride, but also the oxidation of formazane. In a strongly alkaline medium all three reactions occur also in the absence of light, the presence of which is known to catalyse them considerably[1-6]. Heat and the presence of certain colloids, for example, gelatine, also increase the rate of these reactions. It was in the disproportionation and chemical reduction of triphenyltetrazolium chloride that the accelerating effect of gelatine could be observed.

Under the appropriate experimental conditions, the chemical reduction of triphenyltetrazolium chloride to formazane, for example, by the action of ascorbic acid, takes place in a strongly acid medium as well.

The common explanation suggests itself for all these phenomena that the acceleration of these reactions is based on diminishing the activation energy and increasing the reversibility. The effect of gelatine, slightly reminiscent of that of the enzymes, can be explained as follows: a significant part of the activation energy required is furnished by the energy liberated on the adsorption on the gelatine particles of formazane, one product of the reaction. Measured polarographically, its value was about 10 kcal. The reversibility-increasing action of heat and alkalinity could also be shown polarographically. At 20° C., the triphenyltetrazolium chloride $\rightleftharpoons$ formazane system was only found to be quite reversible above $pH = 14$. At lower $pH$ values the irreversibility (the difference between the oxidation and reduction potentials) increased.

Polarographic study of 'photo-triphenyltetrazolium chloride', the final product formed by disproportionation of triphenyltetrazolium chloride on the action of light, has shown: (1) that its polarographic reduction occurs by four electrons, analogous to that of triphenyltetrazolium chloride, but at a more negative reduction potential; (2) that the diffusivity of 'photo-triphenyltetrazolium chloride' is twice that of triphenyltetrazolium chloride in spite of their almost identical molecular weight; the phenyl groups attached to the nitrogen atoms 2 and 3 are forced in the 'photo-triphenyltetrazolium chloride' into a plane; (3) that the polarographic reduction of 'photo-triphenyltetrazolium chloride' results not in the free radical which Kuhn and Jerchel[7] obtained by chemical reduction, but primarily a labile 9-atomic heterocycle is formed, and this is transformed by a secondary reaction into the free radical.

The photo-oxidation of formazane is catalysed not only by its final product (autocatalysis), but also by other fluorescent compounds, showing that autocatalysis is based upon fluorescence. The oxidation of formazane in darkness in alkaline medium is likewise autocatalytic in character; but the catalysis is of a quite different nature: in alkaline medium the 'photo-triphenyltetrazolium chloride' formed as the final product is quickly dismembered with the uptake of hydrogen. The latter is furnished by the as yet unchanged formazane, while this is being oxidized.

In an alkaline medium, disproportionation of triphenyltetrazolium chloride yields in addition to 'photo-triphenyltetrazolium chloride' chiefly formazane, and in an acid medium mainly the colourless 1,2-dihydro-triphenyltetrazolium chloride, exactly the same as in the polarographic reduction of triphenyltetrazolium chloride[10]. In addition, we have studied the behaviour of two ditetrazolium compounds, that of blue tetrazolium and neo-tetrazolium, and found the following:

(1) Their polarographic reduction was analogous to that of triphenyltetrazolium chloride, but many more anomalies could be observed than with the latter.

(2) Light had no catalytic effect on their chemical and enzymatic reduction and disproportionation. Strong alkalinity resulted in their disproportionation; gelatine accelerated their chemical reduction.

(3) Alkalized very carefully in the presence of ascorbic acid, an alcoholic solution of blue tetrazolium becomes red, as a small portion of blue tetrazolium transforms into its red monoformazane readily soluble in water, alcohol or benzene. Under the action of light, benzene solution turns yellow, obviously in connexion with a *cis-trans* transformation[9]; in darkness it turns red again. The diformazane of blue tetrazolium, on the other hand, turns in the light from blue to red, likewise reversibly.

(4) Triphenyltetrazolium chloride, ditetrazolium-salts and 'photo-triphenyltetrazolium chloride' exhibit catalytic polarographic waves.

The details of our results will be published elsewhere[11].

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## Separation within the Homologous Series of *n*-Alkyl Sulphates, *n*-Alkyl Pyridium and *n*-Alkyl Trimethyl Ammonium Halides by Paper Chromatography

Methods have been described for the identification of synthetic detergents in admixture with three or four dyestuffs utilizing an ascending chromatogram[1,2]; but these procedures do not allow the separation of mixtures of detergents, neither do they permit the separation of members of a homologous series.

Work carried out in these laboratories has clearly shown that it is possible to effect a complete separation of the normal saturated alkyl sulphates when the adjacent members differ in chain length by two carbon atoms. Mixtures of *n*-octyl, *n*-decyl and *n*-dodecyl sulphates have been separated by ascending paper chromatography using 15 per cent aqueous ethyl alcohol, while 40 per cent aqueous ethyl alcohol has been found effective in separating mixtures of *n*-tetradecyl, *n*-hexadecyl and *n*-octadecyl sulphates. The chromatograms were run at 30° C. using Whatman No. 1 paper.

The position of the spots of the anionic material can be shown by spraying with an aqueous solution of pinacryptol yellow after drying in a current of warm air. When the sprayed chromatogram is examined under ultra-violet light the spots of anionic material fluoresce a bright orange on a pale yellow background. The minimum amount of material capable of detection by this means is of the order of one microgram. Preliminary tests have indicated that this method of separation is applicable to other classes of sulphated and sulphonated detergents.

A parallel investigation of cationic materials has indicated that paper chromatography is capable of effecting the separation of the homologous series of *n*-alkyl pyridinium halides and also the *n*-alkyl trimethyl ammonium halides. The ascending chromatogram of these materials is carried out at 30° C. using 30 per cent aqueous ethyl alcohol containing 5 per cent of concentrated hydrochloric acid. The position of the spots of cationic material is shown by spraying the air-dried chromatogram with an aqueous solution of rhodamine *BS* containing a commercially available optical bleach. The sprayed chromatogram is then exposed to ammonia vapour to neutralize any mineral acid present and examined under the ultra-violet lamp. The spots of the cationic material are seen to fluoresce a bright vermilion on a white background. The method is sensitive to approximately one microgram of cationic material.

It will be appreciated that these methods allow the differentiation of other classes of organic compounds which by means of chemical reaction may be converted to surface-active compounds of the above-mentioned types.

Further investigations on the qualitative and quantitative aspects of the paper chromatography of other classes of anionic and cationic compounds continue, and the results will be published elsewhere at a later date.

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## Reproduction of Mumps Virus in the Chorio-allantoic Membrane

Little is known about the reproduction cycle of mumps virus. This seems strange, as some of the techniques available for influenza virus should be applicable to this virus, which is in many ways similar in its reactions. The method introduced by Hoyle[1,2] in his study on the multiplication of influenza virus in egg membranes, however, did not yield clear-cut results with mumps virus. The main difficulties were the slow adsorption of the virus to the reproductive cells, the relatively high proportion of free (vital) virus particles not taking part in the reproduction process during the experiments and the relatively low reproduction velocity. This last factor made it necessary to expand the experiments to more than thirty hours, and consequently the experiments had to be divided into many parts. The comparability of the infection-, hæmagglutination- and other titres is impeded by this division of the experiment.

In five series of experiments eggs were inoculated with 0·1 ml. of a dilution of freshly harvested allantoic fluid of the mumps strain 'Enders'. To measure the infection titre of the inoculum a series of tenfold dilutions was made and three eggs were injected with 0·1 ml. of each dilution. Every half-hour after the infection the allantoic fluids of four eggs were tested for hæmagglutination power, and the chorio-allantoic membranes were harvested. These membranes were ground with quartz sand and brought into suspension with saline (containing penicillin and streptomycin). A series of tenfold dilutions was made and with each dilution three eggs were inoculated. With the same material the amount of complement-fixing antigen was measured. As the whole series of experiments could not be carried out at the same time the series was cut into parts of four hours each. With each part a reference test was carried out half an hour after the inoculation of the eggs.

The following results were obtained (Fig. 1).

Complement-fixing antigen could not be detected before 18½ hr. from inoculation.

Hæmagglutinin did not appear before 19½ hr. from the beginning of the experiment.

Infective material remains detectable throughout the experiment. The infection titre decreases from 2½ hr. after inoculation until it reaches a minimum after 5 hr., to remain low until 14½ hr. after injection. From then onward infection titres increase very slowly. No secondary phase of decrease of infection titres can be detected within 30 hr. The absence of complement-fixing antigen between 21½ hr. and 28 hr. after the beginning of the experiment may be due to technical error. Hæmagglutinin titres show a steady increase not followed by a secondary decrease.

In consecutive experiments the above-mentioned results could not always be repeated. In the case when the initial infection dosage was low no hæmagglutinin or complement-fixing antigen could be detected. In the case when the initial infection dosage was high ($10^5$ or more), no decrease in infection titre was detectable and the gain in infectivity-rate was relatively low.

In order to get more clear-cut results, we used another experimental arrangement. Chorio-allantoic membranes of nine days old chick embryos were cut into a great number of pieces each of about 0·01 sq. in. After washing in saline, the pieces were put into a Petri dish containing a mumps virus suspension in saline (infection titre $10^{-3}$–$10^{-4}$). After twenty

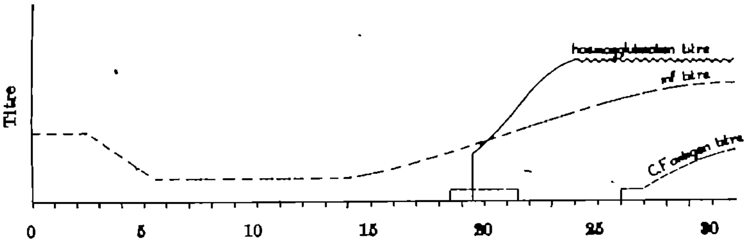

Fig. 1. Multiplication of mumps virus in the chorio-allantoic membrane of incubated hen's eggs

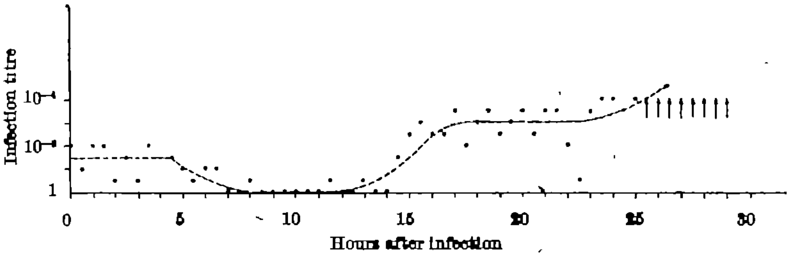

Fig. 2. Virus culture in surviving chorio-allantoic tissues; typical experiment

minutes the pieces were rinsed one by one in several Petri dishes containing saline and then put into roller tubes each containing 1 ml. Tyrode suspension with 400 units penicillin, 0·25 mgm. (0·04 grain) streptomycin, embryo extract and fowl serum. They were then incubated at 37° C. Each half-hour the pieces of membrane from three tubes were ground in a mortar and a suspension was made by adding 0·5 ml. saline (+ penicillin and streptomycin). Tenfold serial dilutions were made and eggs were injected with it and incubated for four days. The results of a typical experiment are demonstrated in Fig. 2.

Mumps virus, we may conclude from these experiments, is reproduced in the living chorio-allantoic cell in about 14–17 hr. The gain in infection titre after such a period is about thirty times the initial amount of virus.

This work was aided by a grant from the (Dutch) National Health Research Council (T.N.O.).

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## *Trichomonas hominis* cultured without Bacteria

*Trichomonas hominis*, like most other intestinal parasites[1], is usually cultured *in vitro* in a Dobell–Laidlaw biphasic medium (horse serum, rice starch and Ringer's solution to which is added 15 per cent liquid horse serum)[2]. Growth of *T. hominis* in that medium occurs only when associated with bacteria. At 25° C. the equilibrium between bacteria and protozoa is optimum, and after forty days of incubation, *Trichomonas* are still numerous and lively. In such conditions, the maximum protozoal concentration attained is about 200,000 cells/c.c.

For the maintenance of the strain, this association is indeed advantageous; in the same way, Sorel[3] pointed out that *Trichomonas vaginalis* lives longer when associated with fungi of the genus *Candida* than in pure culture. Hitherto, attempts to grow *T. hominis* without bacteria have been unsuccessful. Recently, McEntegart[4], who was working with pure strains of *Trichomonas vaginalis*, *T. foetus* and *T. gallinarum*, confirmed in one of his papers that *T. hominis* cannot grow without bacteria.

These characteristics suggested to other investigators that the parasite might be cultured by techniques used for the growth of *Endamoeba histolytica* without development of bacteria. *T. hominis* was cultured by Shaffer and Biegeleisen[5] in a medium 'preconditioned' by the growth of an anaerobic Gram-negative streptobacillus, removed afterwards by centrifugation. In fact, the behaviour of *T. hominis* and *E. histolytica* is not substantially the same, and growth of the flagellate depends on bacterial growth only when it is cultured in a medium of the Dobell–Laidlaw type.

Working with a strain of *T. hominis* (T.H. strain), kindly sent to me by Prof. L. Lamy from the Institut Pasteur of Paris, I was able to separate *T. hominis* from bacteria by changing the culture medium. At 37° C. in complete media, like *CPLM*[6], or in the media used by McEntegart[7] and Feinberg[8], associated bacteria grow abundantly and destroy *T. hominis* in 24 hr., as was pointed out by Williams *et al.*[9] for *T. foetus*. However, addition of 1,000 µgm./c.c. of streptomycin and 1,000 u./c.c. of penicillin allows the growth of *T. hominis* in these media. After three serial transfers in *CPLM* medium to which these antibiotics have been added, sterility tests in bacto-thioglycolate medium show that *T. hominis* is free from bacteria. The pure strain has been maintained by us for four months, with three-week serial transfers. In these conditions, *T. hominis*, like *T. vaginalis*, attains a concentration higher than two million protozoa per c.c.

The parasite cannot grow further without bacteria in Dobell–Laidlaw medium, even if cysteine or ascorbic acid has been added to it, in order to allow the growth of anaerobic micro-organisms. On the contrary, it grows well if it is re-associated with the original bacteria, or with pure strains of bacteria, like *Streptococcus faecalis* A.T.C.C. 6057, and *Escherichia coli* 120 of our collection.

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## Nitrogen Fixation in Detached Non-legume Root Nodules

Previous work has shown that the fixation of nitrogen normally characterizing the root nodules of *Alnus*[1,2] continues after detachment of the nodules from the plant to an extent sufficient for its detection by isotopic technique[3,4]. Bond[4] has shown that the fixation per unit of total nodule nitrogen was considerably greater in such detached nodules from young *Alnus* plants than in detached legume nodules.

Another non-legume possessing nitrogen-fixing root nodules is *Myrica gale*[1,4,5], and the results of isotopic tests with detached nodules of this species are given in Table 1. They show that here also fixation continues to a readily detectable extent.

Table 1. Fixation in Detached *Myrica* Nodules

| | Sample No. | Nitrogen-15 content, atom per cent of total nodule nitrogen |
|---|---|---|
| Exposed to excess nitrogen-15 | 1 | 0·426 |
| | 2 | 0·468 |
| | 3 | 0·468 |
| | 4 | 0·403 |
| | 5 | 0·433 |
| | 6 | 0·463 |
| Controls, exposed to air | 7 | 0·380 |
| | 8 | 0·379 |

Samples (0·5 gm.) of nodules from water-culture plants were placed in specimen tubes (14 ml.) and these then charged at 1 atmosphere with a mixture containing 20 per cent oxygen and 80 per cent nitrogen (with 18 atom per cent nitrogen-15). The nodules were held at 21° C. for 24 hr. and then assayed for fixed nitrogen-15 in the usual way (ref. 6).

In further studies of detached *Alnus* nodules the effect of oxygen supply on fixation and also some features of respiration have been examined. The results in Table 2 show that the fixation (which is proportional to the increase in nitrogen-15 content) is markedly sensitive to oxygen supply. Analysis of variance confirms that the over-all oxygen effect is highly significant, although the differences between means do not all attain the magnitude required for significance (0·043 atom per cent, $P = 0·05$). For various reasons, one of which is the rapidity of nodular respiration (see below), it is difficult to avoid a substantial fall in oxygen supply during such an experiment, so that over the experimental period as a whole the range of mean oxygen supply was considerably smaller than that provided initially.

Fig. 2. Effect of Oxygen on Fixation in *Alnus* Nodules

| | Oxygen initially supplied (per cent) | | | |
|---|---|---|---|---|
| | 21 | 12 | 5 | 1 |
| Mean increase in nitrogen-15 content, atom per cent of total nodule nitrogen | 0·141 | 0·083 | 0·054 | 0·032 |

Four samples (0·6 gm.) of nodules from young water-culture plants were set up at each oxygen-level in specimen tubes afterwards charged at 1 atmosphere with oxygen/nitrogen mixtures containing 20 atom per cent nitrogen-15. Further treatment was as for *Myrica* nodules. The data show increases over the normal figure of 0·372 atom per cent.

The mass spectrometric analyses on which Table 2 is based were carried out on the whole of the nodule nitrogen; the inability of Virtanen *et al.*[3] to detect fixation satisfactorily in detached *Alnus* nodules except by analysis of the soluble fraction only was probably due to their use of nodules from older plants. Calculation shows that in the present experiment the total fixation (nitrogen-14 and nitrogen-15) per sample exposed initially to 20 per cent oxygen was 0·03 mgm. Exposure of nodules to initially 40 per cent oxygen resulted in a marked reduction of fixation, but at present the possibility cannot be excluded that this was due to the reduced nitrogen supply.

In measurements by the Warburg technique, the mean $Q_{O_2}$ (cu. mm. oxygen consumed per hr. per mgm. dry weight) for nodules from first-year *Alnus* plants was 10·5 at 24° C., the nodules being bathed in a nitrogen-free mineral culture solution in an atmosphere of air during the measurements; the corresponding $Q_{O_2}$ for the roots of the same plants was 3·5. Thus such nodules show rapid respiration, both in comparison with the roots that bore them and with a majority of plant tissues. In nodules from second-year plants the mean $Q_{O_2}$ had fallen to 2·0. The $Q_{O_2}$ of nodules falls steeply when the oxygen supply is reduced from the air level, as shown in Table 3, the response in root tissues being considerably slighter. The effect of higher oxygen supply on respiration has not yet been tested.

Table 3. Respiration of *Alnus* Nodules and Roots

| Oxygen supplied (per cent) | Mean $Q_{O_2}$ of nodules | Mean $Q_{O_2}$ of roots |
|---|---|---|
| 21 | 2·72 | 1·03 |
| 12 | 1·86 | 0·80 |
| 5 | 1·14 | 0·64 |
| 1 | 0·35 | 0·33 |

Three samples of nodules or root portions from 2nd-year plants were set up in each oxygen/nitrogen mixture, measurements being continued for four hours, during which time the respiration remained essentially steady. Difference required between means for significance = 0·43 for nodules, 0·08 for roots ($P = 0·05$).

Though comparison of the oxygen effects on fixation and nodular respiration is hindered by the drift in oxygen supply in the fixation experiment, the data show that both processes are markedly and perhaps similarly affected by reduction of oxygen supply. The possibility which thus arises that the two processes are closely linked will be further investigated.

We wish to thank Dr. R. I. Reed for kindly carrying out the mass-spectrometer analyses.

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## Secretion of a Highly Sulphated Acid Mucopolysaccharide by the Brittle-star, *Ophiocomina nigra*

The secretion of a mucus from the tube-feet of ophiuroids is well known[1], although the chemical nature of this substance has not been investigated. In a study of the feeding mechanisms of ophiuroids, I find that *Ophiocomina nigra* (Abildgaard), a common littoral species widespread in the north-east Atlantic and Mediterranean, in addition to the mucin of the tube-feet, secretes all over the body surface an abundant mucus used in conjunction with a detritus-feeding mechanism. Attempts to find the source of this secretion have revealed two types of mucus glands previously undescribed for the species.

(*a*) Large numbers of unicellular glands are distributed over all the general body surface. Histochemically, their secretion gives the general reactions of a simple acid mucopolysaccharide.

(*b*) In addition, there are massive glands within the calcareous structures covering the body, best developed within the lateral arm spines. The mucus within the arm spine is massed along the aboral aspect of a nerve cord which occupies the central longitudinal axis of the spine. These glands open to the exterior along the aboral and lateral surfaces of the spine by means of regularly spaced ducts lined with squamous epithelium. The mucus arises from numerous dense granular areas lying irregularly along the nerve strand. One to several nuclei can be seen in each patch, with no clear cell boundaries separating them. Such multi-nucleated glands have been found within the upper, lower and lateral arm plates, in the tentacle-scales, oral shields, oral papillæ, and in the tubercles of the disk, as well as within the arm spines. In every case, a distinct nerve tract is in association with the granular source.

The secretion product of these granular patches when stained with toluidine blue exhibits an intense γ-metachromasia, and gives a weakly positive Millon reaction; it is negative to the periodic acid – Schiff reaction and to sudan black *B* applied to frozen sections. It is stable to incubation in commercial testis hyaluronidase, and to various extraction techniques for ribonucleic acids. It has a methylene blue extinction point below *p*H 0·65, lower than that of the mouse mast cells used as controls.

The tube-foot mucin of this species gives identical histochemical reactions.

These results characterize the mucus in question as a highly sulphated acid mucopolysaccharide, similar in nature to fully substituted heparin. A similar epithelial mucin, 'mactin *A*', has been described from the labial palps, gills and inner mantle surface of the bivalve mollusc, *Spisula solidissima*, extracts of which have a strong blood anti-coagulant action[2]. The jelly coat of sea-urchin eggs is known to contain a highly sulphated acid mucopolysaccharide, allied to the connective tissue mucins[3].

Among other species of British Ophiuroidea examined so far, glands secreting a highly sulphated acid mucopolysaccharide have not been found in *Ophiothrix fragilis* and *Ophiura texturata*. *Amphipholis squamata*, however, has within its arm spines glands which, though somewhat different anatomically, secrete a mucus histochemically identical with that of *O. nigra*. These glands are the subject of a considerable body of recently reviewed literature[4], as they are considered to be the source of the phosphorescence for which the species is noted. The phosphorescence of other ophiuroid species is attributed to similar gland cells known to be intensely basophilic.

A full report of this work will be published elsewhere.

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## Cytoplasmic Nodules in the Endosperm of some Cucurbitaceae

Cytoplasmic extensions of definite shape growing into the embryo sac during endosperm development have been termed cytoplasmic nodules or vesicles. They are of two types, nucleated and non-nucleated. Nucleated nodules are reported in *Impatiens roylei*[1], *Isomeris arborea*[2] and *Musa errans*[3], while non-nucleated nodules occur in *Oldenlandia corymbosa*[4], *Pennisetum typhoideum*[5] and *Stackhousia linariaefolia*[6]. Billings[2] has reported the development of the embryo from the nucleated nodules in *Isomeris arborea*. Maheshwari and Sachar (unpublished work) have, however, contradicted this and find that the embryo arises from the egg as in other angiosperms. Farooq[4] has reported in *Oldenlandia corymbosa* that these nodules become detached from the general cytoplasm and ultimately degenerate, but I do not agree with him (see below).

The present investigation shows the occurrence of non-nucleated nodules in *Cyclanthera explodens* Naud., *Herpetospermum caudigerum* Wall., *Sechium edule* S.W. and a hermaphrodite variety of *Luffa acutangula* Roxb. Slides of *Cyclanthera explodens* were passed on to me by Prof. Bahadur Singh, while the material of *Herpetospermum caudigerum* and *Sechium edule* was collected from Darjeeling and that of the hermaphrodite variety of *Luffa acutangula* from the Botanical Gardens, B.R. College, Agra.

The endosperm is free nuclear and—in early stages its cytoplasm with free endosperm nuclei—forms a peripheral lining of the embryo sac, with a central vacuole. As the endosperm grows, a balloon-like bulging with a lining of cytoplasm arises in the micropylar region. More protuberances arise in it from the cytoplasm, forming the base of the later bulge (Figs. 1 and 2). These protuberances acquire definite shape and resemble nodules or vesicles described by the authors mentioned above. They are hollow and non-nucleated like the primary cytoplasmic bulging. Endosperm nuclei advance into the primary bulge, being followed later by the formation of more nodules on it (Fig. 1). Cytoplasmic nodules also arise laterally in the vacuole of the embryo sac. All nodules fuse to fill up the space and finally mix with the general cytoplasm. After the fusion of the nodules has taken place, endosperm nuclei advance into the resulting cytoplasm. Any space left in this cytoplasm is further filled up by the formation of fresh nodules (Fig. 3) and finally the whole of the endosperm becomes cellular. Since

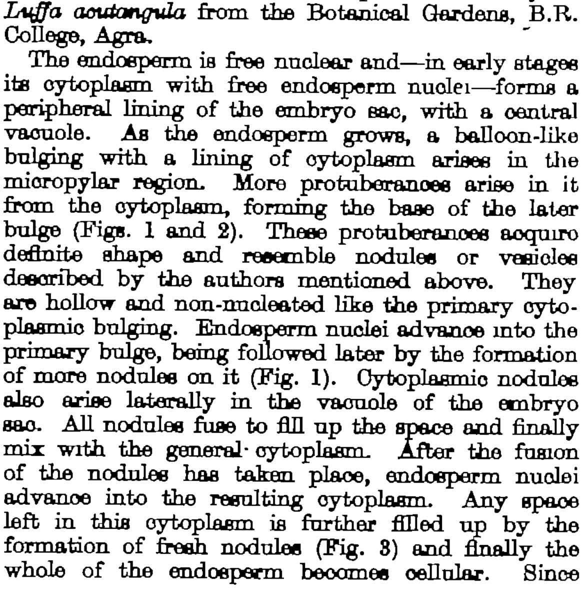

Fig. 1. Longitudinal section of the embryo sac of *Luffa acutangula*; × 300. Fig. 2 Endosperm of *Sechium edule*; × 220. Fig. 3. Embryo sac of *Herpetospermum caudigerum*; × 140. *cn*, cytoplasmic nodules *cv*, central vacuole, and *pcb*, primary cytoplasmic bulge

nodules in Cucurbitaceae show greater chromaticity, belated fusion and ultimate mixing with the general cytoplasm, their detachment, degeneration and disappearance in *Oldenlandia* need confirmation.

I thank Prof. Bahadur Singh for guidance, Prof. P. Maheshwari for kindly going through my slides and Dr. R. L. Paliwal for help. For financial assistance, I thank the Government of India for the grant of a junior research training scholarship.

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## Biosystematics of the *Sisymbrium irio* Complex

*S. irio* Linn. is a polytypic winter annual which grows throughout the Panjab plains. It occurs in diploid, triploid, tetraploid, hexaploid and octoploid races. All these races get considerably modified in response to varying amounts of moisture and sunlight. The phenotypic plasticity has been studied experimentally using the conventional 'water-light' gardens.

The diploid is morphologically uniform and shows seven bivalents. Its artificial autotetraploid shows quadrivalents and does not resemble the natural tetraploid. The latter possesses two ecological races which are markedly different from the diploid. At meiosis it has always fourteen bivalents. It is a genomic alloploid, which is confirmed by the presence of fourteen univalents in its polyhaploid. The triploid is morphologically somewhat akin to diploid but differs in details of leaf shape, flower size and above all in being completely sterile. It is a natural hybrid between diploid and tetraploid. At meiosis it shows seven to eight bivalents plus seven to five univalents. Evidently one of the genoms of the tetraploid is homologous with the diploid. Such plants yield only five to six seeds in strong contrast to the production of several thousand by the parents. Generally these seeds are of hexaploid constitution. The hexaploid is morphologically like the triploid except that it has bigger flowers and long fertile siliquas. At meiosis there are almost always twenty-one bivalents, but at times there are one to two quadrivalents. The octoploid is morphologically somewhat akin to tetraploid. However, it differs from the tetraploid in possessing shorter and thicker stems and fruits and bigger and thicker leaves, flowers and seeds. It shows varying numbers of quadrivalents and bivalents.

Crosses were attempted in all directions, but so far no hybrids except the triploid have either been obtained or seen in Nature. The hexaploid and octoploid have been synthesized. The former is either auto-allo or segmental alloploid, while the latter is auto-alloploid. It is concluded that, in this complex, one of the basic genoms is either the same as that of the diploid or of some form very close to it. The other genom has not been discovered yet.

Identifications carried out at the Forestry Research Institute, Dehra Dun, and Kew Herbariums reveal that all the races are taxonomically under the same species—*S. irio* Linn. Comparison of the various races was very kindly made by Dr. N. Y. Sandwith with the Linnean type material. It has become clear that only the hexaploid race compares very well with the Linnean holotype (Sheet No. 836.35) collected from Spain. These resemble each other in fruit characters, but differ in number of lobes of leaves.

The species has a very wide distribution covering the whole of Europe and extending to the north-western Indian sub-continent. So far it has been possible to study it in Panjab (India) primarily from Amritsar and nearby areas within a radius of approximately fifty miles. For any clear understanding of the variation pattern of the *irio* complex it is imperative to study it from most of the areas of its range.

I would be very grateful to the botanists in the area who are in a position to help me by sending seed samples, if possible accompanied by herbarium sheets giving pertinent information. Furthermore, seed samples of any other species of the genus *Sisymbrium* and allied genera like *Alliaria*, *Arabidopsis*, *Descurainia* and *Eutrema* would also be most welcome.

The details of the investigation involving morphological, cytogenetical, ecological and taxonomical aspects of the problem will be published in due course.

I am indebted to Profs. P. N. Mehra, G. L. Stebbins, jun., R. C. Rollins, K. N. Kaul, Drs. N. Y. Sandwith, W. B. Turrill and Father H. Santapau for their encouragement and valuable help.

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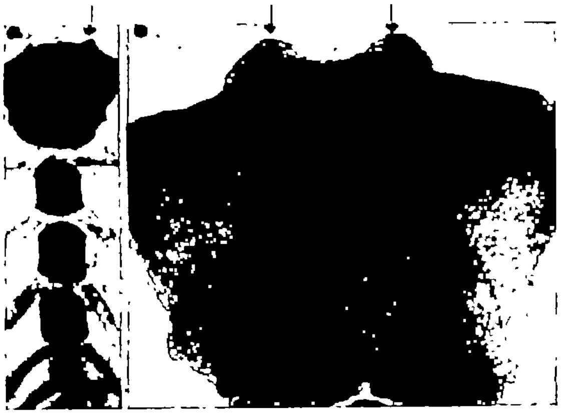
## Supra-sternal Ossicles in Primates other than Man: some Isolated Cases in Gorilla and Chimpanzee

SCHULTZ[1] examined nearly three hundred gibbon skeletons and his report contains the following interesting observation: "Separate suprasternal ossicles occur in two of the gibbons examined (= 0·07%). . . . These ossicles are quite common in Man. . . . Never before have they been observed in primates other than man". Cobb[2] found no evidence of suprasternal ossicles in the skeletons of sixty-one gorillas, thirty-eight chimpanzees and eight orangs. Schultz has not seen this primitive condition "among many hundreds of monkey and ape skeletons examined, except in the two gibbons mentioned".

In view of these statements, it is of interest to record that I have found the condition unilaterally, in one chimpanzee, and, bilaterally, in one gorilla out of a total of 101 chimpanzee and 110 gorilla specimens examined. Radiographs of (*a*) the entire chimpanzee sternum and (*b*) the manubrium of the gorilla sternum are shown in Fig. 1. In each case the ossicles were situated towards the posterior margin of the upper border of the manubrium as is always the case in man.

The significance of suprasternal ossicles is still a matter for speculation. The first record of their appearance in man occurs in a paper by Béclard[3], but their discovery was claimed by Breschet[4]. Béclard considered the ossicles to represent rudiments of the furcular clavicle of birds; Breschet believed them to be atavistic remnants of the ventral ends of cervical ribs; Gegenbaur[5], Ruge[6] and Eggeling[7] were of the opinion that they were derived from the



(a) (b)

Fig. 1. Suprasternal ossicles are indicated by arrows: (a) specimen from a juvenile female chimpanzee; (b) specimen from an adult male gorilla

primitive episternum; Rambaud and Renault[8], Götte[9] and Dawson[10] derived them from the clavicle; Carwardine[11] from the precoracoid; Anthony[12] regarded them as sesamoids. Finally, after an extensive study, Cobb[2] expresses the view that the suprasternal ossicles are rudiments of the epicoracoids of the primitive shoulder girdle.

The specimens concerned are in the Birchington Collection of anthropoid skeletons. I am indebted to Prof. S. Zuckerman for permission to study this material.

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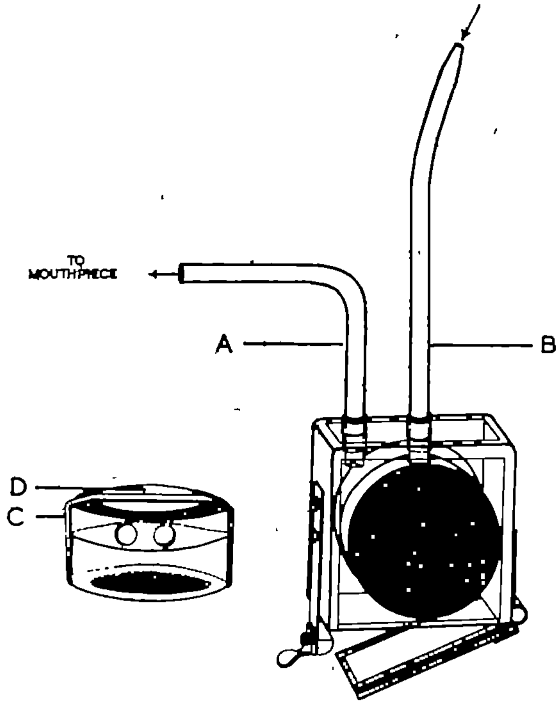
## A Combined Aspirator and Feeding Cage for the Collection and Testing of Insects as Vectors of Plant Viruses

This apparatus (Fig. 1b) has been designed to minimize the handling of insects during their collection and transfer from plant to plant in virus-transmission tests. It combines the principles of Kunkel's[1] aspirator for the collection of insects and Maramorosch's[2] leaf-feeding cage, so that insects can be sucked direct into the feeding cages.

The aspirator consists of a 'Perspex' box 2¼ in. × 2¼ in. × 2¼ in. with side walls ⅛ in. thick, and base and top ¼ in. thick. Joints are cemented with chloroform. The hinged base has an ⅛-in. flange, fitted with a 'Sorbo' rubber seal which is air-tight when closed by the spring clip. Two ¼-in. glass tubes are fitted in the top, using rubber sleeves to make an airtight union. One tube (*A*), projecting slightly into the box, is bent at right angles and connected by rubber tubing to a mouthpiece. The second or inlet tube (*B*) projects 2 in. into the box and is drawn into an ⅛-in. jet at the outer end.



(a) (b)

Fig. 1. (a) Insect-vector cage. (b) Combined aspirator and insect-vector cage

The cage (Fig. 1a) is made from a commercially manufactured polystyrene pill-box, 2 in. × 1 in., with a tight-fitting lid. Holes 1¼ in. in diameter are cut in the lid and base of the box and covered with 34-mesh nylon gauze, which is cemented in position with a solution of the plastic in chloroform. Matching ¼-in. holes are cut in the sides of the box and the lid. On the opposite side of the box a small hole is made through which a string-wick is fitted (not shown in Figs. 1a or 1b).

The cage is inserted in the aspirator so that the intake tube passes through the matching holes in the lid and side of the cage. Insects are drawn through the jet and into the cage by sucking air through the aspirator. The cage is then withdrawn, the inlet hole closed by twisting the lid, and another cage inserted.

In feeding tests, the cage is clipped on to the leaf with a 2-in. × ¼-in. rubber band (*C*). The disks (*D*), which were cut from the pill-boxes, can be used to press the surface against the nylon gauze through which the insects feed. The cage is orientated so that the string-wick is at the lowest point, and absorbs the honey-dew.

When several species of insects have been collected into one cage, they can be separated most conveniently by replacing the cage in the aspirator and anaesthetizing the insects with carbon dioxide passed in through the inlet tube.

J. T. Legg

East Malling Research Station,
Maidstone, Kent.
May 9.

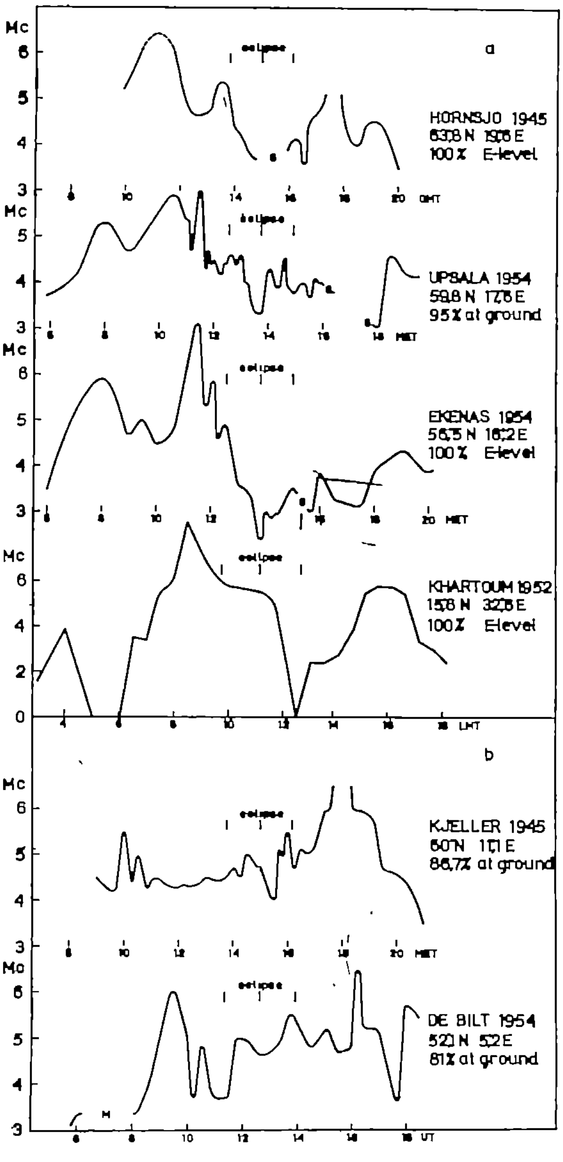
[1] Kunkel, L. O., *Amer. J. Bot.*, 13, 646 (1926).
[2] Maramorosch, K., *J. N.Y. Ent. Soc.*, 59, 49 (1951).

## Variation of *fEs* during Solar Eclipses

In a recent paper[1] Minnis has discussed the observed values of the *Es* layer during the total solar eclipse at Khartoum in 1952. He is of opinion that there is no obvious reason for attributing the observed decrease in *fEs* to an eclipse effect. It is known that a number of observers of other eclipses have not found any typical variations of *fEs*.

During the total eclipse on July 9, 1945, a typical variation of *fEs* was noticed[2], consisting of an increase some four hours before, with following decrease and total disappearance during the eclipse. The *Es* was of the special type present only in summer-time.

Particular attention was paid to the variation of *fEs* during the total eclipse on June 30, 1954, at Upsala and Ekenas, both stations operated by the Upsala Ionosphere Observatory. At both places the same typical variation was found. Fig. *a* shows the variation of *fEs* together with the observed values from Khartoum, 1952[1]. Fig. *b* shows the variation of *fEs* at places where the eclipse was somewhat less than 100 per cent.



The origin of the different types of *Es* is not definitely made clear. A comparison with observations from other stations requires great care because of the limitations in accuracy of the measurements. The median values of *fEs* from a great number of ionosphere observatories show, however, that the effect of the radiation from the sun is one of the agents producing *Es*. This is evident from the diurnal and seasonal variations of *fEs*. The decrease of *fEs* simultaneously with the course of the eclipse thus seems quite reasonable. The decrease of *fEs* is only found at places where the eclipse is total or nearly total. It seems that no eclipse variations are found at places with less than about 75 per cent obscuration.

The increase of *fEs* some hours before the moon's shadow strikes the earth cannot be due to any direct eclipse effect. Yet it seems that the typical eclipse configuration of sun–moon–earth is responsible in some manner for producing this effect.

W. Stoffregen

Upsala Ionosphere Observatory,
Upsala 10. April 29.

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[1] Minnis, C. M., *J. Atmo. Terr. Phys.*, 6, 91 (1955).
[2] Stoffregen, W., *Terr. Mag. Atmo. Elect.*, 51, 495 (1946).

## Dielectric Strength of Organic Liquids

Work in this laboratory on the conductivity of hexane at high steady fields has shown that measurements can be made at field-strengths far in excess of those previously reported. For gaps of 25 and 150 microns, it was possible to measure the conductivity up to stresses of 1,500 kV./cm. and 1,150 kV./cm. respectively.

This can be achieved by eliminating the pulses occurring at high fields which prevent current measurements. Spectroscopically pure hexane was used, and it was further dried and slowly distilled in a closed system under a reduced pressure to obtain a moisture- and dust-free liquid. The electrodes were polished so that no scratches were visible when they were viewed under an optical microscope, and they were finally cleaned with hexane. Even with this treatment, some current pulses occurred, and it was essential to keep these to a small amplitude because of the ensuing deterioration of the electrodes and the liquid and to reduce the risk of a spurious breakdown.

By keeping the applied voltage only slightly in excess of the onset voltage of the pulses, it was possible to control and eliminate them by a conditioning process. For this purpose a high resistance was connected in series with the test cell and the test voltage was increased only after the pulses had subsided. To facilitate the observation of the pulses, a high-gain pulse amplifier together with a cathode-ray oscillograph was used. A high-speed electronic diverter (operating time $\simeq$ 0·7 μsec.) safeguarded the electrometer and prevented spurious breakdown damage during conditioning.

As a rule, numerous pulses of appreciable magnitude were observed in a field region of 300–400 kV./cm., but beyond this the pulses were small except near the breakdown field, where very severe isolated pulses were likely to occur. Very pure liquids were relatively easy to condition, and a liquid showing no detectable pulses at high fields could be obtained; but for less pure liquids it was not often possible to reach the higher fields. The immediate breakdown region was indicated by the rapid rise in the steady current and by the further isolated current pulses which began to occur. In practice, the liquid was conditioned up to 100 kV./cm. or so beyond the maximum stress used during the measurements.

A series of conductivity curves for several gap-distances in the range 300–50 μ have been obtained. These tests show that:

(i) Once conditioning has been carried out for one polarity, no further conditioning is necessary for measurements of the other polarity.

(ii) For symmetrical electrodes with a spacing of about 75 μ there is no polarity effect, and identical conductivity graphs were obtained for stresses up to 1,150 kV./cm.

(iii) For electrodes of different metals, the conductivity curve depends on the nature of the cathode; for example, using chromium and silver for the electrodes, the current for 1,000 kV./cm. was 2½ times greater when silver was the cathode.

(iv) With proper conditioning the consistency of the results was very noticeable, provided the test electrodes remained in the closed system during the tests. In a long test the initial curves could be reproduced at the end of the test; but the purity conditions appeared to be so exacting that slightly different curves were obtained after a rest period of 12 hr.

The impression has been gained that the conductivity may be largely determined by adsorbed layers on the electrodes and hence depends upon the state of purity of the liquid; the two would be expected to be related, and a dynamical equilibrium would be established between them.

It is intended to publish a more detailed account of this work elsewhere.

H. HOUSE

High Voltage Laboratory,
Queen Mary College,
London, E.1. May 6.

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## A New Thermal Method for Sound Absorption in Liquids

AFTER establishing[1] the equivalence of sonic and thermal energies (given by the relation $I = JH$, where $I$ is the intensity of sound at the source, $H$ is the heat produced by absorption of this sound and $J$ the conversion factor which has the same value of $4{\cdot}19 \times 10^7$ ergs/sec. as the mechanical equivalent of heat) this relationship was utilized in this Laboratory to develop a novel technique for the measurement of ultrasonic absorption coefficient in liquids. It consists of the measurement of heat produced at different points along the path of an ultrasonic beam, and its application in the formula $H = H_0 \exp(-2\alpha x)$ where $I$ in the usual formula for attenuation is replaced by $H$ because of the earlier equivalence relation. A series of measurements of absorption coefficient have been taken with this technique and the results have already been reported[2] elsewhere along with full experimental details. These results have shown that the accuracy of this method is high and the values of absorption coefficient so obtained are in close agreement with those obtained by other methods of measurement.

Recently, Dutta and Samal[3] have reported in *Nature* measurements of absorption coefficients using the same principle. According to them, the absorption coefficients of benzene and carbon disulphide are $75 \times 10^{-17}$ cm.$^{-1}$ sec.$^2$ and $115 \times 10^{-17}$ cm.$^{-1}$ sec.$^2$ respectively, as against the values obtained by others which are about $800 \times 10^{-17}$ cm.$^{-1}$ sec.$^2$ and $7,500 \times 10^{-17}$ cm.$^{-1}$ sec.$^2$.

Table 1

| No. | Liquid | Observed $\alpha/\nu^2 \times 10^{17}$ cm.$^{-1}$ sec.$^2$ at 28° C. | Previous results $\alpha/\nu^2 \times 10^{17}$ cm.$^{-1}$ sec.$^2$ | References |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1 | Benzene | 816 | 900 at 20°–25°<br>906 ,, 30°<br>812 ,, 30° | 4<br>5<br>2 |
| 2 | *m*-Xylene | 89 | 80 ,, 27°<br>76 ,, 30° | 6 and 7<br>5 |
| 3 | *n*-Propyl alcohol | 84 | 77 ,, 26°<br>75 ,, 22°–38° | 8<br>9 |
| 4 | *n*-Propyl acetate | 138 | 145 ,, 30° | 5 |

To check on these results we have repeated our experiments at about 5 Mc./sec., utilizing our thermal technique. The results obtained are given in column 3 of Table 1. For comparison, results of earlier measurements are given in column 4. It may be seen from these values that the reproducibility is good.

It may also be noted that these results compare well with values obtained by other methods in this Laboratory, as well as with the commonly accepted values based on the results obtained by other workers using a variety of refined techniques[4–9]. Our thermal technique has also been used by Grossetti[10], who reports good results in water. For our experiments by this technique we have used a generator capable of delivering 10 watts radio-frequency power but set to a low output to prevent the crystal from giving rise to violent ripples in the liquid. It has been observed that, with correct matching, only a small amount of electrical power is needed for the work. Again, the sound energy is completely absorbed in the cell containing a long column of highly absorbing liquid and no correction is required to be made for sound energy leaving the system. This feature also gives rise to more heat, with the result that the accuracy of measurement is comparatively high in this method.

As against this, the results obtained by Dutta and Samal are in complete disagreement with those obtained by us by the above technique and confirmed by us here, as also with other results by workers using different methods. The deviation is obviously due to some flaws in the method and in interpretation of observations. A detailed paper on this work will be published elsewhere.

S. PARTHASARATHY
M. PANCHOLY
C. B. TIPNIS

National Physical Laboratory of India,
New Delhi 12.
June 14.

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[1] Parthasarathy, S., Chari, S. S., and Srinivasan, D., *Ann. d. Phys.*, 12, 8 (1953); *J. Acoust. Soc. Amer.*, 25, 335 (1953). See *Nature*, 173, 110 (1954).

[2] Parthasarathy, S., Chari, S. S., and Mahendroo, P. P., *Z. Naturforschung*, 8a, 273 (1953); *J. de Phys. et le Rad.*, 14, 366 (1953). Parthasarathy, S., and Mahendroo, P. P., *Il Nuovo Cimento*, 10, 1196 (1953). Parthasarathy, S., Mahendroo, P. P., and Mathur, S. S., *J. Sci. Indust. Res.*, 12B, 457 (1953).

[3] Dutta, A. K., and Samal, K., *Nature*, 174, 976 (1954).

[4] Markham, J. J., Beyer, R. T., and Lindsay, R. B., *Rev. Mod. Phys.*, 23, 353 (1951).

[5] Parthasarathy, S., Tipnis, C. B., and Pancholy, M., *Z. Phys.*, 140 156 (1955).

[6] Willard, G. W., *J. Acoust. Soc. Amer.*, 12, 438 (1941).

[7] Pinkerton, J. M. M., *Proc. Phys. Soc.*, 62B, 129 (1949)

[8] Parthasarathy, S., Tipnis, C. B., and Pancholy, M., *Z. Phys.* (in the press).

[9] Pellam, J. R., and Galt, K. J., *J. Chem. Phys.*, 14, 608 (1946).

[10] Grossetti, E., *Il Nuovo Cimento*, 11, 250 (1954).

# FORTHCOMING EVENTS

## Wednesday, September 28

Physical Society, Colour Group (in the Small Physics Theatre, Imperial College, Imperial Institute Road, London, S.W.7), at 3.30 p.m.—Prof. W. D. Wright: "A Report on International Discussions on Colour, 1955: The C.I.E. Meeting, Zurich; the Colour Congress, Heidelberg; the F.A.T.I.P.E.C. Congress, Spa".

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. G. I. Hitchcox: "Extending the Limits of Resistance Measurement Using Electronic Techniques".

## Wednesday, September 28—Friday, September 30

National Smoke Abatement Society (in the Grand Hall, Town Hall, Bournemouth)—Twenty-second Annual Conference.

## Thursday, September 29—Friday, September 30

Institute of Physics, Stress Analysis Group (at Stephenson Hall, The University, Sheffield)—Ninth Annual Conference.

## Saturday, October 1

Association of Clinical Biochemists (joint meeting with the Association of Clinical Pathologists at the Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2), at 9.30 a.m.—Scientific Papers.

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chemists (with a first- or second-class honours degree and preferably with some postgraduate research experience), at the North Thames Gas Board, Chemical By-Products Works, Beckton, East Ham, London, E.6, for research on problems in connexion with coal tar distillation, and the manufacture of phenols, naphthalene and bases—The Staff Controller, North Thames Gas Board, 30 Kensington Church Street, London, W.8, quoting 666/288 (September 30).

Curator (with a university degree in engineering and/or naval architecture or equivalent qualification) of Shipbuilding and Engineering—Town Clerk, City Chambers, Glasgow (September 30).

Lecturer or Assistant Lecturer in General and Physical Chemistry—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1 (September 30).

Physical Chemists (with good honours degree), for work covering both fundamental and applied research on coal—National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting 88/68 (October 5).

Scientific Officer (with first- or second-class honours degree in physics, mechanical or chemical engineering or equivalent qualification) at the Ministry of Supply Research and Development Establishment, Waltham Abbey, to assist in research on heat transfer phenomena at high temperatures—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.329/5A (October 8).

Assistant Mathematical Statistician (with a degree in statistics or science or mathematics which has included a statistics course), to assist in the design and analysis of laboratory and small-scale plant experiments—National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting 88/70 (October 12).

Chair of Physical Chemistry at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 12).

Chair of Physics at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 18).

Chair of Geology at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 24).

Assistant Lecturer or Lecturer (with a degree in agriculture or science) in Entomology, at Canterbury Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Chair of Education at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Chair of Medicine at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Chair of Surgery at the University of Sydney—Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31)

Lecturer or Senior Lecturer in Dental Biochemistry at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, October 31).

Senior Lecturer or Lecturer (preferably with experience in the design and construction of hydraulic works and apparatus) in Civil Engineering at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

Senior Lecturer in the Department of Metallurgy and Assaying at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, October 31).

Assistant Lecturer in the Department of Economics—The Registrar, The University, Liverpool (November 1).

Biochemist (with experience in the chemistry of proteins), for a laboratory engaged in work on human plasma—Secretary, Lister Institute of Preventive Medicine, Elstree, Herts.

Fuel Technologist (graduate in fuel technology, chemical or mechanical engineering, physics or chemistry, and preferably with experience of high temperature furnaces) in the Fuel Technology Section, to work on problems involving fuel utilization and heat transfer in the iron and steel industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1 quoting F.T.1.

Lecturers (3) (with a degree in engineering or science, lecturing experience and specialist knowledge of either electrical engineering electronics or servo-mechanisms) at the R.E.M.E. Training Centre Arborfield—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.422/5A.

Microbiologist (with first- or second-class honours degree and at least three years postgraduate research experience in bacteriology or allied fields), for basic research on taxonomy and biochemistry of marine bacteria—The Superintendent, Torry Research Station Aberdeen.

Physicists and Electrical Engineers, Scientific Officer or Experimental Officer grades (with first- or second-class honours degree or H.S.C. (science) or equivalent qualifications) at the Armament Research and Development Establishment, near Sevenoaks, Kent for research and development work on weapon systems and in particular fuse techniques, also experimental design, development and operation of physical measuring apparatus—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.335/5A.

Pleistocene Geologist (with first- or second-class honours degree in geology and postgraduate experience in sedimentary geology of the Tertiary and Quaternary formations, and special interest in geomorphology and stone age cultures) in the Geological Survey Department, Uganda, to undertake field mapping with special reference to the Plio-Pleistocene rocks of Uganda, including lacustrine and alluvial deposits and their associated physiographical features—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.105/9/05.

Production Chemists (with honours degree in chemistry or chemical engineering or A.R.I.C. or A.M.I.Chem.E. or equivalent qualifications), for Royal Ordnance Factories in South-West Scotland, Pembrokeshire and Somerset, to assist in technical control or administration for explosives and acids manufacture, including development work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.696/5A.

Scientific Officer (with first- or second-class honours degree in mechanical engineering, physics or chemistry or equivalent qualification) at the Ministry of Supply Chemical Defence Experimental Establishment, Porton, to apply results of research to development of personal and collective defensive equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.336/5A.

Senior Experimental Officer (with at least H.S.C. (science) or equivalent; a degree in physics or electrical engineering an advantage) in the General Physics Division, to carry out research and development work in the field of high speed frame and streak photography—Establishment Officer, United Kingdom Atomic Energy Authority, A.E.R.E., Harwell, Didcot, Berks, quoting 2/103/395.

# REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

## Great Britain and Ireland

Forestry Commission. Bulletin No. 21: Tree Root Development on Upland Heaths. By C. W. Yeatman. Pp. iv+72+24 plates and diagrams. 10s. 6d. net. Leaflet No. 34: Badgers in Woodlands. Pp. 10. 9d. net. Leaflet No. 35: Pine Sawflies. Pp 8. 9d. net. (London: H.M. Stationery Office, 1955.) [67

World Power Conference. Annual Report, 1954. Pp. 17. (London: World Power Conference, 1955.) [67

Reporting Back: a Report of the Groups of Young Managers attending the Universities of Cincinnati and Syracuse under the auspices of the Mutual Security Agency, 1951–1953. Pp. vii+60. (London: Management Publications, Ltd., 1955.) 7s. 6d. [67

Association of British Chemical Manufacturers. Notes on Work Study. No. 1: How to Start. Pp. v+9. 2s. 6d. No. 2: Some Results. Pp. v+14. 2s. 6d. (London: Association of British Chemical Manufacturers, 1955.) [67

Kent Incorporated Society for Promoting Experiments in Horticulture. East Malling Research Station. Annual Report, 1954. (Forty-second year, 1st October, 1953 to 30th September, 1954.) (A.38.) Pp. 170+34 plates. (East Malling: East Malling Research Station, 1955.) 12s. 6d. net; 2 dollars. [67

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# UNIVERSITY AUTONOMY IN SOUTH AFRICA

THE Hoernlé Memorial Lecture on "Education and Race Relations in South Africa"* given by Dr. T. B. Davie, principal and vice-chancellor of the University of Cape Town, one of the four universities of the Union which thus far has held to the ideals of British universities in respect of policies of the open door and complete academic freedom, is an important and scholarly discussion of the interaction of educational policies and race relations in South Africa. Those strained and worsening relations, as Dr. Davie notes, in the present world situation are far from being a matter of purely domestic concern to the Union of South Africa, and for that reason alone the publication of this lecture would be welcomed as a contribution to the clear understanding of a problem of international import. Still more, however, is this lecture to be welcomed as a contribution to clear thinking on the issues of academic freedom in the modern world, and the place of the university in a modern community, whether multiracial or not.

Dr. Davie starts by proclaiming the conception of the functions and ideals of a university as understood by the Western democracies. That concept, he argues, is essentially of a community dedicated to the pursuit, preservation and dissemination of learning for its own sake, open to all who can benefit by or contribute to its teaching or work, and demanding of them absolute intellectual integrity, prizing scholarship and research as the major requirements of those who work within its walls, and demanding the fullest possible measure of academic freedom as the condition for fruitful creative work. Nevertheless, the modern university is not divorced from the realities of the modern State, from which in increasing measure it derives its financial support, and in return the university provides much of the theoretical and technological training for the professions and the higher levels of the public service.

Attention is directed to the potential clash between this responsibility for service to the State and the responsibility for unprejudiced, untrammelled search for the truth; though, as Dr. Davie emphasizes, the two functions are not necessarily inconsistent or opposed. Danger arises if, in practice, service to the State comes to mean service to the ideology of a particular section in political power at that moment. Where universities have taken training for service to the State as their primary function, discriminations against staff and students on ideological grounds and perversions of the truth in the content of their teaching are liable to occur, and may develop into indoctrination.

Reviewing the position in relation to the State of the nine institutions which, with the University College of Fort Hare, rank as universities in the Union of South Africa, Dr. Davie points out that English-medium and Afrikaans-medium universities differ also in racial origin, in religion, in political background, and in their degree of urbanization, the latter drawing a larger proportion of students from farms, villages and small towns, while most of them are also adherents of the Calvinistic protestantism of the Dutch Reformed Churches. Moreover, the use of Afrikaans as the medium of instruction restricts the supply of lecturers and increases the risk of inbreeding. In these universities, from which non-Europeans are rigidly and completely excluded, the requirements in respect of staff and students attached to their concept of academic freedom thus came to differ from those of the English-medium universities. While this may be an expression of university autonomy, that it should be linked with a party-political and publicly announced government policy points to a different scale of values. Dr. Davie does not enter further into this question of racial discrimination in the universities, beyond indicating the strength with which the idea that there should be no such racial discrimination in the academic field is held by at least two of the English-medium universities, both in the interests of the universities themselves and of the country. Apart from this, it should be remembered that strong protests have already been made outside the universities against the projected extension of racial segregation in the South African universities, and a commission which reported on the situation to the Fifth International Student Conference at Birmingham last July urged that at least the remaining unsegregated universities should continue to be multi-racial, and could find no reason why any South African university should discriminate between races in the admission of students or segregate students once admitted to a university.

In a statement issued last year, it was argued that the existence of the two open universities has enhanced South Africa's reputation overseas and afforded concrete expression to the desire for goodwill between Europeans and non-Europeans. The report made to the International Student Conference referred explicitly to the influence which foreign public opinion often exercises on the policy of the South African Government, and suggested that responsible representations from overseas, given effective publicity, could assist in preventing further encroachment on the autonomy of the South African universities. Dr. Davie makes it clear that there is a division in this matter among the students themselves, but that there is strong student support for the open university; and one of the merits of his lecture is the plain warning he gives of the serious consequences likely to follow from the Government policy, in view of the cultural and political divisions which are the counterpart of educational deficiencies in the Union. First he points out that the Government's apparent intention to enforce uniformity of policy on all the universities involves risks of psychological damage to the Government party itself. Next, it undermines the concept of a South Africa large enough to embrace elements of both African and European descent. Thirdly, it threatens to determine the future education of the coloured and native elements in a way likely to provoke embitterment and opposition among those of non-European origin.

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* "Education and Race Relations in South Africa." By Dr. T. B. Davie. (Eleventh Hoernlé Memorial Lecture.) Pp. iii+31. (Johannesburg: South African Institute of Race Relations, 1955.)

Dr. Davie is concerned more particularly to note the way African education generally is likely to be affected if all leaders of the community are trained in universities in which the primary objective is training for service to the State. Inevitably, educational policy and practice at all levels will be directed to the same objective rather than to the development of the child to the full extent of its capabilities. Ignoring the political and religious aspects of the policy represented by the Bantu Education Act of 1953, Dr. Davie points out that, while the Act will double the number of children to be admitted to the schools, the restricted daily amount of teaching need not be seriously retrogressive if the child can be induced to remain at school for a longer period. He is more concerned, however, as to the effect of insistence on using the mother tongue as a medium of instruction, coupled with the teaching of the elements of both English and Afrikaans; and that the obvious intention of the Act is that education of the African child shall be different from that of the Afrikander, and establish and perpetuate an inferior status for the former. This is bound to affect the type of education provided in the upper standards of the primary school, as well as the curriculum of the high school; and it is likely also to diminish the chances of fostering the eager zest for knowledge which is the hallmark of the true candidate for university education. Most of the aspirations of the potential scholar will be suppressed, and a sense of bitter frustration produced in those who do succeed in entering the universities.

This depressing educational outlook for the non-European in South Africa is presented by Dr. Davie quite objectively; but he points out unequivocally that if Government policy specifically limits non-European education to fitting the pupil for a place in society inferior in social and political status to that of the Afrikander, there can be no place for him in universities to which the latter are admitted without creating discord and dissension within the universities to an extent incompatible with good work. To encourage, however, an academic education similar to that of the Afrikander might well result in an increase in the number of those of non-European origin seeking and meriting admission to the Universities of Cape Town and the Witwatersrand, for example, which would demand action on an extensive scale. He does not believe that the present friendly relations between students of all races in those universities would be endangered if the proportion of non-white to white students approached equality, though new universities located in certain areas might also be required; and he suggests that the establishment of new institutions of a type similar to the 'junior college' of the United States, for two-year courses of higher or post-matriculation education and working in conjunction with an established university, might meet a real need of all classes of the population.

Dr. Davie is clearly concerned that the South African universities may soon be faced with additional demands far beyond their capacity without considerable expansion. He points out that in this connexion it is important to consider the severely limited openings for the educated African which at present exist, and the detrimental effect of this position both on race relations and on the curricula of the university itself. Although, however, tension is steadily rising between non-European and European, and the relation between British and Afrikaans sections of the population is also steadily and rapidly deteriorating, there is little that the universities can do to promote rapprochement. Dr. Davie seeks rather a solution at the other end of the scale: in the infant school, not in the universities. The separation of the English-speaking from the Afrikaans-speaking children in unilingual schools is, Dr. Davie believes, more than any other single factor, responsible for keeping alive the animosities and divergencies between the two sections. Mother-tongue instruction, while obviously desirable, is not necessarily the best in the interests of South Africa. With instruction both in the mother-tongue and in the official language, within one generation the high schools and universities would be fed by fully bilingual scholars; and its beneficial results would be manifested within five years, once politicians were determined to seek full co-operation between the two main sections of white South Africans.

While the universities can do little to relax the present tension between the two groups of Afrikander and English-speaking South Africans, Dr. Davie believes that the universities could make a tremendous difference by taking a stand against all measures of coercion in the educational field. They could do this in the knowledge that they would thereby implement the recognized policy of universities throughout the Western democracies. It is the high and solemn duty of all universities to inculcate in their students that toleration of ideas which characterizes the really educated man, and the ideal of rendering available the whole of knowledge to everyone who can benefit by it. In the measure with which they address themselves to that task, the universities of South Africa can count on the understanding and firm support of universities throughout the free world.

Dr. Davie addresses himself indeed primarily to a South African audience. His two specific requests, that each university be allowed to decide on and develop its own policy in relation to the admission and academic privileges of its students, European or non-European, and that, when planning for the further university needs of the socially and educationally awakened non-Europeans, the facilities provided should be additional and not alternative to those now available, are manifestly matters for South Africans alone. But like his dignified plea for toleration and for unbiased judgments, they breathe a spirit of integrity and impartiality which commands confidence. The Hoernlé Memorial lecture of 1955 is evidence that South Africa does not lack those capable of making a university an independent centre of informed and reasoned criticism and of constructive creative thought, and this in itself demonstrates the importance of university autonomy.

# VICTORY OVER THE PLAGUE

## Plague

By R. Pollitzer. (World Health Organization: Monograph Series, No. 22.) Pp. 698. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) Cloth: 10 dollars; 65*s.*; 40 Swiss francs. Paper: 9 dollars; 60*s.*; 36 Swiss francs.

In the preface to this important work, Dr. R. Pollitzer says that the most recent publication in English which dealt comprehensively with plague was the treatise by himself in collaboration with Drs. Wu Lien-teh, J. W. H. Chun and C. Y. Wu which appeared in 1936. This book had long been out of date, and Dr. Pollitzer, the only surviving author, had been frequently asked to publish a revision. The advances in the control and treatment of plague made in the intervening years rendered it desirable to prepare an entirely new work. This Dr. Pollitzer did, and it was published serially in the *Bulletin of the World Health Organization* between 1951 and 1953. It is now republished in the form of a well-produced monograph. Incidentally, when Dr. Pollitzer was writing this preface, the book by another great authority, Dr. L. Fabian Hirst, entitled "The Conquest of Plague", had not appeared. It should be said that these two works do not compete with each other. Dr. Hirst's very stimulating and penetrating study is more in the nature of an extensive essay on epidemiology than a text-book.

At the present time, plague is confined largely to India, Burma, Thailand, certain areas of China, Java, Madagascar, and the equatorial belt of Africa. Cases occur also in Arizona and New Mexico, in South Africa, and in certain South American States, but these are 'sylvatic' or 'wild-rodent' plague. The disease has always shown the character of long-term periodicity, and the last great pandemic wave began in 1894. As this wave has not yet subsided, it is still too early to say whether the very marked reduction which has occurred in the incidence in recent years is a result partly of this natural decline or whether it has been caused or accelerated by the latest methods of control. Although intimate association with plague is at present confined to workers overseas, the complex epidemiology of the disease, and the fact that its absence from the European scene is due largely to effective anti-plague measures, make it desirable that there should be available a comprehensive and authoritative reference book on the subject. Dr. Pollitzer's book fulfils this purpose admirably.

In the fight against plague, great advances were made following the discovery of *Pasteurella pestis* in 1894, especially by the work of Simond, Ghon, Haffkine, and the Plague Commission under the late Sir Charles Martin. Although a typical concomitant —or rather antecedent—of a plague outbreak is an epizootic of the disease in rats, it is surprising that it took so long for this fact to produce practical results in the field of control. The association between disease in rats and in man is mentioned in some ancient writings, and it was noted in China in 1792, in 1834, and again in 1894, the year in which Yersin demonstrated the plague bacillus in dead rats. Yet in Hong Kong the destruction of rats was not begun until 1901, and the importance of the rat in carrying plague in ships was not recognized until 1906. The equally important role of the rat-flea in sporadic plague was first elucidated by Simond in 1897; yet the method of infection by regurgitation during attempted feeding was not shown until 1914. Since that date very extensive researches have been carried out on the fleas of the black rat, the sewer rat and other rodents, and Dr. Pollitzer's book contains a section of eighty pages on this subject. Despite suggestions which were made to the contrary not very long ago, the result of recent work has been to establish the vital importance of the genus *Xenopsylla* in spreading plague, and especially of *X. cheopis*. Dr. Pollitzer suggests that the role of the flea in spreading plague must be confined to comparatively short distances on land. Long-distance spread of plague through maritime traffic has nowadays almost ceased to occur; if it were due to fleas, it would have been found not infrequently, despite the universal measures practised for the extermination of rats.

It is perhaps not realized widely enough that, from the epidemiological and clinical aspects, bubonic and primary pneumonic plague are virtually distinct diseases. It has been shown that pneumonic plague is not due to any peculiar characteristic of the organism, or to a mixed infection. Various hypotheses have been advanced to explain the fact that certain patients develop plague pneumonia; of these, possibly the most important is the theory that patients who travel during the early stages are liable to detach thrombi which give rise to pulmonary emboli, and the theory that vitamin deficiency is specially liable to accelerate pneumonic complications, as in the Black Death. The most significant feature is that plague due to wild rodents is nearly always pneumonic. Before the advent of the new drugs, patients suffering from pneumonic plague almost invariably died within two days from the onset. Fortunately, the disease is relatively easy to control by the methods applicable to any droplet-borne infection; but there is in some areas a drawback in that the relatives of the patient object to his being taken to hospital and to their own enforced segregation.

There are two aspects of the plague problem to-day which are worthy of the widest notice. The first is the fact that even in Britain unobtrusive changes have been taking place in the prevailing rat species. *Rattus rattus*, the black rat, was supposed to have been brought to Europe by returning Crusaders in the twelfth century, though, as MacArthur, Hirst and others have pointed out, there is evidence that this species was known in Europe from much earlier times, and the Romans may have known both it and the sewer rat. Whatever may be the truth about the early history, there is no doubt that in 1727 there occurred a westward migration of the sewer rat, *R. norvegicus*, from the shores of the Caspian Sea. From that period the black rat fought a losing battle, and by the beginning of the present century it was supposed to be extinct in Great Britain. But since 1911 *R. rattus* has again been present in London, and by 1937 it formed 90 per cent of all rats found in the London area. Conditions during the Second World War were again favourable to *R. norvegicus*, but it appears that the black rat is once again winning the battle. Hence, should the other factors necessary for a localized plague outbreak appear again in Britain, the organism would have no difficulty in finding suitable animal hosts.

The other aspect which deserves mention is the fact that the plague bacillus finds a biologically congenial habitat in the wild rodents of the great open spaces of the world, and that from them the disease is constantly being spread to man. In 1856 Tcherkasoff mentioned in his "Memoirs of a Hunter in Siberia" that the natives of Transbaikalia on the Asiatic plateau were aware of an infectious disease of the local marmots (tarabagans) which spread to man, but which they were able to avoid by not catching or eating sick tarabagans. In 1910 large crowds of inexperienced Chinese invaded these breeding grounds of the tarabagans, since at that time the price for skins was high. They snared both healthy and sick animals, and the result was the great Manchurian epidemic of pneumonic plague which cost sixty thousand lives. Since then, ground rodents in many countries have been incriminated as normal hosts of the plague bacillus. The resulting plague outbreaks in man were until recently labelled 'sylvatic'. But Pollitzer thinks that the term is ambiguous and calls the condition 'wild rodent' plague. Hirst has coined the word 'campestral'. There are fundamental differences between rat-borne and campestral plague. The former leads to collective cases in human settlements, and the numbers of persons affected may be very large. Campestral plague, on the other hand, results only in sporadic cases among those who have penetrated to the haunts of the rodents. Against this must be set the fact that, in numbers and in the areas involved, the extent of campestral infection is very great; against it also must be set the high case-mortality of this type of plague.

Despite the great difficulties, efficient control measures have generally kept plague away from Western Europe during most of this century, and in recent years a great weapon has been made available in DDT. In the sphere of therapy, enormous advances have been effected. A text-book of medicine of 1941, which I picked off my shelf at random, states that treatment is symptomatic, as no specific is known. By 1953 streptomycin and the sulphonamides had revolutionized treatment and had almost permitted us to speak of plague in all its forms as a mild disease.

Dr. Pollitzer is to be heartily congratulated on the completion of this great work. As a students' text-book it will find its place immediately, and as a work of reference it will be consulted for many years.

E. Ashworth Underwood

# A NEW INTRODUCTION TO NEWTON

## Sir Isaac Newton

By Prof. E. N. da C. Andrade. (Brief Lives Series.) Pp. 140. (London: William Collins, Sons and Co., Ltd., 1954.) 7s. 6d. net.

IN 1950 the firm of Max Parrish and Co. published in its series of "Personal Portraits" an "Isaac Newton" by Prof. E. N. da C. Andrade (reviewed in *Nature*, 166, 1046; 1950). Prof. Andrade's latest study of Newton is not a revised edition of this earlier book, but is an entirely new work for another publisher, specially written for a series of "Brief Lives" which includes, among others, Queen Victoria, Elizabeth I, Drake and Wren. In writing the first book, Prof. Andrade had the young reader particularly in mind, his aim being to set down what he himself when young would have liked to know about Newton; this second book also has been kept as simple as possible, so that it may be suitable for young as well as older readers. It is not surprising, therefore, that the two books, of approximately the same length, written by the same author and addressed largely to the same public, should be very similar in scope and treatment. The texts, however, are nowhere identical.

Prof. Andrade's main object is to make clear what it was that Newton did and why it was of such importance for the development of scientific thought (p. 11). To this end he begins by reviewing the state of science at the time of Newton's birth: the influence of Aristotle on men's attitude to scientific inquiry, the survival of the Aristotelian idea of natural and non-natural motion, the accepted view that white light was simple, colour a complication. In view of the important part played by astronomy, in particular the motion of the planets, in Newton's work, Prof. Andrade outlines the history of that subject up to Newton's time: the Ptolemaic and Copernican systems, Kepler's Laws, Descartes's theory of vortices.

Turning next to Newton himself, Prof. Andrade shows him first as a boy of no particular genius but with a marked bent for handicrafts; and then as an undergraduate at Cambridge, where only Barrow saw in him something quite out of the ordinary. The crucial period spent at home at Woolsthorpe during the plague years, "perhaps the most fruitful years of his life" (p. 40), form the subject of the next chapter (Chapter 3). It was during this time that Newton, intellectually alone, made his fundamental discoveries concerning the moon's motion and the composition of white light, invented the method of fluxions, and, as Prof. Andrade considers almost certain, arrived at his 'laws of motion'.

Newton returned to Cambridge early in 1667; in October 1669, at the age of twenty-six, he succeeded Barrow as Lucasian professor of mathematics. At this time his great interest lay in optics, and his early work in this field, including the construction of the reflecting telescope, is described in Chapter 4. Then follows an account of the events which led to the publication in 1687 of the "Principia", sufficient being said of the contents of this great work to bring home the magnitude of Newton's achievement.

The prodigious feat involved in producing the "Principia" in the space of eighteen months, took its toll of Newton's health and led to a period of acute mental depression. Prof. Andrade deals very understandingly with this period, rejecting the suggestion sometimes put forward that it was a period of madness from which Newton never completely recovered; the "silly story" of the dog Diamond is dismissed as quite out of keeping with the facts.

Newton had recovered by 1693; in 1696 he went to London as Warden of the Mint, and the important work which he did here in connexion with the reform of the coinage, as well as his continued scientific activities, affords ample evidence that his mental powers had suffered no permanent setback. In discussing the "Opticks", Prof. Andrade points out (p. 108) that, though all the work was probably done before Newton went to London, the added "Queries" in the second edition (1717) not only show the profound thought given, since the publication of the first edition in 1704, to the matters with which they deal, but also contain some of Newton's most inspired suggestions. Prof. Andrade concludes his account of Newton with a chapter on "Newton the Man", an unbiased assessment of his character.

Apart from a few obvious misprints, there are only two points which call for correction. The statement of Kepler's third law (p. 30) was probably intended to read: "the cube *of the mean radius* of the orbit". The text on p. 136 does not tally with the accompanying figure illustrating the retrograde motion of the planets: to conform with the figure, line 3 should read "between *d* and *e*" and line 6 "from backwards to forwards" (or alternatively broken arrows should be shown between *b* and *c*).

This masterly introduction to Newton will be welcomed by all interested in the history of science, not only as a penetrating study of Newton himself, but also for the insight it affords into many matters affecting Newton's life and work.

N. H. DE V. HEATHCOTE

## EARTHQUAKE GEOGRAPHY

### Seismicity of the Earth and Associated Phenomena

By B. Gutenberg and C. F. Richter. Second edition. Pp. x+310. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1954.) 80*s*. net.

THIS work on earthquake geography by two well-known seismologists, Prof. B. Gutenberg and Prof. C. F. Richter, now working in Pasadena, may be considered to be the modern counterpart of the work of such giants of the past as Count R. de Montessus de Ballore and Dr. C. Davison, and is an extremely important work.

In a young and vigorous subject, such as this relatively is, in which the recording apparatus and hypotheses are changing and in which the data are accumulating so rapidly, it is indeed a pleasure to note that a second edition of this book is required so soon. This contingency has enabled the authors to bring the work up to date to the end of 1952, and in order to save additional printing costs this has been done in a manner so as to cause as little disturbance as possible to the original printing. With regard to the tables numbered 14, 15, 16, which are lists of earthquakes arranged according to depth of focus and location, these have been extended chronologically, and it must be remembered that they are selective within the limits set by the authors. Profs. Gutenberg and Richter do not intend them to supplant the more complete records of the International Seismological Summary, the authors of which are now working on the 1946–47 reductions. Tables 4 (largest earthquakes) and 6 (annual energy release in earthquakes in ergs), being small, have been brought up to date and rearranged where necessary without difficulty. Tables 17, 18 and 19 (regional lists) have had their additions put at the end, and references to new literature have been added. Where major additions have been required, these have been collected together, beginning on p. 104.

Better seismographs such as those constructed recently by Prof. W. Hiller, of Stuttgart, and better timekeeping (now in many seismological observatories measured correct to 0·1 sec.) have given better data, and hence it is now possible to determine the velocities of seismic waves at various depths in the earth with greatly increased accuracy. Moreover, data from new stations such as those at Kiruna (north Sweden), Tamanrasset (West Africa) and Lwiro (Belgian Congo) assist in the elucidation of local deep structure. Lateral and vertical variations in earth structure are not confined to the difference between continents and oceans and to mountainous regions. In this connexion, explosion seismology has been increasingly used in attempts to solve academic problems concerning earth structure, as well as in the search for minerals.

Though not always found at exactly the same depth, the Mohorovičić discontinuity (p. 26, etc.) has been found to be present under all continents and under the Atlantic and Indian Oceans (depth 37 km. under the Canadian Shield and 45 km. under Japan). The velocities of primary waves above it approximate to 6·5 km./sec. and those below it to 8 km./sec. The generalized word for the layer immediately under the sedimentary rocks, namely the "granitic layer", is gradually being discontinued for various reasons, and in this new edition has been replaced to some extent.

Prof. Gutenberg believes that above the Mohorovičić discontinuity there exists at least one layer having low wave velocity and presumably relatively low strength. The consequences of this hypothesis and the comparison of these consequences with those of other hypotheses are still being considered.

The book is essential for students of geophysics, geology, geography, civil engineering and earthquake insurance, and its value has been enhanced in this new edition by the additions and amendments.

ERNEST TILLOTSON

## TEACHING OF M.K.S. UNITS

### The Teaching of Electricity, with special reference to the Use of M.K.S. Units

(A Report of a Sub-Committee of the Science Masters' Association.) Pp. xii+135. (London: John Murray (Publishers), Ltd., 1954.) 10*s*. 6*d*. net.

THE teaching of electricity is a matter of great importance to schools, technical institutions and universities, and this book on the subject, sponsored by the Science Masters' Association, is one which should be very carefully considered. It is really an attempt to present a case for the teaching and use in Britain of the rationalized M.K.S. system of units in schools, and it can be said at once that the committee of the Association charged with the task has done it well. Now, it is not the province of a reviewer to present an opposing point of view, although in passing he may mention that in his teaching and, still more in his researches, he has never found the traditional units to fail him; and he is of the opinion that the rush to popularize M.K.S. units in certain quarters is ill-conceived and likely to be of relatively short duration, except for those workers who are fundamentally interested in and continuously working in electromagnetic theory.

The book is divided into seven main parts: the recommendations of the committee, the syllabus intended for advanced and scholarship levels in the General Certificate Examination and notes thereon, definitions of units, theoretical proofs, experiments and, finally, two appendixes on experimental details and additional experiments which may be used to support the syllabus. They are all worthy of careful perusal. Some of the experiments are highly ingenious; for example, it is interesting to find a description of a form of the Lorenz rotating-disk method for the absolute determination of the ohm adapted for use in schools.

But, among the recommendations of the committee, one finds the omission of quantitative magnetism, "because we now know that an isolated pole is an impossibility and that a magnet with permanently disposed poles is an impossibility". So too is a permanent electric current. A sixth-form pupil is asked to accept without question $\epsilon_0 = 1/\mu_0 c^2$; but he may not be asked to imagine that a sheet of surface magnetism may be pictured as made up of free poles!

As a university teacher, the reviewer dreads to think of what is likely to happen if these recommendations are adopted in their entirety—no magnetism because of lack of imagination, and probably little or no electrostatics because some teachers consider that something must be left out and that the experiments never work anyway. Still, it is good to know that a knowledge of magnetism may be useful in the 'degaussing' of ships; perhaps their navigation is relatively unimportant !

But assuming that we are to cease to train physicists and that we are only interested in producing electronic engineers, may one commend the following suggestions which will enable some quantitative magnetism to be done. On p. 44 is given an expression for the field along the axis of a coil carrying a current. Let us now use two coils and so introduce the Helmholtz coil system. Let the Helmholtz system be mounted with its axis along the magnetic meridian (assuming that this is known), with a small vibration magnetometer mounted at the centre of the system. In this way, by passing known currents through the coils one ventures to hope that the idea of the magnetic moment of a small permanent magnet (high-coercivity 'Alcomax' can be obtained) and of the horizontal component of the earth's field may be gained. Now rotate the Helmholtz system through 90° about a vertical axis, leaving the vibration magnetometer fixed. On passing different currents through the Helmholtz system, one may obtain deflexions of the magnet (using a mirror attached to it for accuracy of measurement) and verify the usual tan θ relation. Next, replace the Helmholtz coils by a solenoid of small cross-section placed in the Gauss *A* position, and so obtain an idea of the $2Md/(d^2 - l^2)^2$ relation, where $M$ is given an appropriate value by passing a current through the solenoid. Now replace the solenoid by a permanent magnet and again verify a $2Md/(d^2 - l^2)^2$ relation. The way is now open for the use of short magnets in the traditional manner.

These are matters which the readers of this stimulating book will undoubtedly ponder upon, and they may conclude that the rationalized M.K.S. system of units is not necessarily bound up with the rejection of point electric charges and magnetic poles.

L. F. BATES

# AMERICAN CHEMICAL INDUSTRY

## American Chemical Industry

A History. By Williams Haynes. Volume 1: Background and Beginnings, 1608–1910. Pp. lxxvii + 512 + 32 plates. Volume 5: Decade of New Products, 1930–1939. Pp. li + 622 + 32 plates. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1954.) 112s. 6d. each vol.

THE appearance of these volumes completes the ambitious design which is set out with somewhat disarming modesty in the first volume, only now available. Vols. 2 and 3 appeared in 1946, Vol. 4 in 1948, and Vol. 6 (a history of 219 United States companies in the chemical and allied fields) in 1949. Vol. 5, now published, is logically the last volume and concludes with the outbreak of the Second World War in 1939, though there is sporadic mention of later developments (that is, in Vol. 6).

The work is mainly economic and political in bias, and there is no technical detail, though practically all technical advances are mentioned with adequate references, very often to review articles. The whole is obviously a reference work and scarcely for general reading, and the aspects of American industry with which it is mainly concerned are not of great interest in Britain, or indeed in any European country. The first volume is perhaps an exception, especially in the earlier chapters, where an excellent review of Colonial policy and Colonial history is concisely set forth with the always interesting beginnings of the early industries. This might repay study by other than science students, and indeed the appeal of all six volumes to the economist and historian might be considerable.

Perhaps the strength and weakness of the whole work is to be seen in the thirty-two pages of "Chemical Chronology" in Vol. 5, where it is most highly developed, set out in four columns—general; industrial–commercial; technical–scientific; and contemporary events—remembering that the work is founded primarily on Column 2, though with references to most of the items in Columns 1 and 3 and, in some cases, to Column 4. Thus on p. xx, under the year 1930, three of the ten items in Column 1 are: Hawley-Smooth Tariff in effect; Bureau of Industrial Alcohol, Treasury Department, separated from the Prohibition Bureau, Justice Department; and tri-*o*-cresyl phosphate found cause of bootleg Jamaica ginger paralysis. In Column 2 there are nine short items, such as methanol absolved as health hazard, one-third output in anti-freeze; tankcar shipment of anhydrous hydrofluoric acid; and Mallinckrodt opened Canadian factory; followed by a complete list of company mergers and, on the next page, a list of new companies and incorporations. In Column 3 there are eighteen items ranging from kojic acid from corn sugar, and cellulose acetate moulding powder introduced, to element 87 discovered, F. Allison and E. J. Murphy, and Armour Research Foundation opened; in this column, at the end of each year, is a list of medals and awards, not confined to the United States. Finally, in Column 4 there are seven items, including London naval reduction treaty; discovery of ninth planet, Pluto; international rayon conference; and tercentenary of first use of cinchona bark in malaria celebrated at Missouri Botanic Gardens. It should be said at once that the comprehensiveness and not the inconsequence of the items is what the reviewer has in mind. To see the work in a just perspective it might be well to imagine the fascination of a similar work on the British industry, with its concise biography of practically every founder, director and prominent research worker mentioned, though one could scarcely parallel the unfortunate "killed in a payroll holdup in 1933" (p. 246 *n*).

The list of errata included in Vol. 1 shows how few and unimportant these, in general, are, though in that volume itself, p. 248, "viscous" is printed for "vicious" with a rather contradictory effect. There is no general index, and in spite of a claim to the contrary, it was found difficult to trace items from volume to volume through the separate indexes, as the important references are not distinguished.

Summarising, the six volumes together constitute an indispensable work of reference to anyone interested in the growth of American industry, and the appendixes alone are a mine of statistical and other information and occupy about one-fifth of the first five volumes. As a guide to the working of tariffs and other industrial legislation, they should be of interest far outside the chemical field.

# THE PEACEFUL USES OF ATOMIC ENERGY

## REACTOR PHYSICS AND CHEMISTRY

By Dr. J. GAUNT and D. J. LITTLER
Atomic Energy Research Establishment, Harwell

PREVIOUS articles by Sir John Cockcroft and Dr. R. Spence on the Geneva Conference on the Peaceful Uses of Atomic Energy (see *Nature*, September 10, p. 482, and September 24, p. 574) have described the plenary sessions, and those sessions devoted to reactor development and chemical technology. The present article deals with the more specialized technical sessions in the fields of reactor physics and chemistry.

The sessions on reactor physics began with descriptions of the various techniques used for the measurements of neutron cross-sections; these included descriptions by American, Soviet and British scientists of mechanical velocity selectors, time-of-flight instruments, and methods for determining inelastic cross-sections. The papers which were read showed that the work had been proceeding on similar lines in all three countries. The delegates were interested to hear a description of a new type of neutron spectrometer developed in the U.S.S.R. A pulsed deuterium–tritium neutron source, embedded in a large block of lead, is used; by observing the neutrons a definite time after the source has been pulsed, one can select neutrons which have been moderated by elastic collisions in the lead and therefore have a particular energy. This technique should prove useful for measuring neutron absorption cross-sections in the so-called intermediate energy region, and will supplement experiments being made by another method at Harwell.

In later sessions, some of the results obtained by these techniques were described. Most of the cross-section values presented were ones which had previously been classified; they included the total and fission cross-sections of the three fissionable isotopes, uranium-233 and -235 and plutonium-239, for all neutron energies up to several MeV., and the absorption cross-section as a function of energy of the very important fission-product poison xenon-135. The cross-sections of the fissionable isotopes had been independently measured in Canada, France, Great Britain, the United States and the U.S.S.R., and the curves showing the variation of cross-section with energy agreed remarkably well in all cases. One interesting feature was that a small resonance in uranium-233 was only fully disclosed by combining all the data. Its presence had been suspected in each country, but in every case it was thought that insufficient data had been accumulated to be sure that the resonance was real.

The absolute values of the cross-sections of the three isotopes, uranium-233 and -235 and plutonium-239, showed some discrepancies. At the suggestion of the chairman of the session on fissionable isotopes, D. J. Hughes, the British, French, Soviet and American scientists met after the formal session to consider the thermal (2,200 m./s.) absorption and fission cross-sections of these isotopes. It was decided to prepare a set of 'world average values' for these cross-sections, which could be used as a means of co-ordinating reactor calculations based on them. The quoted errors of the world average values given here are based primarily on the spread in reported results and are sometimes larger than errors of specific quoted results:

| | $\sigma_{abs}$ (barns) | $\sigma_f$ (barns) |
|---|---|---|
| Uranium-233 | 593 ± 8 | 524 ± 8 |
| Uranium-235 | 698 ± 10 | 590 ± 15 |
| Plutonium-239 | 1,032 ± 15 | 729 ± 15 |

Almost a whole session was devoted to discussing what are the best values of the number of neutrons per fission and the number of neutrons per neutron captured for the three fissionable isotopes. Papers were read by British, American and Soviet physicists, and again it was found that there was good agreement on these hitherto classified numbers. It was shown that breeding with a positive gain-factor with a uranium-238–plutonium-239 system is not possible in either an intermediate or thermal energy reactor; but that breeding should be possible in a thermal reactor with the thorium-232–uranium-233 system. An important contribution from the United States was on the delayed neutrons following the fission of uranium-233 and -235 and plutonium-239; here, again, most of the information had previously been classified.

Several sessions were devoted to describing measurements of importance to thermal reactor design, such as slowing-down and diffusion-lengths in beryllium, graphite and water; resonance integrals for uranium and thorium; and exponential experiments made with uranium and the three moderators, graphite, light water and heavy water. Here there were contributions from India, Sweden, Norway and The Netherlands as well as from France, Great Britain, the United States and the U.S.S.R. An interesting paper was also read on the British zero-energy fast reactor (ZEPHYR), to which reference has already been made in Sir John Cockcroft's article. Papers were also read describing the work done on thermal homogeneous critical assemblies at Harwell and Oak Ridge; the latter paper described some very painstaking work done over a period of several years. Part of a session was devoted to the subject of fission-product poisoning, which is of importance in evaluating the reactivity lifetimes of thermal reactors; contributions from the United States, Great Britain and Canada were presented. The sessions on reactor physics closed with the reading of papers on reactor kinetics and reactor theory.

The sessions on chemistry, metallurgy and technology started logically with discussions on the natural occurrence of uranium and thorium. Each nation was originally invited to submit papers on the occurrence of these metals within its own territory, and a summary of all the data submitted was presented by P. F. Kerr for the United Nations, followed by a panel discussion between representatives of some twelve countries. In the subsequent session, methods of prospecting, including ground, aerial, aero-radiometric and radio-hydrogeological methods, were discussed. Although it appears that prospecting for uranium is now being carried out at a rate unparalleled for any other metal, S. H. U. Bowie and

C. F. Davidson (Great Britain) and A. H. Lang (Canada) stressed the need for a geological approach to the problem rather than the present tendency for "wildcat weekend schemes".

The sessions on the fission process and the chemistry of fission products and heavy elements demonstrated the vast amount of work of a fundamental nature that has been carried out since the first discovery of fission. During the course of these meetings, the names were publicly announced for the elements 99 (einsteinium), 100 (fermium) and 101 (mendelevium), and much interesting information was presented by Great Britain, the United States and the U.S.S.R. on the fundamental chemistry of elements such as ruthenium, technetium, americium and curium, while delegates from many countries took part in the discussion.

Three sessions were devoted to discussions on the effects of radiation on reactor materials, solids and liquids. Here again it was evident that, while a very considerable effort has been expended by many nations in an endeavour to obtain information of technological importance, much work of a purely fundamental nature has also been carried out, as exemplified by A. O. Allen and by C. J. Hochanadel (United States) in their contributions on the effect of radiation on water.

Although much information on the production of metallic uranium and metallic fuel elements was released by Great Britain and the United States for the Conference, only a limited number of papers could be presented orally. Of these, the paper by J. P. Howe described some of the extensive work being carried out in the United States on a large variety of potential fuel elements such as ceramics using uranium dioxide, uranium bonded in zirconium and a dispersion of uranium carbide in graphite, while G. E. Kaplan and G. A. Meyerson (U.S.S.R.) described the production of thorium by electrolysis of a fused salt and the powder metallurgy of this very important element.

In the sessions devoted to the production technology of special materials, particular attention was paid to graphite, zirconium, beryllium and heavy water. M. Benedict (United States) gave a condensed account of his extensive survey paper of production processes for heavy water and the economics of various methods, while I. Dostrovsky and Y. Lehrer (Israel) presented some interesting information on basic design equations for the distillation process in isotope-separation plants.

The sessions devoted to the study of separation processes for uranium and plutonium were supplied with much information from Great Britain and the United States which had hitherto been classified. This information was virtually complete and should be of immense value to other nations contemplating the design and operation of extraction plants. It covered not only the practical experience gained from the operation of existing extraction plants, but also surveyed the practical limitations of solvent extraction processes and the processing of aqueous homogeneous reactor fuels. Liquid-metal technology was also discussed from the point of view of the use of liquid metals for reactor coolants. The paper by M. A. Mikheyev on heat transfer of molten metals showed that the U.S.S.R., as well as Great Britain and the United States, is pursuing work on this subject with great vigour.

Finally, the chemistry and technology sessions ended with discussions on waste treatment and disposal; the contributions in these sessions coming from Canada, Great Britain and the United States provided interesting accounts of the disposal practices in these countries.

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# FERTILITY IN FARM ANIMALS

THE importance of a high standard of fertility in farm animals is pointed by the fact that, on September 5, at Bristol, Section M (Agriculture) of the British Association spent a complete morning discussing the problems involved in it. Quite apart from the fact that a large proportion of farm animals, such as dairy cows, are kept simply because they breed and their productivity depends on their doing so, efficient animal production is closely related to regular high fertility in most other species and types of animal also. Furthermore, selection and improvement by breeding are dependent, if they are to be efficient, on the maximum number of offspring being produced. The problems associated with fertility were presented and reviewed in three papers: Dr. J. A. Laing, on standards of fertility; Dr. J. Hammond, on factors augmenting fertility; and Mr. A. F. Holt, on factors reducing fertility.

In discussing standards of fertility, it was pointed out that in pigs and sheep no absolute standards exist. The inherited differences in fertility between breeds of sheep and the manner in which inherent fertility is conditioned by environment can cause very wide variations in lamb production in normal circumstances from 100 to 200 per cent annually. Wide variations in fertility also exist between breeds of pigs with average litter sizes from seven to eleven, variation which is again increased by differences in management and husbandry. In the case of cattle, there do not seem to be the same inherited differences, but there are very great diversities which are associated with environmental factors. A distinction must be drawn between inherited fertility and inherited infertility. The differences in the former are referable to numbers of ova ovulated, whereas the latter is in general associated with specific anatomical abnormalities which prevent either male or female animals from breeding. It is for this reason that the number of lambs or the number of pigs born after each pregnancy can be varied by inheritance, whereas in cattle the twinning-rate is so low as to be insignificant in its effect on fertility. Inherited infertility also, while it is found in all species, is of low incidence and affects standards only in a minor way. The conclusion which has been reached by many workers that only small improvements in fertility can be achieved by selection and breeding for this character was questioned on the grounds that the statistical analyses made may not have been based on the correct premises. Certainly, very great improvements of existing standards should be possible by alterations in environmental conditions, and with them increases in productivity.

These improvements can be approached in two ways, either by the method of eliminating those factors which reduce fertility or by that of introducing new methods which enhance fertility beyond the physiologically normal level.

In the case of the bull and ram, the present method of dilution and storage of semen has greatly increased fertility, and further extensions of this method have been possible through the development of storage of semen at −79° C. Extension of the fertility of horses and boars, however, has until recently not been possible because of the lack of suitable diluents for the preservation of spermatozoa; but the use of glycine as a diluent for boar semen has recently been successfully developed, and preservation of spermatozoa by means of glycine diluents is now being applied under farm conditions, so that the fertility of the individual boar may be considerably increased.

Female fertility may be increased by stimulating the production of larger numbers of ova by means of injected gonadotrophic hormone. The ovulation-rate of the ewe can be raised in the normal breeding season by means of 500 I.U. of pregnant-mare serum (mare serum gonadotrophics) given four days before œstrus. Œstrus and ovulation can be induced in the summer ancestrous period by the injection of pregnant-mare serum following progesterone. This is particularly important because of the unproductivity of the ewe for half the year. This method marks an advance, for, until recently, hormonal methods of inducing summer œstrus in ewes have been unreliable, causing either ovulation without œstrus or vice versa, but rarely the two together.

The fertility of cows of high genetic value could be increased by the intra-uterine implantation of their ova in other less valuable 'incubator' cows. The practical difficulties associated with this method have not yet been solved, although such transplants have been made by surgical methods in many species, including the cow. If this method were possible, fertility and thus productivity could be multiplied by the transfer of gonadotrophin-stimulated fertilized ova from pre-pubertal cattle, because fertilized ova have been produced in this way from calves less than one month old.

Looking at the other side of the picture—the removal of factors reducing fertility—one of the most impressive features is the transitory nature of most forms of infertility, particularly in cattle. Recent surveys at cattle breeding centres have shown that about 5 per cent of herds experience widespread infertility annually, but only 1 per cent remain infertile for more than one year. Many of the associated factors are unknown, although climate and the effect of season of the year, age, size of herd and time of breeding in the œstrous period may be involved. The nutritional problems are particularly complicated, and there is now good evidence that the combined effects of phosphorus, calcium and vitamin D may be of considerable importance, although the complete and precise pathological processes involved have yet to be clarified. Infectious diseases, such as brucellosis and trichomoniasis, have been controlled by the introduction of suitable measures of preventive medicine and alterations in animal husbandry. Vibriosis, a disease the pathogenesis and diagnosis of which have now been clarified, will eventually be similarly dealt with. It is striking that in all types of disease which depress fertility, whether infectious or otherwise, and in all species of animal, one prominent pathological feature is early embryonic mortality. If the causes of this lesion could be determined, a great step forward would be taken towards the reduction of infertility and so to the increase of productivity.

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# TRACE ELEMENTS AND PLANT GROWTH

AT the recent British Association meeting in Bristol, a joint session of Sections K (Botany) and M (Agriculture) was held on September 6, at which the subject of "Trace Elements and Plant Growth" was discussed. The session was opened with an introductory paper by Prof. T. Wallace (Long Ashton), who reviewed aspects of the subject of interest both to botanists and agriculturists, and illustrated the main points by reference to crop plants. He began by presenting a general picture of the content of mineral elements in plants, for which the term 'mineral status' might be used to express the resultant of the quantities and interactions of the elements present in the plant on its growth and metabolic activities. The mineral elements that occur in plants are generally classified into three groups: essential mineral nutrients; beneficial elements; and other elements. While the essential mineral nutrients comprise the most important group, the other elements are of importance and may present special problems both in the growth and utilization of plants.

The total number of mineral elements now regarded as essential for the growth of higher plants is thirteen, and these are usually divided into two groups, major and trace elements, purely on the basis of the amounts commonly found in plants. The grouping is as follows:

*Major*: nitrogen, phosphorus, calcium, magnesium, potassium and sulphur.

*Trace or minor*: iron, manganese, boron, copper, zinc, molybdenum and chlorine.

Chlorine is the last element to be proved to be essential and is tentatively placed in the trace element group, although it probably occupies a position intermediate between the two groups. In the subsequent sections of Prof. Wallace's paper the discussion was restricted to the six well-established trace elements—iron, manganese, boron, copper, zinc and molybdenum—all of which have been shown to be essential for a wide range of plants and to be of considerable importance in crop production.

After surveying the historical aspects of trace elements, dating from the experiments of Sachs and Knop about 1860, the special effects of trace elements in relation to deficiencies, excesses and interactions were outlined and illustrated by photographs. Prof. Wallace pointed out that the particular effects shown are not only of economic importance, but also are of use in assessing the mineral status of plants and in investigating special problems of plant nutrition, such as in the examination of factors causing injurious effects produced on many plants in acid soils.

An outline was given of the soil factors that are of special importance in influencing the supply of the trace elements in soils to plants, particular mention being made of the effects of $pH$, organic matter and drainage conditions. Availability of five of the six trace elements tends to decrease progressively with increases in $pH$ values, but the reverse holds for molybdenum. The effects of organic matter are complex, and the availability of manganese, copper and zinc may be seriously decreased by 'fixation' effects. Drainage effects are possibly largely due to changes brought about in conditions affecting oxidation and reduction in the soil. Efficient methods now exist for the control of deficiencies of all the trace elements in field crops, with perhaps the exception of iron, and for this element promising results have been recently obtained with iron chelates, such as the iron salt of ethylene diamine tetra acetic acid, used both as foliage sprays and as soil dressings. Methods for the control of excesses of the elements are not so satisfactory, particularly for copper and zinc, which among other effects produce a deficiency of iron.

Following Prof. Wallace's introduction, three papers were presented dealing with special topics of current research on trace elements. The first of these was by Dr. E. J. Hewitt (Long Ashton), who described the methods he has employed at Long Ashton to produce deficiencies of the trace elements in sand and water cultures, and in his investigations to establish the essentiality of further elements that might be expected to be needed by plants in trace amounts. The methods used involve several considerations that apply equally to investigations with higher plants and micro-organisms. Mineral element contamination, ranging from negligible to injurious concentrations, may occur at random from many sources. It should always be assumed to be present, and specific precautions should be adopted as routine measures to reduce it to a minimum. Ideally the culture medium should provide quantitatively known amounts of all the elements regarded as essential.

-Culture equipment and materials, comprising containers, water supply, solid media and nutrient reagents must all be specially selected and treated to eliminate likely impurities. Minimum concentrations of some known essential elements, for example, molybdenum, may need to be of the order of 0·000 005 parts per million to obtain severe deficiency effects. These levels may be achieved in water purified by ion-exchange resins or by distillation in 'Pyrex' apparatus. Specific nutrient purification methods should achieve 99·95 per cent efficiency of removal at initial concentrations of only a few micrograms per litre, without introducing physiologically active residues. Seed or inoculum inevitably provides elements essential to the species and may require initial depletion under deficiency conditions before a response can be observed. Atmospheric contamination may enter directly through foliage or by aeration treatments, and air-conditioned equipment may be necessary. Large-scale experiments greatly magnify the difficulties. Estimates of total mineral contamination and its sources are desirable, and for these chemical and spectrographic methods, radioactive isotopes and biological assays each have limited uses.

Many experiments to demonstrate the essential nature of mineral elements have exploited existing methods to the limits of their efficiency. The interpretation of negative results in such investigations should be limited to the statement that requirements, if any, are below the threshold set by the experiment. The most painstaking experiments often fail to eliminate traces of certain elements from the ash of the test organism. Tests of cobalt, nickel and vanadium omissions, using tomato in water culture, suggest residual contamination that is 10–100 times greater than expected from residual levels normally achieved for copper or molybdenum employing comparable techniques, and the levels found are within the known range of adequate supply for some essential micronutrients.

On the other hand, although some elements—for example, magnesium—are regarded as being generally essential, the absolute or qualitative requirements of organisms may differ for certain elements, or for a given element in different nutritional circumstances. Recent advances in knowledge of differences in the utilization of cobalt, molybdenum, vanadium and sodium in bacteria, algæ and fungi support this view, which is compatible with the effects of evolution on differences in specific properties of enzyme proteins. Beneficial elements may also be revealed, as although these are not essential, they may materially supplement growth or metabolic efficiency either under conditions of partial deficiency, or in the presence of the full complement of the known essential elements where two or more enzyme systems may have incompatible optimal requirements for a single element.

There is considerable scope for further investigation of these more specialized aspects of mineral nutrient requirements. The limits of existing techniques must be extended to lower thresholds of sensitivity for elements of uncertain nutritional status, and the range of organisms studied must be greatly increased.

Dr. D. J. D. Nicholas (Long Ashton) discussed the role of molybdenum in the nitrogen metabolism of plants and described investigations on the nitrate reductase system of higher plants and micro-organisms in which molybdenum has been shown to be the metallic component of the enzyme. The results have established for the first time a definite role of molybdenum in the metabolism of plants. The enzyme that catalyses the reduction of nitrate to nitrite in higher plants, fungi and some bacteria is a molybdoflavoprotein, which transfers electrons from reduced pyridine nucleotides via flavin and molybdenum to nitrate, and the latter is thereby reduced to nitrite. Molybdenum was identified as a constituent of the enzyme by the facts that increased enzyme activity was paralleled by an increase in its content in the enzyme, while other metals were without effect, and that it was possible to reactivate the dialysed enzyme specifically with molybdenum.

During nitrate reductase action, molybdenum undergoes oxidation-reduction changes involving $Mo^{6+}$ and $Mo^{5+}$. The valence-states of molybdenum, including $Mo^{6+}$, $Mo^{5+}$ and $Mo^{3+}$ prepared by paper chromatography, were used in experiments with the pure enzyme. $Mo^{5+}$ acts as an effective electron donor for the enzymatic reduction of nitrate, but $Mo^{6+}$ is without effect. $Mo^{3+}$ reduces nitrate non-enzymatically. It is unlikely that the chemical reduction of the nitrate ion by $Mo^{3+}$ is important for nitrate reduction in plants, because $Mo^{3+}$, which is readily oxidized to $Mo^{5+}$ in the presence of $Mo^{6+}$, has not been detected in plant tissues and the enzymatic reduction of nitrate involves $Mo^{5+}$ and $Mo^{6+}$ only.

It has not been possible to effect a non-enzymatic reduction of $Mo^{6+}$ to $Mo^{5+}$ or of $Mo^{5+}$ to $Mo^{3+}$ with either reduced tri- or reduced di-phosphopyridine nucleotide as the electron donor. Neither of the reduced nucleotides appears to reduce $Mo^{5+}$ to $Mo^{3+}$ chemically or enzymatically. $Mo^{4+}$ is unlikely to be important in metabolism, because it dismutes readily to Mo$^{4+}$ and Mo$^{6+}$ in the presence of a trace of water and is stable only in strong alcoholic solution. Nitrate reductase requires phosphate for maximal activity, so that the molybdenum is probably associated with the apoenzyme as a phosphomolybdate complex and probably undergoes oxidation-reduction in this form. The —SH groups in the enzyme may be important in binding the phosphomolybdate to the protein moiety.

The lower valence-states of molybdenum appear to be important in the initial stages of the fixation of atmospheric nitrogen by *Azotobacter*. The uptake of molybdenum and fixation of nitrogen per unit protein are greater when Mo$^{5+}$ is supplied to the organism instead of Mo$^{6+}$. When ammonium nitrogen is substituted for nitrate nitrogen in the culture solution, nitrogen fixation is retarded and there is no longer a differential uptake of molybdenum from culture solutions containing Mo$^{6+}$, Mo$^{5+}$, and Mo$^{4+}$ respectively.

In the final paper of the session, Mr. J. W. Hannay (Manchester) described his methods of culturing excised roots and reported some of the results he has obtained in studies with manganese, iodine and molybdenum. The rapid growth of the root from a small inoculum facilitates the production of micronutrient deficiencies, and the sterile nature of the cultures allows suspected metabolic intermediates to be supplied.

The culture of an isolated organ raises the possibility that the micro-nutrient requirements of such an organ might be different from those of the intact plant; and, in fact, it has been suggested by one worker that only copper and iron are essential for the growth of excised tomato roots. Other workers, however, have shown that molybdenum and zinc are essential, and Mr. Hannay has described methods by which the essentiality of manganese has been demonstrated. The manganese could not be replaced either by cobalt or nickel, both of which were toxic even at 0·005 p.p.m. either in the presence or absence of manganese. Thus copper, iron, zinc, molybdenum and manganese are essential for the growth of excised tomato roots, as they are for growth of the intact plant. The status of boron has not been determined, since 'Pyrex' culture flasks have been used throughout and these would probably supply the boron requirements of the roots.

In Mr. Hannay's experiments, iodine has been added as a micronutrient in the standard White's culture medium used. Omission of the iodine resulted in a 25 per cent reduction in the growth produced in one week; after three weeks, the growth was reduced by more than 50 per cent. The optimal concentration of iodine, added as potassium iodide, was between 0·1 and 0·5 p.p.m. iodine. If iodoacetic acid was substituted for potassium iodide, an even greater stimulation of growth occurred, the optimal concentration again being between 0·1 and 0·5 p.p.m. iodine. The results suggest that iodoacetate is active because of its iodine content, and this idea is supported by the fact that an —SH group inhibitor, *p*-chloromercuribenzoic acid, would not produce a similar growth stimulation in the absence of iodine. These effects of iodine are of interest in view of the concept of a 'beneficial element' proposed by Dr. Hewitt in his paper.

Investigations concerning the effect of the source of nitrogen upon the molybdenum requirement of excised tomato roots were also described. The techniques for using excess calcium carbonate as a buffer in the medium when roots are grown with ammonium nitrogen, and of making aseptic additions of nitrite nitrogen, were outlined. The interactions between nitrogen source and molybdenum requirement were as follows: when either nitrate or nitrite nitrogen was supplied, growth was very much reduced in the absence of molybdenum from the medium; when ammonium or amino-nitrogen was supplied as the sole nitrogen source, there was no significant difference due to molybdenum. These facts indicate that not only is molybdenum required in the nitrate reductase enzyme, but also in the system reducing nitrite. This latter point, however, requires further study. It has not been possible in these experiments to decide whether molybdenum may have any further role in plant nutrition other than in nitrogen metabolism.

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# PRINCIPLES OF GAS REFRIGERATING MACHINES

By Dr. J. W. L. KÖHLER

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REVIEWING present-day means of producing cold, one is struck by the fact that refrigerators, that is, machines for producing cold, operate over only the temperature range between the ambient or room temperature and −80° C. A second point is that in most refrigerators the cold is produced by evaporating a liquid. It is amazing that of the many possibilities offered by Nature, only one is actually utilized. In this article, we give a survey of another method, which may provide a welcome extension of refrigerating technique[1].

## Fundamental Cycle

The cold is produced in this machine by the reversible expansion of a gas. The gas performs a cycle, during which it is compressed at ambient and expanded at the desired low temperature, the transition between these temperatures being accomplished by heat exchange between the gas going in the one direction and the other. The gas refrigerating machine is fundamentally a special case of the Stirling cycle (Robert Stirling, a Scottish minister, invented the air engine in 1816; the first actual refrigerating machine, based on the Stirling cycle, was described by A. G. Kirk[2]) whereby the compression and the expansion are alternating processes and the heat exchange already mentioned takes place in a regenerator. The $p$–$V$ diagram of the ideal cycle consists of two isotherms and two isochors, as shown in Fig. 1; it is to be noted, however, that the isochors may be replaced by isobars, or in general by any pair of lines which permit heat exchange by regeneration.

Fig. 2 shows stages in carrying out the ideal cycle. In this diagram, 1 is a cylinder, closed by the piston 2, and containing a nearly perfect gas. A second piston, the displacer 3, divides the cylinder into two

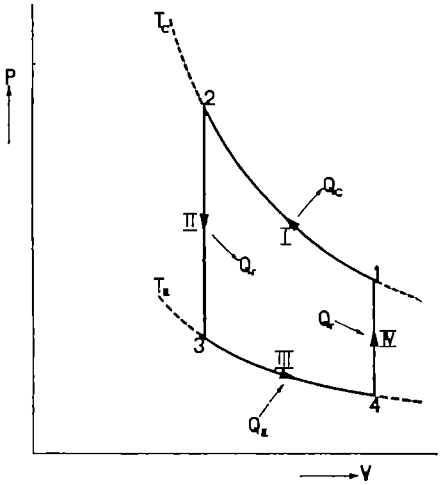

Fig. 1. $p$–$V$ diagram of the ideal Stirling cycle between the temperatures $T_C$ and $T_E$. At $T_E$ the amount of heat $Q_E$ is absorbed during phase III, at $T_C$ the heat $Q_C$ is rejected during phase I. The heat $Q_r$, rejected in phase II, is stored in the regenerator and absorbed in phase IV

spaces, 4 at room temperature and 5 at the low temperature, connected by the narrow annular passage 6. This passage contains the regenerator 7, a porous mass with a high heat capacity; the temperature in the passage is shown in the graph. The cycle, consisting of four phases, runs as follows: (I) Compression in space 4 by the piston 2; the heat of compression is discharged through the cooler 8. (II) Transfer of the gas through the regenerator to space 5 by movement of the displacer. The gas is reversibly cooled down in the regenerator, the heat of the gas being stored in the regenerator mass. (III) Expansion in the cold space by the combined movement of the piston and the displacer; the cold produced is discharged into the refrigerant in 9 and utilized. (IV) Return of the gas to space 4; thereby the gas is reheated, the heat stored in the regenerator being restored to the gas.

Actually, the discontinuous motion of the pistons implied here is not very practicable. Fortunately, little change is required if the pistons are actuated by a crank mechanism, with the condition that space 5 is leading in phase with respect to space 4. In this harmonic cycle the four phases are of course fused, so that the basic processes are more difficult to distinguish. The harmonic motion allows a high speed of the machine, causing the compression and the expansion to take place adiabatically; this entails only a small loss, as the compression ratio is rather low (approximately 2), due to the volume of the heat exchangers (dead space).

## General Characteristics

The properties of the ideal cycle are easily derived from the $p$–$V$ diagram. We find that, in contrast to the evaporation process, the output drops only gradually with temperature, so that the cycle is particularly suited to work over a large temperature ratio. Another important result is that the output is proportional to the pressure of the gas; this enables the design of machines with a high output for their dimensions by choosing a high pressure-level. As the ideal cycle is assumed to be completely reversible, its efficiency is equal to that of the corresponding Carnot cycle. In the actual process, the efficiency is reduced by losses, some of which are particularly important at a small temperature ratio (mechanical and adiabatic loss), whereas other losses reduce the output at very low temperatures (cold losses, for example, regeneration loss). This brings about an optimum working range, at present between −80° C. and −200° C.; future development, however, may extend this range.

## Regeneration

The practical realization of the Stirling cycle has only become possible with the development of efficient regenerators. The following argument demonstrates the severe conditions which must be met by regenerators in gas refrigerating machines[3].

Owing to imperfections, an amount of heat $\Delta Q_r$, the regeneration loss, is transmitted through the regenerator. As this loss reduces the effective cold production, we may compare it with the ideal production $Q_E$. For well-designed machines we find:

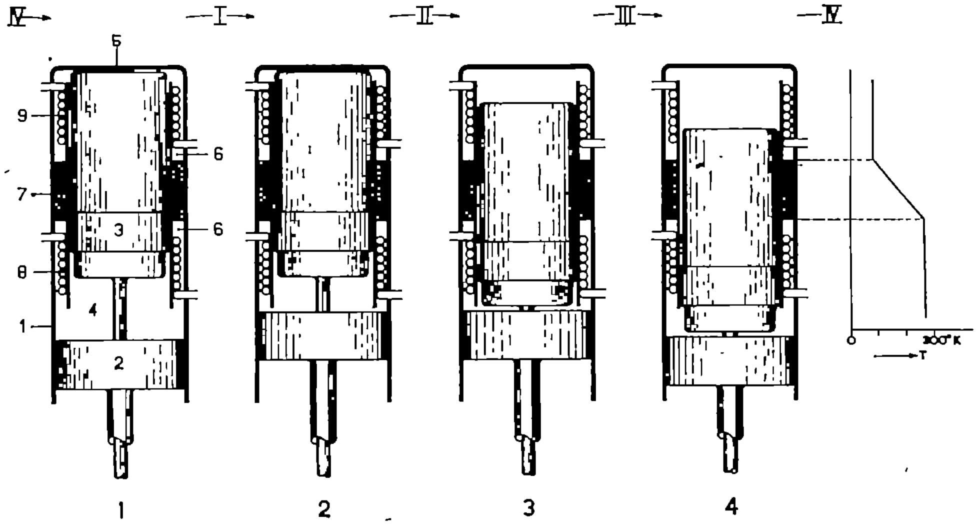

Fig. 2. The ideal Stirling cycle. The figure shows the different positions according to points 1–4 of Fig. 1. I–IV refer to the four phases of the cycle. The graph on the right shows the temperature distribution in the machine

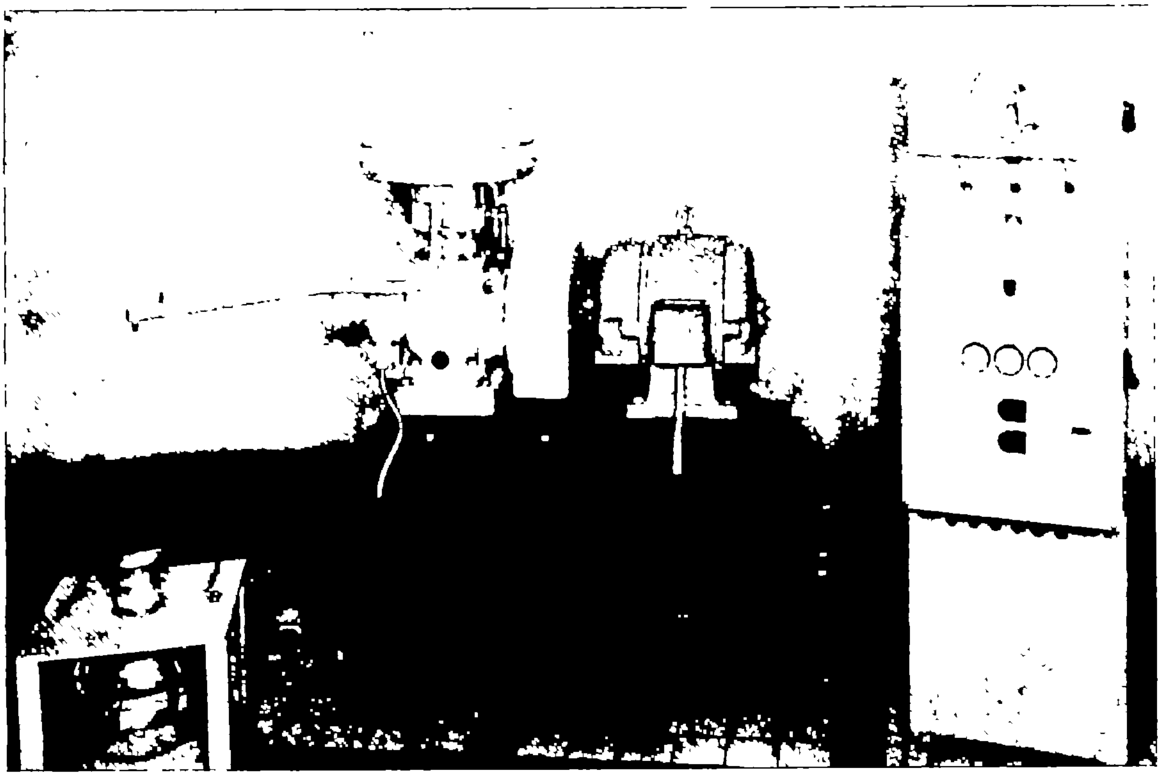

Fig. 3. The complete air liquefier with electric motor and control panel. The large hood on top of the machine contains the ice-separator, in which the ice and carbon dioxide are deposited; it must be de-iced once in 24 hr. The air is sucked in automatically and is discharged as liquid from the protruding delivery pipe

$$\frac{\Delta Q_r}{Q_E} \approx 7\ (1 - \eta_r)\frac{T_C - T_E}{T_E}$$

$T_C$ being the compression temperature (300° K.), $T_E$ the expansion temperature, and $\eta_r$ the efficiency of the regenerator.. Taking $T_E = 75°$ K., this reduces to:

$$\frac{\Delta Q_r}{Q_E} \approx 21\ (1 - \eta_r)$$

showing that a regeneration loss of 1 per cent entails a loss of 21 per cent in output (at 20° K. the result would be 98 per cent). Thus the lowest temperature that can be obtained is mainly determined by the quality of the regenerator.

It has been found that with a light, felt-like mass of very fine wire, regenerators can be prepared with efficiencies higher than 99 per cent (at frequencies as high as 50 c./s.). It should be borne in mind, however, that the regenerator acts as a resistance to the gas flow as well, so that in designing them there must be a compromise between regeneration loss, flow loss and loss by dead space. Finally, the heat capacity of the regenerator must lie above a certain value and the heat capacity of the gas must be independent of pressure (nearly perfect gas), requirements that are difficult to meet at very low temperatures.

## Applications

A first application of the new process is a machine working at −194° C. for liquefying atmospheric air.

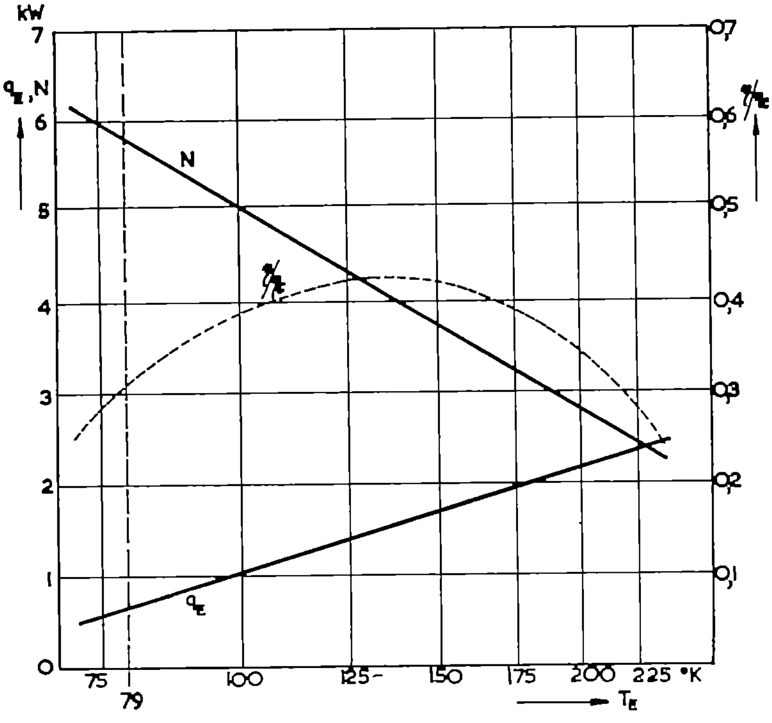

Fig. 4. Refrigerating capacity, power consumption and figure of merit of the air liquefier at different temperatures

The fact that the air to be liquefied need not be compressed makes this unconventional air liquefier very simple and easy to handle. Fig. 3 is a photograph of the complete installation (with hydrogen or helium as working fluid), producing 5·5 litres/hr. liquid air and designed for unattended use. The efficiency of this liquefier compares favourably with that of conventional types; particulars are given in literature quoted. Fig. 4 gives the refrigerating capacity, the power consumption and the figure of merit of this machine at different temperatures. It is clear from this graph that the air liquefier is only one application of the gas refrigerating machine, and that we may expect many more applications, in particular, in the temperature-range between −80° C. and −200° C.

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[1] Köhler, J. W. L., and Jonkers, C. O., *Philips Tech. Rev.*, 16, 69, 105 (1954).

[2] *Min. Proc. Inst. Civ. Eng.*, 37, 244 (1873–74).

[3] The theory of regenerators has been developed, among others, by Hausen, H., *Z. angew. Math. Mech.*, 9, 173 (1929).

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# INTERNATIONAL ASTRONOMICAL UNION

## GENERAL ASSEMBLY IN DUBLIN

MORE than six hundred astronomers, from forty-one countries, attended the meetings in Dublin during August 29–September 3 of the International Astronomical Union, under the presidency of Prof. Otto Struve (Berkeley, California). The largest national delegation came from the United States, and there were also large groups from France, Germany and Great Britain. Among other representatives were about twenty from the U.S.S.R., the largest number of Russian astronomers yet to attend a meeting of the Union.

The International Astronomical Union was founded in 1920, holding its first meetings in Rome in 1922, and can claim to be one of the oldest and most successful of the international scientific unions. It was born amid political difficulties created by the First World War, and since then has had to contend with the growing tensions of the 1930's, the disasters of the 1940's, and the ill-feeling of the early 1950's. Despite these troubles, astronomers have held steadily to the belief that full and effective international co-operation is essential for the well-being of their science. In consequence, the Union has managed to survive and grow; it has a record of substantial achievement, and the recent meeting was attended by more astronomers, and was perhaps marked by more general cordiality, than any previous one.

Since 1920 astronomy has developed enormously. Perhaps it may be recalled that at that time the structure of the Milky Way system was mostly unknown, the extragalactic character of the spiral nebulæ was not universally accepted, interstellar matter was regarded as quite negligible, and the theoretical basis of present-day astrophysics was only just beginning to come into existence. It is not entirely surprising that the original organization of commissions, each dealing with its own special branch of the subject, which has worked tolerably well for thirty-five years, is now requiring reform. At the beginning there were about thirty commissions, each a fairly compact group of about a dozen members. This year there were forty commissions, with an average membership of about forty, as well as fifteen sub-commissions. Some commissions have become much too large to be effective and a great deal of their work has in recent years been done by the sub-commissions. To meet this difficulty of unregulated growth, the General Assembly has taken the important decision that in future the International Astronomical Union shall consist of a main body of ordinary members and a comparatively small body of commission members. The details of the transition from the present arrangements have still to be worked out.

In his address at the inaugural ceremony this year, Prof. Struve reminded his audience of the speech of his predecessor Prof. W. W. Campbell, in 1925, in which it was pointed out that the Union was not to be an international society to provide the opportunity for the reading of papers describing work already done and results already obtained, this function being well taken care of by existing national societies, but should have other and broader aims, especially "(1) To facilitate the relations between astronomers of different countries where international co-operation is necessary or useful; (2) To promote the study of astronomy in all its departments". At recent meetings there has been a tendency to forget these early ideals and to devote too much time to the reading of formal papers in rapid succession, a procedure calculated to give early intellectual indigestion to the great majority of hearers. Prof. Struve's remarks were welcomed by the growing body of members who have deplored this tendency, and who have themselves generally found greater profit in informal discussions, both within commissions and without, with colleagues from distant countries whom they rarely see except at these meetings.

In the commissions dealing with solar and terrestrial matters, considerable attention was given to plans for the International Geophysical Year of 1957–58. Some members raised doubts as to the practicability of completing with the available labour force all the ambitious and comprehensive series of observations proposed, still less the subsequent reductions and computations. On one hand, astronomical problems are greatly increasing in number and complexity and demand an ever-increasing number of workers; on the other, some countries are now facing a famine in young scientists having a basic training in mathematics or physics, and this is already causing serious concern to the directors of observatories and other astronomical institutions. This growing difficulty affects not only the coming International Geophysical Year but also nearly all branches of observational astronomy, especially those involving long series of observations or measurements.

A number of joint meetings and symposia were held, for the most part well organized and with plenty of time for discussion. The subjects included non-stable stars, the large-scale structure of the galactic system, solar flares, photoelectric image tubes, turbulence in stellar atmospheres, and fundamental stars. The discussions showed generally a commendable restraint in the interpretation of new observations and discoveries, with the emphasis more on the bewildering complexity of astronomical phenomena than on our progress in understanding them. There were no signs of the pseudo-omniscience which often colours popular writing in astronomy and which does the subject no little harm with critical readers.

Among recent results announced at the meetings a few call for special mention. Photographs of the solar spectrum showing extremely clearly the variation of line shifts and line profiles over the coarse granulation have been made at the McMath Observatory with a new large grating spectrograph giving a resolving power greater than 500,000. Remarkable films of solar flares, also photographed at the McMath Observatory, aroused much interest. Recent rocket flights in the United States have provided photographs of the solar spectrum into the ultra-violet beyond $L\beta$. The rotation of the Large Magellanic Cloud has been measured at the Radcliffe Observatory, Pretoria. Evidence for the very recent formation of certain stars has been found by workers at the Lick Observatory. Photometric measures made at Mount Wilson of the old nova, *DQ* Herculis, now an eclipsing binary, have shown at some phases a remarkable regular pulsation with a period of a little more than one minute.

A few resolutions of more general interest may be mentioned out of the many submitted by commissions and approved by the General Assembly. With regard to notation, A is to be preferred to Å as an abbreviation for the angstrom unit; 'kayser' is rejected in favour of cm.$^{-1}$. Two proposals of the International Committee on Weights and Measures were endorsed, one relating to a re-definition of the metre in terms of the wave-length of the red cadmium line, the other (which may very soon be made obsolete by recent work with cæsium resonators) defining the second as 1/31 556 925·975 of the tropical year for 1900·0. A number of recommendations were made concerning secondary wave-length standards of iron, neon, and argon. Strong support was given to the efforts of the International Scientific Radio Union to obtain frequency-bands for the use of radio astronomers, free of interfering radio transmissions.

The recognition that photoelectric image tubes may ultimately give considerably greater speed for faint sources than the ordinary photographic process, and that they promise to be of the greatest importance to astronomers, has led to the formation of a new sub-commission to encourage developments in this field. Other new sub-commissions have been formed on 'seeing', on meteorites, on variable stars in globular clusters, on the determination of the galactic pole and the zero of galactic longitude. Two commissions and four sub-commissions have been abolished.

The new president of the Union is to be Dr. A. Danjon, director of the Paris Observatory. He will hold office until the 1958 meetings, which on the invitation of the National Academy of Sciences of the U.S.S.R. will be held in Moscow. The U.S. National Committee has issued an invitation to hold the 1961 meetings in Pasadena.

At the concluding session of the General Assembly, warm appreciation was expressed of the hospitality of the Irish Government, of University College, the Institute for Advanced Studies, the Dunsink Observatory, and other institutions in Dublin. That the meetings were so successful and enjoyable was due in large part to the efforts of the Dublin organizers and their helpers, efficiently and energetically led by Prof. and Mrs. H. A. Brück. R. O. Redman

# OBITUARIES

## Prof. V. A. Dogiel

Prof. Valentine Alexandrovitch Dogiel, who died on June 1, was the most outstanding Russian protozoologist of our times. Born in Kazan on March 10, 1882, he was the son of the eminent histologist, Prof. A. S. Dogiel, whose investigations on the minute structure of the nervous system are known throughout the world. V. A. Dogiel received his training in protozoology from V. T. Schewiakoff, whom he succeeded in 1913 as professor of invertebrate zoology in the University of St. Petersburg (now Leningrad), a post which he occupied until the end of his days. On his election as corresponding member of the Academy of Sciences of the U.S.S.R. in 1939, Dogiel also took charge of the protistological laboratory of its Zoological Institute.

Among Dogiel's earlier works (1916–23), those dealing with the parasitic flagellates of termites are noteworthy; but his most important contributions concern the systematics, morphology, and evolution of the Ophryoscolecid ciliates of ruminants. Dogiel's protozoological work culminated in the publication of a remarkable treatise on "General Protistology" (1951), providing a comprehensive, critical account of the fundamental principles and problems of protozoology.

From 1930 onwards Dogiel's researches were directed to the ecological aspects of parasitology, especially the effect upon the parasitic fauna of changes in the environment and physiology of their hosts. In 1941 he produced a "Textbook of General Parasitology", a second edition of which appeared in 1947. This book, which is devoted to the biology of parasites, is an outstanding contribution to parasitological literature, unique in conception and masterly in presentation. Dogiel was also the author of a "Textbook of Invertebrate Zoology" (four editions, 1934–47) and of a "Handbook of Comparative Anatomy of the Invertebrates" (1938–40), both of which are standard university text-books in the U.S.S.R. Finally, a year before his death (1954) he published a book on "Oligomerization of Homologous Organs: One of the Main Paths of Animal Evolution", in which he develops the idea that various groups of Metazoa have evolved by a gradual diminution, or oligomerization, in the number of homologous and homodynamic organs which were present in their ancestors.

During the forty-two years of his tenure of the chair of zoology in Leningrad, Dogiel built up a school of protozoology and parasitology, to which numerous students (including the present writer) owe their training in these subjects.

C. A. Hoare

## Prof. C. F. W. McClure

Prof. C. F. W. McClure, the distinguished American comparative anatomist and embryologist, whose death has recently been announced in his ninetieth year, was born in Cambridge, Massachusetts, in 1865. After an undergraduate career in Princeton, he studied at Columbia University in New York and in Berlin, Kiel and Würzburg. His academic career, however, was essentially linked with Princeton, where he was successively instructor in biology and assistant professor. In 1901 he was appointed to the chair of comparative anatomy in Princeton, and held that professorship with great distinction until his retirement in 1934.

In his early investigative work McClure inclined to neurology, and he published work on the brain of primitive vertebrates and on the structure of nerve cells in molluscs. His association with Prof. G. S. Huntington, however, led his interests into the field of the morphology and the functional anatomy of blood vessels and the lymphatic system. The collaboration led to classic accounts of the development of the mammalian inferior vena cava, accounts which really deserve the adjective exhaustive. The work with Huntington also resulted in a large number of publications on the early differentiation of lymphatic vessels. These contributions, in which it was insisted that lymphatic vessels can differentiate *in situ* from the embryonic mesenchyme, represented one side of a controversy that shook American anatomy during a period of years, for Dr. Florence Sabin's point of view, that lymph vessels arose only by centrifugal extension of endothelium from veins, was strongly supported by the powerful Johns Hopkins group of investigators. Strangely, the polemics on this problem were almost completely restricted to workers in the United States, possibly because of the preoccupation of European anatomists during the First World War. It was, however, a rewarding controversy, out of which much knowledge and some new techniques emerged.

McClure had been president of the American Association of Anatomists and for many years was a member of the Anatomical Society of Great Britain and Ireland. His distinction in his chosen field of work was such that he was included in the Cattell group of the leading thousand students of science of the United States as early as 1906.

J. D. BOYD

## Prof. C. T. Brues

CHARLES THOMAS BRUES was born in West Virginia in 1879, took his first degree at the University of Texas, and briefly held appointments at Columbia, with the U.S. Department of Agriculture, and at the Milwaukee Public Museum. At the age of thirty, he went to Harvard as instructor in entomology under Wheeler, and he spent the remainder of his working life there. To be an entomologist in 1909 meant to be a systematist; and Brues was soon a recognized authority on several families of Hymenoptera and Diptera. During this phase he published his catalogue of African Braconidae, the volume on Phoridae in the Genera Insectorum and, with A. L. Melander, the first edition of their well-known "Key to the Families of North American Insects". But Brues was also a naturalist and his interests gradually developed along two principal lines: the fauna of hot springs, and the correlation of systematic affinities with food habits. Food selection by insects increasingly occupied his attention. He wrote several important papers about it, interesting and valuable both to economic and academic entomologists; and finally, in 1946, summarized the whole field in his useful book, "Insect Dietary".

As a teacher of graduate students at the Bussey Institution, Brues was characterized by his helpfulness. His room was always open and he seemed cheerfully ready to put aside his own work and to lend himself, his mind, hands, time and tools, to his students. He was skilful in many small crafts and his skill was there to be called upon. In conversation and at symposia he rarely criticized, but was ready with useful suggestions. This willing disposition led Brues to undertake much extra work. Single-handed he edited thirty-six annual volumes of the entomological journal *Psyche*, and he served on innumerable boards and committees.

Brues was a man who helped where help was needed without counting the cost to himself or looking for any return. His former pupils and colleagues in many parts of the world will hear with regret that he died on July 29 in his seventy-seventh year, and will think of him with gratitude and affection.

GEORGE SALT

## Dr. S. G. P. Plant

DR. S. G. P. PLANT, who was senior lecturer and demonstrator at the Dyson Perrins Laboratory and secretary to the Delegates of the Oxford University Museum, died at Oxford on September 10.

Sydney Glenn Preston Plant was born at Leicester in 1896. He was educated at Wyggeston Grammar School and, in 1915, went up to Oxford as a Scholar of St. John's College, where he read for the final honour school of chemistry. As a young graduate he worked first under Dr. N. V. Sidgwick and later, as a senior demy of Magdalen College, under Prof W. H. Perkin. He became a lecturer and demonstrator at the Dyson Perrins Laboratory, and since 1928 he had also been secretary to the Delegates of the Oxford University Museum. He served on the Council of the Chemical Society and on its publication committee, and he contributed many papers to its journal. He had, for many years, been treasurer of the Ashmolean Natural History Society.

Dr. Plant's interest in indoles and carbazoles grew out of his early work with Perkin, and he and his pupils have contributed much to our knowledge of this field of heterocyclic chemistry. He published a long series of papers on the substitution and addition reactions of the indole nucleus and the determination of the position of substituents in indoles and carbazoles. It is worthy of note that he discovered some of the first-known covalent derivatives of the alkali metals, compounds of great interest to Sidgwick in his early work on the electronic theory of valency.

But it is, perhaps, as a lecturer and tutor that Plant will be best remembered. His great love of chemistry and his outstanding powers of lucid exposition have inspired, year after year, numbers of undergraduates; many of them began their researches with him and are better chemists for the excellent training they received under his keen and kindly supervision. He found scope for his real flair for organization at the Museum, and there, too, his unfailing good judgment, his tolerance and his delightful sense of humour stood him in good stead. He was as adept at dealing with the gratuitous communications of the discoverers of perpetual motion as with the everyday business of the Museum. A quiet and kindly man, he was liked and respected by all who knew him; he will be long remembered in Oxford, particularly at the Dyson Perrins Laboratory to which he gave such devoted service.

He married, in 1924, Winifred, daughter of William Crawford of Leicester. He is survived by her and by their two daughters.

J. C. SMITH
M. L. TOMLINSON

# NEWS and VIEWS

## Microbiology in the Department of Agriculture, Canada: Dr. A. G. Lochhead

Dr. A. G. Lochhead retired on June 21 from his post as chief of the Bacteriology Division, Science Service, Department of Agriculture, Ottawa, Canada, to devote his full time to research. Dr. Lochhead studied first at McGill University; during 1912 he completed the requirements for the Ph.D. degree at the University of Leipzig, but the outbreak of the First World War not only prevented his receiving the degree but also resulted in his internment in Germany for the duration of the War. However, his academic work and thesis were accepted by McGill University on his return to Canada in 1918. After lecturing in bacteriology at Macdonald College, McGill University, he left academic work for several years and gained valuable experience in industry by joining the staff of the Canadian Milk Products, Ltd., Toronto, and the Malt Products Company of Canada, Ltd., as bacteriologist-chemist. For a year he was lecturer in biochemistry in the University of Alberta. In 1923 he joined the Department of Agriculture as chief of the Division of Bacteriology, Experimental Farms Service. With the amalgamation in 1938 of the Dairy Research Division of the Dairy and Cold Storage Branch, he became chief of the Division of Bacteriology and Dairy Research. Through his leadership the Division has become widely known as a centre of fundamental research in soil microbiology, especially in regard to the relationship between the soil microflora and plant roots, and for his pioneering investigations on the classification, nutrition and growth factor requirements of the bacterial population of the soil. This devotion to the study of the soil microflora has not prevented his attacking other problems in microbiology and achieving recognition in specialized fields such as that dealing with the description, classification, nutrition and metabolic activities of sugar-tolerant (osmophilic) yeasts, with the microbiology and fermentation of honey, with the etiological agents of foulbrood of the honey bee and with halophilic bacteria. His rare critical faculties, his keen logic and his acute powers of observation have been combined with a most enviable talent for writing; his gentle and courteous treatment of everyone with whom he comes in contact has made him loved by all. He was president during 1953–54 of the Canadian Society of Microbiologists.

### Dr. H. Katznelson

Dr. H. Katznelson, principal bacteriologist of the Bacteriology Division, Science Service, Department of Agriculture, Ottawa, Canada, has succeeded Dr. A. G. Lochhead. Dr. Katznelson was born in a Russian village near the Polish border in 1912. At the age of eight his family settled in Vancouver, B.C., Canada. Katznelson studied bacteriology at the University of British Columbia, where he specialized in soil bacteriology, and at Rutgers University. This was followed by a year at Cornell University, and at the outbreak of the Second World War he returned to Canada to join the staff of the Division of Bacteriology and Dairy Research, Science Service, under Dr. Lochhead. Although Dr. Katznelson's main interest was in soil microbiology, he was able to carry out studies on a variety of problems ranging from antibiotics and bacterial viruses to diseases of the honey bee. His contributions to the control of these diseases, including the use of fumagillin to control Nosema disease and of antibiotics such as terramycin for American and European foulbroods, are well known. During the War he was engaged, in co-operation with the National Research Council of Canada, in studies on the microbiological production of 2,3-butylene glycol, a precursor of synthetic rubber. After this he turned to bacterial nutrition and physiology, with a few sorties into dairy bacteriology, where he and others on the staff demonstrated the significance of bacteriophage and antibiotics in cheesemaking. His own interest in bacterial viruses led to the development of a diagnostic procedure for detecting bacterial plant pathogens in seed which is used in various countries. After spending a year studying bacterial metabolism at Stanford University, Katznelson was made head of the Unit of General Agricultural Microbiology. He is at present particularly interested in problems of soil microbiology, halophilic bacteria, the metabolism and diagnosis of bacterial plant pathogens, diseases of the honey bee and tobacco fermentation.

## Physical Chemistry in the University of the Witwatersrand: Prof. J. O'M. Bockris

Prof. J. O'M. Bockris has been appointed to the newly created chair of physical chemistry in the University of the Witwatersrand, Johannesburg. Prof. Bockris graduated in 1943 from the Imperial College of Science and Technology, London, and continued there, working on electrode processes. In 1945 he was appointed to the staff of the College; for eight years from 1946 onwards he led a large research team on electrochemical problems, and this team carried out work in the following fields: the evaluation of the effect of trace impurities on electrode processes; the evaluation and application of diagnostic criteria in the determination of the mechanism of electrode processes (particularly in hydrogen and oxygen evolution); the technique of quantitative physico-chemical measurements at temperatures up to 2,000° C., leading to the establishment of the ionic nature and detailed lattice structure of the liquid silicates; and the application of statistical mechanical methods in electrochemistry—for example, the absolute calculation of electrode reaction-rates, the theory of salting in, and the mechanism of proton transport. Some work of an applied electrochemical nature was also undertaken, supported by both British and United States government and industrial bodies. During 1953–54 Prof. Bockris held a visiting professorship in the University of Pennsylvania and was later appointed professor of chemistry there. He is co-author of a text-book of electrochemistry, editor of "Modern Aspects of Electrochemistry", and co-author of the *Proceedings* of the International Committee for Electrochemical Thermodynamics and Kinetics.

## New National Parks in Great Britain

Designation orders have been made by the National Parks Commission for the ninth and tenth national parks, the orders being still subject to confirmation by the Minister of Housing and Local Government. The parks in question are the Northumberland National Park, incorporating the Forestry Commission's Border Forest Park, and the Brecon Beacons National Park. The Northumberland National Park comprises most of the upland country of Northumberland, from the Cheviots in the north to the Roman Wall in the south; part of its western boundary marches with the Forestry Commission's Kielder Forest, and this forest and the adjoining ones of Kershope in Cumberland and Newcastleton and Wauchope in Roxburghshire have been declared a national forest park, to be known as the Border Forest Park, by the Forestry Commission. The forest plantations will be opened to the public as soon as is practicable; in some cases this stage has already been reached, but new plantations will have to be protected for a number of years to come. The Brecon Beacons National Park, which comprises a total area of approximately 515 square miles, lying within the counties of Brecon, Carmarthen and Monmouth, is the third such park in Wales. It is one of the lesser-known of Britain's mountain areas, but none the less contains some of the finest scenery of South Wales, and indeed of Great Britain. The River Usk offers some of the finest salmon-fishing outside Scotland, and there is also fishing in the Llangorse Lake under the shadow of the Black Mountains, where many varieties of wild fowl are to be found. Some old and interesting towns lie within the park, including Brecon itself with its cathedral and the once-walled market town of Hay-on-Wye; sites of Roman and ancient British settlements abound, and there are several fine Norman and medieval castles, interesting churches and country houses.

## Research in the Belgian Congo

Workers at the Institute for Scientific Research in Central Africa, Bukavu, Belgian Congo, have produced more than three hundred and fifty original papers in the biological, social and physical sciences since 1948. Those directing the policy of the Institute decided at the outset not to publish a special journal, but to send their contributions to recognized periodicals, usually in Belgium although, where appropriate, in other countries also. They felt that a separate journal would contain too diverse a collection of papers to be generally useful and might tend to isolate the workers at the Institute, already geographically at something of a disadvantage, from their fellow scientists in other countries. The Institute has now started to issue quarterly its *Folia Scientifica Africae Centralis* (1, No. 1; 1955). This is not intended to compete with existing publications, but to supplement them and at the same time to make it easier for readers to grasp the scope of the work of the Institute. Four reasons for producing this publication are given. First, it will contain reports on the current programmes of the different sections, written in French and Flemish with a summary in English. Secondly, brief preliminary notes on new discoveries will be printed in French and English. Thirdly, there will be résumés in English of some of the more important papers by workers at the Institute appearing in Belgian and foreign journals. Finally, there will be annual lists of titles of new papers; the first number has a supplement of 360 titles, covering the period from 1948 to December 1954.

## Centro Appenninico, Terminillo: Biological Research Station in the Apennines

Some years ago the Italian National Research Council, at the instigation of Prof. Carlo Jucci, professor of zoology in the University of Pavia, decided to set up on Mount Terminillo, in the Apennines, a biological research station concerned with the pure and applied aspects of agricultural science, especially in their relation to the mountains (see *Nature*, 163, 811; 1949). This station, known as the Centro Appenninico, Terminillo, was formally inaugurated in August last year, and its work is now in full swing. It is situated in Terminillo, a village on the middle slopes of the mountain of the same name, which is a winter sports and also a summer resort, and for this reason enjoys good road communications, the bus trip from Rome, via Rieti, taking about three hours. The station stands on sloping grassland at 5,700 ft. (1,730 m.) at the lower limit of the zone of sub-alpine vegetation which extends to the top of the mountain at 7,300 ft. (reached in 1¼ hr. on foot). The winter climate is severe, with patches of snow still remaining on the mountain as late as May. The summer is never unduly hot but usually very dry, the rainfall being largely confined to the winter months. The Centre includes a meteorological station.

Cultivated plots for research purposes (mostly terraced owing to the steep slopes) are available close to the station itself, and also at 3,500 ft. half-way down to the plain; arrangements are being made for the use of a plot on the plain itself (about 1,200 ft.). There are six small laboratories equipped for standard work in microbiology, biochemistry, entomology, agrarian genetics, cryptogamic botany, cytogenetics and also physics. There are also a small museum and library. Board and lodging are available on the premises. The work so far undertaken at the Centre has been mainly concerned with the genetical study, and the improvement by selection for mountain environments, of crops which are important, or potentially important, to a hill population—especially the potato and the tomato. Hill pasture improvement has also been studied, and, as a minor mountain industry, the cultivation of medicinal herbs. It is hoped that the Centre will in time become well enough known abroad to attract numerous foreign workers in a much wider range of scientific activities, and assume an increasingly international character. Already a number of scientific meetings have been held there. Those interested in the Centre should write to the director, Prof. Carlo Jucci, at the Istituto di Zoologia della Università, Palazzo Botta, Pavia.

## World Power Conference: Report for 1954

The annual report for 1954 of the World Power Conference (pp. 17. London: World Power Conference, 1955) records the admission to membership of Paraguay, Spain and Thailand at the July 1954 meeting of the International Executive Council, bringing the membership to forty-three. The Brazilian Sectional Meeting of the Conference was held at Petrópolis, Rio de Janeiro, during July 25–31, 1954, being attended by 522 members from thirty-four countries, and the bound transactions were due for publication this year. The fifth World Power Conference will be held in Vienna during June 15–23, 1956, and a summary of the technical programme is appended to the report. "Statistical Year-book No. 7" of the Conference was published in July 1954, and the usual list of publications issued, or to be issued, under the auspices of the International Executive Council is also appended to the report, which includes a note on the twenty-first executive meeting of the International Commission on Large Dams of the World Power Conference. A new edition of the "List of National Committees and Representatives" was published in June, and the British National Committee has issued a list of twenty-six papers to be presented at the Fifth World Power Conference: these include three dealing with nuclear energy. Sir John Hacking was re-elected vice-chairman and Mr. F. G. Brewer honorary treasurer of the Committee at its recent annual general meeting, and Mr. C. E. Iliffe has been appointed to serve on the Committee as representative of the United Kingdom Atomic Energy Authority. A third impression of the fifth edition of "Technical Data on Fuel" was published in June.

### Statistical Aspects of the Nucleus

The proceedings of the conference on "Statistical Aspects of the Nucleus", held at the Brookhaven National Laboratory, Upton, New York, during January 24–26, 1955, were tape-recorded, and the uncorrected report of the talks and discussions produced from the recording has recently been published (pp. 113; obtainable from the Office of Technical Services, Department of Commerce, Washington 25, D.C.; 1955; n.p.). The conference consisted of four sessions devoted to low-energy scattering, elastic scattering, inelastic scattering and reactions I (residual nuclei in discrete states), and inelastic scattering and reactions II (residual nuclei in continuum states). The chairmen were E. P. Wigner, K. M. Watson, L. Wolfenstein and V. F. Weisskopf, respectively, and the speakers were E. Vogt, R. G. Thomas, K. M. Watson, D. S. Saxon, H. Feshbach, H. McManus and P. C. Gugelot. The proceedings concluded with a summing up by V. F. Weisskopf. The talks were obviously stimulating and produced lively discussion, which is all faithfully reproduced; but in the privacy of one's study the printed report appears to lack conciseness, and the essential points made by the speakers are lost in a bewildering mass of question and answer. As is pointed out in the foreword, editing was kept to a minimum in order to make the report available rapidly; but it is open to question whether the usefulness of the report has not been jeopardized by this course.

### Biochemical Activity of Pea-Seedling Mitochondria

D. D. Davies has reported the isolation of a diphosphopyridine nucleotide-specific *iso*citric dehydrogenase from pea-seedling mitochondria, a tenfold purification having been effected (*J. Exp. Bot.*, 6, No. 17, 212; 1955). In the presence of manganese the enzyme catalyses the oxidative decarboxylation of *d-iso*citrate to α-oxoglutarate and carbon dioxide, but under similar conditions does not catalyse the reverse reaction. Evidence is presented indicating that —SH groups of the enzyme are essential for activity. The properties of the enzyme are described.

### Reactions to Potato Virus Y

An account has been given of the reactions of certain Solanaceae to strains of potato virus *Y* by J. Munro (*Canad. J. Bot.*, 33, No. 4, 355; 1955). Strains of potato virus *Y* that were not clearly differentiated from each other by their reaction on potato varieties were shown to be separate entities by the differing reactions that they caused in several other solanaceous species. One strain did not infect *Physalis floridana*, but this same strain caused necrosis and a severe distortion of the young leaves of *Nicotiana sanderae*. After infection with certain other strains, *N. rustica* showed leaf-drop streak symptoms; this observation has not been previously reported. An avirulent strain in all potato varieties and seedlings tested so far caused a severely necrotic disease in *N. tabacum* and other *Nicotiana* species. The author notes that isolates of potato virus *Y* can only be recognized as mutants when they have ceased to cause the symptoms peculiar to this virus in certain homozygous hosts. During the course of this work the different strains remained constant by this criterion, and there was no evidence that mutations or changes frequently arise from this virus. However, the fact that several distinct strains were picked up in the field without difficulty indicates that changes may commonly occur.

### Cytology and Taxonomy of Ceylon Pteridophyta

As a further contribution to our understanding of the relationships between cytology and evolution in pteridophytes, I. Manton and W. A. Sledge (*Phil. Trans. Roy. Soc.*, B, 238, 127; 1954) have made a considerable study of fern material, largely collected by them in Ceylon, but also from other countries. In all, in the present work, cytological observations on 155 entities, referred provisionally to about 140 existing taxa in the fern flora of Ceylon, together with some sixty-nine entities from other sources, chiefly Malaya, are reported. A list of chromosome numbers is given, with an indication of the ploidy, or possible ploidy, of each species. The paper is illustrated by some silhouettes of plants, or leaves, and by a large number of diagrams and photographs of chromosomes. In discussing their findings, the authors consider that the new facts justify the view that cytology "will be at least as helpful in unravelling groups of difficult species in the tropics as it has long been known to be in temperate latitudes". The cytological data are considered in relation to the taxonomic systems of Copeland and of Holttum, and in a number of species and genera the authors have been able to indicate the need for revision. The distinctness of a number of little-known species has been confirmed, and apogamy has been demonstrated in a number of species. Two cases of putative intergeneric hybrids, from Ceylon and Malaya, have been investigated with confirmatory results. In the light of the new cytological information, the splitting of two of Copeland's families is recommended.

### Oil Reserves and the Petroleum Industry during 1954

The Annual Review for 1954 of the Esso Petroleum Co., Ltd., discloses some interesting economic facts concerning the industry generally and, in particular, the position of oil in Great Britain. Production of crude oil (world total) in 1954 was 2 per cent greater than in 1953, reaching 12·2 million barrels daily, due largely to progressive developments in the Middle East. Proved reserves of crude oil increased in 1954 by an amount more than enough to compensate for the total quantity of oil extracted. It is estimated that proved reserves "in the free world" amount to 147,000 million barrels (30 years consumption), of which the Middle East is likely to produce two-thirds. In Great Britain the growth of petroleum exports rose from a value of £6,900,000 in 1949, or one-seventh of the amount for coal, to £84,200,000 in 1954. Five years ago Great Britain refined less than half the petroleum products consumed. By 1952 the gap was closed. To-day there is a good surplus of home-refined products available for export.

### Coryndon Memorial Museum, Nairobi: Report for 1954

The annual report for 1954 of the Coryndon Memorial Museum, Nairobi (pp. 24+3 plates; 1955;

1*s*.), mentions that the continued state of emergency throughout the year has again been responsible for fewer visitors; but in view of the fact that few Africans could enter Nairobi, the reduction was not so much as was anticipated. Much curatorial work was accomplished, especially the development of a new Hall of Mammals, and work on transforming a large room into a Bird Gallery was in progress. Many important field trips were made for collecting, especially to a part of East Africa otherwise difficult of access and of great botanical interest. A well-preserved hand of a Miocene ape was found in blocks of limestone at Rusinga, and a nearly complete skull of a lemuroid was another important discovery. All this material is now being closely examined by a group of specialists.

## The Night Sky in October

FULL moon occurs on Oct. 1d. 19h. 17m., U.T., and new moon on Oct. 15d. 19h. 32m. The following conjunctions with the Moon take place: Oct. 11d. 16h., Jupiter 6° N.; Oct. 14d. 09h.; Mars 6° N.; Oct. 17d. 00h., Venus 4° N.; Oct. 18d. 05h., Saturn 4° N. In addition to these conjunctions with the Moon, Mercury is in conjunction with Venus on Oct. 8d. 08h., Mercury 4·3° S., and Venus is in conjunction with Saturn on Oct. 30d. 22h., Venus 2° S. Mercury is too close to the Sun during the greater part of October for observation, but towards the end of the month it rises about an hour and a half before sunrise and is visible for a short time in the eastern sky. Venus sets shortly after the Sun during the month and is not favourably placed for observation. Mars rises about 4h. 30m. throughout October and is visible in the constellation Leo in the early part of the month, moving later into Virgo, and is close to $\eta$ Virginis about October 19 and to $\gamma$ Virginis about October 28, its stellar magnitude remaining 2·0 during this time. Jupiter rises at 1h. 50m., 1h. 10m. and 0h. 20m. on October 1, 15 and 31, respectively. Its eastward movement in Leo is easily seen, and towards the end of the month it is very close to $\alpha$ Leonis. Its stellar magnitude varies from − 1·4 to − 1·5 owing to its distance from the Earth decreasing from 558 to 522 million miles during the month. Saturn sets at 19h. 10m., 18h. 15m. and 17h. 20m. on October 1, 15 and 31, respectively. Its eastward movement can be detected by noticing that it approaches $\gamma$ Librae during the month. Its stellar magnitude remains 0·8, although its distance from the Earth increases from 991 to 1,013 million miles during October. The Orionid meteor shower attains a maximum during October 20–23; the radiant at R.A. 6h. 24m., Dec. 15° N., near the north-east of the constellation Orion, is close to $\gamma$ Geminorum.

## Announcements

THE ninth Eddington Memorial Lecture will be given by Prof. R. B. Braithwaite, of King's College, Cambridge, on November 22, at 5.15 p.m., in Oxford. He will speak on "An Empiricist's View of the Nature of Religious Belief".

DR. W. B. LITTLER has been promoted to a chief scientific officer and appointed principal director of scientific research (defence), Ministry of Supply, in succession to Dr. W. Cawood, who is to become principal director of scientific research (air) on November 1.

DR. W. STEVEN has been appointed superintendent of the Development and Research Department Laboratory of the Mond Nickel Company, Ltd., Birmingham, in succession to the late Mr. Howard Evans. Dr. Steven, who is a graduate of the University of Glasgow, was for five years engaged in research and works control on tool steels, constructional steels and stainless steels at Wm. Jessop and Sons, Ltd., Sheffield. Then in July 1947 he joined the Mond Nickel Company, where he has been working on alloy steels and cast irons, particularly on transformation in steels and problems associated with spheroidal-graphite cast iron. He was at one time secretary of the Hardenability Sub-Committee of the Ministry of Supply Special and Alloy Steels Committee.

MR. F. S. O. BROUGHTON, assistant secretary of the Development Commission, has been appointed to succeed Mr. E. H. E. Havelock as secretary of the Commission. Mr. Havelock will continue to serve the Commission for a further period as secretary to a committee appointed to inquire into and advise upon the future organization of fishery research.

THE Science Museum, London, is showing for about six months a special exhibition on the evolution of the dividing machine. Until the middle of the eighteenth century, measuring scales of scientific and other instruments were divided by hand or by the use of a dividing plate, but in 1775 Jesse Ramsden built a successful dividing engine which divided circular scales mechanically. Since his time progress has been in the direction of automatic operation of the machines and increased accuracy of their work. The eight circular dividing machines to be shown range in date from 1778 to 1955, and two of them will be shown in operation.

DR. GABRIEL KRON will deliver three lectures at the Imperial College of Science and Technology, London, on the "Method of Tearing" on October 7 and 8. He will discuss a technique for the numerical and analytical solution of complex physical systems such as large electrical networks and large mechanical structures. Further particulars can be obtained from the Deputy Registrar, City and Guilds College, Imperial College, London, S.W.7.

THE annual reports for 1954 of the British Rubber Development Board and of Rubber Technical Developments, Ltd. (pp. 47 and 15, respectively; from the Board at Market Buildings, Mark Lane, London, E.C.3), refer to progress in the development of unwoven fabrics bonded with rubber deposited from latex, the use of rubber in roadmaking, rubber rail pads (inserted between rail and sleeper), and the use of latex foam in furniture.

THE Electron Microscopy Group of the Institute of Physics is arranging a conference on "The Electron Microscopy of Textile and Other Industrial Fibres", to be held in the University of Leeds during January 3–4. The main groups of topics it is hoped to discuss are specimen techniques, the fine structure of cellulose, synthetic and protein fibres and the surface properties of fibres. Correspondence relating to the conference should be addressed to Dr. J. Sikorski, Textile Physics Laboratory, University, Leeds 2, and sent to him as soon as possible.

IN *Nature* of September 17, p. 526, there was a review of "Michael Tswett's First Paper on Chromatography", issued by M. Woelm, of Eschwege. L. Light and Co., Ltd., Poyle Estate, Colnbrook, Bucks, are the British agents for M. Woelm for the sale of their activated alumina for chromatography, and they have a few copies of the brochure; it is free of charge.

# MAN AND HIS MACHINES

SECTION L (Education) of the British Association organized on the afternoon of September 2 a symposium on the automatic age under the title of "Man and his Machines". Three papers were presented before an audience of 350–400 in the following order: (1) "New Concepts of Science and Advanced Industrial Techniques", by Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research; (2) "The Training of Technicians for the Automatic Age", by Dr. J. E. Richardson, principal, Northampton Polytechnic, London; (3) "Automation and Education", by Mr. H. A. Rée, headmaster of Watford Grammar School.

Sir Ben Lockspeiser said that automation has come along because fundamentally "People turn to machines to save themselves trouble, and as few want to do more arithmetic than they must, they have always been on the lookout for devices to make arithmetic easier". He surveyed the development of computers from the days of Charles Babbage to the elaborate electronic machines of to-day which have been given the label of 'electronic brains'. He sees some justification for the label though it can be misleading, and spoke of their very reliable memories, built-in facilities of judgment and fantastic speeds. The applications of these machines are far-reaching in their consequences and already include: passenger reservations at La Guardia Airport, New York; mail-order business in an American firm, where with its aid ten clerks handle 80,000 orders a day covering 12,000 different items; commercial operations at Messrs. J. Lyons and Co., Ltd., in preparing the pay-roll for 10,000 employees as well as a large variety of other requirements.

Sir Ben foresees an end to the vast and otherwise increasing volume of paper-work which has been the bane of large business houses; in its place will come the automatic routing of information, resulting in the replacement of intelligent guessing by exact information, and the bringing in of efficiency in direction and economy of practice.

Turning from computers to production, Sir Ben sees the counterpart of the automatic control of fluids in the oil, chemical and food industries in the new handling machines for transferring work from one operation to another. These techniques, introduced by Morris Motors so far back as 1923, have now been developed considerably, not only in the United States but also in Britain and on the Continent, especially in connexion with the automobile industry.

As a digression, it may be mentioned that on the previous day, Mr. Alec Rodger, of Birkbeck College, London, had told Section J (Psychology) that in a Moscow factory making pistons for the whole of the Russian light-car industry, only nine men were employed per shift.

Sir Ben concluded by saying that the fruits of fully automatic production will only be gathered by a population substantially upgraded in skill and intellect. There would be a need for many more scientists and technologists than are available at present. In Great Britain, this involves a sufficient number of good-quality teachers of mathematics and science for the schools of the country.

Dr. Richardson's paper covered the much narrower field of the resources of the technical colleges of Britain to cope with the training of technicians for the automatic age. He sounded a note of optimism based on the following factors:

(1) Automation is neither new nor sudden in its appearance.

(2) The first industrial revolution saw both mechanization and automation (for example, mule spinning and jacquard weaving) without the aid of technical colleges as we now know them. The second industrial revolution, as some are naming the present phase, will, however, be served by a nation-wide system of colleges second to none in any other country.

(3) The present numbers of B.Sc. degrees, Higher National Certificates and City and Guilds of London Institute certificates gained in the technical colleges of Britain are most impressive. Of perhaps even greater significance in the present context is the large number and variety of short courses in advanced studies designed to take well-qualified men to higher levels of study in subjects already covered, or into new subjects not previously studied. Many of these subjects are concerned with electronics, computers, automatic process control, servo-mechanisms, and the like.

On the question of the numbers of technicians required, Dr. Richardson believes that they will preponderate over other grades of employee, but he does not think the total numbers will be alarmingly great. If automation were to reduce the number of workers needed as drastically as many claim, the total numbers could scarcely increase. The electrical industry, it is said, uses personnel in the ratio of 1 : 5 : 8 for professional engineers, technicians and craftsmen respectively. Dr. Richardson hazarded the opinion that the ratio might become 1 : 3 : 2.

Despite the reasonably satisfactory state of affairs in the technical colleges of Britain, Dr. Richardson mentioned six essential requirements for the changing emphasis brought in by automation. These are: large laboratories for pilot plant; smaller laboratories adequately equipped with the latest gadgets; closer integration with industry in the planning and running of courses; generous financial provision which would take as normal a piece of equipment costing £25,000 such as the computer he hopes to instal in the Northampton Polytechnic in the near future; abolition of restrictive practices by boundary-conscious local education authorities; adequate salary scales for staffs.

Mr. Harry Rée's contribution was entirely different from the preceding in that philosophical and humanistic considerations replaced scientific and technical factors. Dealing with the contribution of the schools, he wondered in the first place where all the extra technicians are to come from. From the grammar and public schools, he said, they can only come by decreasing the number of arts students. From the modern secondary schools, in which are to be found some 80 per cent of the nation's children, only a mere trickle can be expected of those capable of reaching graduate or Higher National Certificate level. Maybe on the short-term issue, British parents had anticipated the need by the increased birth-rate in early 1940's.

After expressing the fear that technical colleges are not educational institutions but teaching shops, he emphasized that "in building a world where machines do the work which used to be done by men, it is not good enough to build men who can only work like machines. It is not enough to produce managers who know *how* to increase production; of far greater importance is it to produce managers who know *why* they should increase production, or even *whether* they should".

To the recognized "deeply humanizing, deep moral importance of liberal studies", Mr. Rée added the less recognized importance of planned and wisely used leisure. He warned that "To an ever increasing extent we have handed over the organization of our spare time to those who can make money out of us, to the purveyors of entertainment, to those who can offer us diversion without exertion, and hour after hour we are content to watch, to listen and to consume".

He concluded by envisaging the great contribution educational institutions could make by a counter attack on the creeping disease of passive pleasures which is eating away the soul of modern man. "If we could make the effort, all these things (commercial entertainment, ostentatious expenditure, slot machines and cinemascopes) could be swept away and we should look upon automatic factories and computing machines as our benefactors enabling us and our children to taste to the full the real joys of life."

In the discussion which followed, the suggestion was made that we may have to look to women to swell the force of technicians. Sir Ben Lockspeiser disagreed with Dr. Richardson's complacency on numbers; he emphasized that every technical industry, including government departments, is crying out increasingly for more and more technicians. He concluded by warning his audience that automation is not before us as a choice—it is a sheer necessity. Without automation we cannot increase production, without increased production we cannot remain competitive, without trade we shall perish.

J. E. RICHARDSON

# THIRD INTERNATIONAL CONGRESS OF BIOCHEMISTRY

THE Third International Congress of Biochemistry was held in Brussels during August 1–6, under the presidency of Prof. E. J. Bigwood, and was attended by more than seventeen hundred delegates from all parts of the world. The official opening on August 1 was followed by the inaugural lecture, given at the Palais des Beaux-Arts by C. Martius, of Würtzburg, his subject being "Thyroxin und oxidative Phosphorylierung". On the evening of the same day the official reception was held at the Musées Royaux d'Art et d'Histoire du Cinquantenaire, and was preceded by a tour of the exhibits.

Besides the opening and closing lectures, formal lectures were given by P. S. Sarma (India) on biochemical aspects of *Corcyra* nutrition; R. H. S. Thompson (Great Britain) on biochemical disorders in peripheral neuritis; N. M. Sissakian (U.S.S.R.) on biochemical properties of plastids; P. H. Bell and R. G. Shepherd (United States) on purification and structure of β-corticotrophin and its active degradation products; P. Grabar (France) on the study of mixtures of proteins by electrophoretic and immunoelectrophoretic analysis in gels; and L. Seekles (Holland) on the role of the trace elements in nutrition. F. B. Straub (Hungary), who was also due to speak, was unable to attend.

The remainder of the scientific programme was divided into two classes of communications which were concurrent. These were, first, report sessions, which consisted of reviews given by workers in the various fields, and which were followed by prepared discussions by invited speakers who had been provided with advance copies of the talks; and, secondly, the scientific communications proper, which were short papers dealing with recent research.

The reports, most of which were printed and circulated to members of the Congress beforehand in the form of a most useful booklet, covered a wide field ranging from pure chemistry, on one hand, to pure biology on the other. The subjects discussed included the biosynthesis of peptides (H. Borsook), photosynthesis (M. Calvin), transmethylation (G. L. Cantoni), formation of organic acids in moulds (E. B. Chain), growth stimulation by antibiotics (M. E. Coates and S. K. Kon), antibiotic polypeptides (L. C. Craig), proteolytic enzymes (P. Desnuelle and M. Rovery), hexose monophosphate oxidation (F. Dickens), physical chemistry of deoxyribonucleic acid (P. Doty and N. Simmons; C. Sadron), structure of polypeptides and proteins (A. Elliot), genetic function of deoxyribonucleic acid (H. Ephrussi-Taylor; O. Maaloe), incorporation of amino-acids in the presence of ribonucleic acid fragments (E. F. Gale), amino-aciduria (H. Harris), effects of ionizing radiation (G. Hevesy and A. Forssberg), antimetabolites related to purines (G. H. Hitchings and G. B. Elion), mucopolysaccharides (R. W. Jeanloz), carbamyl phosphate (M. E. Jones, L. Spector and F. Lipmann), energetic coupling (H. Lardy), uridine coenzymes (L. F. Leloir), metalloflavoproteins (H. R. Mahler), ribonucleic acids (R. Markham), determination of steroids (G. F. Marrian), biochemistry of the nucleus (A. E. Mirsky), brain biochemistry (A. V. Palladine; A. J. Rosenberg), skeletal muscle metabolism (S. V. Perry), antibiotics and intestinal flora (L. Y. Quinn), biochemistry of anæsthesia (J. H. Quastel), aseptic breeding of rats (J. Reyniers), bacterial cell structure (M. R. J. Salton), cell structure and metabolism (W. C. Schneider), porphyrin biosynthesis (D. Shemin), respiratory chain phosphorylation (E. C. Slater), respiratory adaptation (P. Slonimski), enzymic adaptation (S. Spiegelman), antibiotics and nutrition (E. L. R. Stokstad), hormonal regulatory mechanisms (E. W. Sutherland), ion transport (H. H. Ussing and B. Andersen), nitrogen fixation (A. I. Virtanen), muscle and cell contraction (H. H. Weber) and the chemistry of nerve activity (I. B. Wilson).

The original communications, which numbered more than eight hundred in all, were given in seventeen sections: organic chemistry of substances of biological interest; chemistry and physical chemistry of proteins and polypeptides; chemistry and physical chemistry of nucleoproteins and nucleic acids; enzymology; intermediary metabolism; cellular oxidation and oxidative phosphorylation; biochemical regulation; cellular biochemistry; biochemistry of muscle and the central nervous system; chemical microbiology; plant and soil biochemistry; zoological chemistry; nutrition; pathological chemistry and immunochemistry; pharmacological chemistry; clinical chemistry; and industrial biochemistry. Such a division into sections is somewhat arbitrary and, consequently, related papers were to be found in several different sections. A gallant and partly successful attempt to overcome this deficiency was made by the organizers, who provided the delegates with a timetable for each day and who enforced a most rigid control over the time taken by each speaker. However, on occasion, as many as twenty choices were afforded at any one time, in as many different places, and it is unlikely that anyone managed to attend all the papers which he wished to hear.

An excellent item of organization, and one which can be recommended to organizers of future congresses of this size, was the provision of ample space for informal meetings between delegates, both at the Congress headquarters at the University of Brussels and in the adjacent Cité Universitaire, where all manner of facilities were provided.

In addition to the opening reception a number of social activities were arranged, the main one being a concert given by the Belgian National Orchestra at the Palais des Beaux-Arts. There was no formal Congress banquet, but some informal sectional dinners were given, and the International Association of Clinical Chemistry arranged a banquet open to all members of the Congress. Both the Russian and the Polish delegations gave receptions at their respective embassies, and these were attended by guests from both sides of the Atlantic. An exhibition of scientific equipment was given at the Congress headquarters, and a number of British scientific equipment manufacturers were represented. The closing lecture was given by V. du Vigneaud (New York) on the isolation and proof of structure of the vasopressins and the synthesis of octapeptide amides with pressor-antidiuretic activity.

The next Congress will be held in Vienna in 1958.

# RADIATIVE BALANCE IN THE ATMOSPHERE

## ROYAL SOCIETY DISCUSSION

It is appropriate, in view of the forthcoming intensification of atmospheric research during the International Geophysical Year of 1957–58, to examine the present state of research in such a subject as radiative balance in the atmosphere, and a one-day discussion meeting on this subject was held in London at the Royal Society on June 9. In such a short period it was clearly out of the question to attempt any comprehensive survey, and attention was concentrated instead on subjects in which research is being actively pursued. Many of those who took part are contributors to the Gassiot Committee programme of research on photochemical equilibrium in the atmosphere. Two invited speakers from abroad, Dr. F. Möller (University of Mainz) and Dr. M. V. Migeotte (Institut d'Astrophysique, Liège), made interesting contributions. The programme was arranged so that the morning and early afternoon were mainly devoted to the lower atmosphere, up to and including the stratosphere, and the late afternoon to the higher levels of the atmosphere.

The discussion was introduced by Prof. H. S. W. Massey (University College, London), who first outlined the general nature of the radiation balance in the atmosphere and indicated the importance of the different absorption, emission and scattering processes which are involved. The second part of his talk was concerned with the temperature and pressure distribution in the atmosphere. These may be directly studied up to altitudes of 150 km. by means of instruments transported by rockets. Methods of measurement of pressure, temperature and density were outlined, and the interrelation of these three quantities was pointed out as a useful check on the results obtained. Special attention was directed by Prof. Massey to the way in which the rocket observations of pressure, taken above White Sands, New Mexico, agree well with results obtained by balloon flights up to altitudes of 24 km. The importance of further rocket measurements in different geographical locations was stressed.

Dr. Moller next discussed the pattern of radiative heating and cooling in the troposphere and lower stratosphere. After describing the distribution of temperature and of the cooling-rate by water vapour in some characteristic atmospheres at different latitudes, he directed attention to systematic differences from this characteristic behaviour which have been observed in the last year. These differences he ascribes to the effect of cloud layers, and the remainder of his contribution was concerned with these effects. Statistical studies of the frequency and thickness of clouds over Germany during the period 1930–40 are now proceeding at the Meteorologisch-Geophysikalisches Institut at Mainz, these being based on the observations of the Wetterflugstellen. Using these data, radiation fluxes and mean cooling water characteristics of cyclonic warm air have been computed and show that at every height the cooling is slightly increased by the cloud. Further work on these lines is proceeding.

Dr. A. R. Curtis (University of Sheffield) described the elaborate computations which he is carrying out on radiative heating-rates in the atmosphere. The starting-point is the derivation from the equation of radiative transfer of an expression for the rate of heating at any height in a plane-stratified atmosphere due to interaction of molecules of a single absorbing constituent with radiation. Even in this simplified case the expression is quite formidable. Knowledge of line frequencies and intensities and of line shape as a function of height is required. To make the calculations tractable, it is assumed that the line intensities are distributed according to a probability function. Approximate calculations for the 15-$\mu$ carbon dioxide band have been made, but further work will be carried out using electronic computation.

Dr. Migeotte described the results of high-resolution spectroscopic investigation of minor atmospheric constituents—ozone, nitrous oxide, methane, monodeuterated water and carbon monoxide. Several bands, as they appeared on solar spectrograms taken at the International Scientific Station on the Jungfraujoch at an altitude of 3,850 m., were shown; they were obtained using the prism-grating infra-red spectrograph of the University of Liège. Attention was directed by Dr. Migeotte to the presence of the 9-$\mu$ band of ozone and the 17-$\mu$ band of nitrous oxide in the solar spectrum. An atlas of the solar spectrum containing reproductions of the Jungfraujoch records is now ready for publication.

The afternoon session of the meeting began with a discussion by Dr. G. D. Robinson (Kew Observatory) of the scope of observations of solar and terrestrial radiation at the earth's surface. This included a critical survey of recent measurements of quantities important in determining the radiative balance at the latitude of Kew. In addition, Dr. Robinson discussed the contribution that can be made to the solution of the meteorological problem by the programme of measurements proposed for the International Geophysical Year. He concluded that, although these measurements must of necessity be limited for economic reasons, useful results can be obtained with existing equipment. The importance, both during and after the International Geophysical Year, of observations on solar radiation at a high level, such as those made by the Meteorological Research Flight, was stressed. He also said that, in order that separate estimates of albedo in the infra-red and visible plus ultra-violet can be made, as many stations as possible should make measurements of solar radiation in the infra-red.

Three papers followed on the important subject of the use of high-altitude aircraft as laboratories from which measurements of radiant intensities and infra-red spectroscopic studies can be made. The opening paper was by Dr. F. E. Jones (Royal Aircraft Establishment, Farnborough), who described the design of an infra-red spectrometer for use in a Canberra aircraft, with which it is hoped to record the solar spectrum out into the far infra-red from heights up to 50,000 ft. Initial measurements from a Lincoln aircraft at 30,000 ft. have permitted observation of the $\nu_3$ band of methane (this being the first observation of methane as a constituent of the atmosphere over England) and the complete nitrous oxide doublet at 4·5 μ. Next, Dr. J. Yarnell (de Havilland Propeller Co.) gave an account of the promising experiments undertaken in collaboration with Dr. R. M. Goody with an aircraft of the Meteorological Office Research Flight. Although these experiments did not lead ultimately to definite results, they were of interest and importance in providing design data and experience for the work which is now projected. The final paper on this subject was read by Dr. J. Houghton (University of Oxford), who described work carried out with Dr. A. W. Brewer on the measurement of the water vapour and ozone in the troposphere and lower stratosphere from aircraft. The technique used has proved successful in obtaining important results over Britain. At the time of the discussion, Dr. Brewer was in Norway carrying out similar measurements with the collaboration of the Norwegian Air Force; this work has also proved very successful.

The origin and distribution of the polyatomic gases in the atmosphere was next discussed by Prof. G. M. B. Dobson (University of Oxford), special attention being paid to water vapour and ozone. The water vapour concentration usually decreases rapidly with increasing height, particularly in the lower stratosphere, and this leads to a very low concentration at an altitude of about 15 km. Ozone, on the other hand, has a maximum concentration at an altitude of about 30 km. and diffuses downwards. Data were presented on the water vapour content of the lower stratosphere and on the average values of the ozone/air ratio in the upper troposphere and lower stratosphere (obtained largely from flights over southern England by the Meteorological Office Research Flight). The difficulties encountered in attempting to interpret these results were pointed out.

The next paper to be presented, by Dr. R. M. Goody (Imperial College of Science and Technology, London), was an account of work carried out with Dr. A. R. Curtis on thermal equilibrium in the upper atmosphere. Dr. Goody pointed out that the assumption of a Boltzmann distribution of molecules among the vibrational and rotational levels, which is usually assumed in atmospheric radiation calculations, must break down at sufficiently high altitudes when the pressure is inadequate to maintain a sufficiently high collision-rate. An equation of transfer was derived for a vibration-rotation band which does not assume a Boltzmann distribution among the vibrational levels. From this in turn was derived an equation for the heating-rate due to the band in a plane-stratified atmosphere. Departure from a Boltzmann distribution becomes serious above about 75 km. For the rotational levels the effect is unimportant for vibration-rotation bands, but it limits computation in the rotation bands of water vapour to heights less than about 90 km.

The temperature distribution at higher altitudes (200 km. and above) was the subject of a paper by Prof. D. R. Bates (The Queen's University, Belfast), which was concerned primarily with the importance of thermal conductivity in relation to the temperature distribution at these high altitudes. Prof. Bates argued that the temperature gradient, instead of remaining almost constant up to great altitudes, as commonly assumed, must fall off above the base of the $F_1$-layer. Rocket and radio measurements suggest that the temperature near the 250-km. level is only about 800° K.; and the usual theory of the apparent escape of atmospheric helium into interplanetary space requires that the temperature in the exosphere is at least 1,500° K. According to Prof. Bates, the temperature rise of about 700 deg. K. that is thus indicated is an order of magnitude greater than can be accepted. It would necessitate that the local rate of gain of thermal energy by absorption at the 250-km. level be some $10^4$ eV./cm.$^3$ sec. Little plausibility can be attached to the existence of such a potent heat source.

The important new data now being obtained in the solar spectrum in wave-length regions previously unobservable because of atmospheric absorption were described by Dr. R. L. F. Boyd (University College, London). The results have been obtained in the United States using apparatus carried by rockets to altitudes greater than 100 km. A variety of techniques have been used employing photon counters, photographic plates, thermoluminescent phosphors and spectrographs as observing devices. More than forty flights have been made. At the height of the $E$-layer, solar X-radiation has been detected, of sufficient intensity to produce the $E$-layer ionization. Lyman α-radiation concentrated in a narrow line has been observed down to altitudes of 74 km. It has also been found that the intensity of the solar spectrum falls off in the ultra-violet at a faster rate than for a black body at 6,000° K.; thus at 2000 A. the intensity corresponds more nearly to that from a black body at 4500° K. The importance of these results was discussed.

The concluding paper was given by Prof. R. W. Ditchburn (University of Reading) on the absorption of ultra-violet radiation by the atmospheric gases. He discussed the order of magnitude of the absorption coefficients for photoionization and photodissociation continua and their relation to absorption lines and bands. A summary was given of measurements and calculations on nitrogen, or molecular and atomic nitrogen and oxygen and ozone. Using these data and the model atmosphere assumed by the United States Rocket Panel on the basis of its observations, effective depths of penetration of radiation into the atmosphere were obtained. Data available on the absorption by minor atmospheric constituents were also presented in tabular form.

# CHEMISTRY OF NATURALLY OCCURRING PYRONES

## SYMPOSIUM IN DUBLIN

A SYMPOSIUM on recent advances in the "Chemistry of Naturally Occurring Pyrones" was held in the Department of Chemistry, University College, Dublin, during July 12–14. The symposium was organized by the College and the Institute of Chemistry of Ireland to mark the fortieth anniversary of the first paper on flavones published by Prof. Hugh Ryan, who was professor of chemistry in University College during 1899–1931. This branch of chemistry has been systematically studied in Dublin since 1915, and a number of useful syntheses of flavonoids have been devised. The meeting was opened by Prof. T. S. Wheeler on behalf of Dr. Michael Tierney, president of University College, Dublin. Some one hundred and thirty chemists from twelve countries took part in the proceedings.

Prof. W. Cocker (Trinity College, Dublin) was chairman of the first of five half-day sessions. Prof. J. Algar (University College, Dublin) gave a brief account of the researches of Prof. Hugh Ryan. He was followed by Prof. Gertrud Woker (University of Berne), who assessed the pioneering work of Kostanecki in the flavone field.

Prof. T. R. Seshadri (University of Delhi) reported some new results on the occurrence of chalkones and flavanones in plant products. The presence of a 5-hydroxyl group in flavanones makes the structure so stable that the corresponding chalkones do not occur in the plant. This effect is attributable to chelation. Detailed work on the flowers of *Butea frondosa*, on the bark of *Prunus puddum*, and on carthamin, the pigment of the safflower, was described.

Prof. F. E. King (University of Nottingham) discussed the constitution and synthesis of leucoanthocyanidins. The identification of melacacidin (from *Acacia melanoxylon*) as 7 : 8 : 3′ : 4′-tetrahydroxyflavan-3 : 4-diol and the nature of the products obtained from its treatment with hot mineral acid afford conclusive evidence that the flavan-3 : 4-diol structure is typical of the majority of the ill-defined natural products known collectively as leucoanthocyanidins. The (±)-tetramethoxyflavandiol—one of four theoretically possible racemates—which is formed by the catalytic reduction of 7 : 8 : 3′ : 4′-tetramethoxyflavonol is believed to be *dl-O*-tetramethylmelacacidin. The probable conformational structure of this product was discussed.

In the second session, over which Dr. V. C. Barry (Medical Research Council of Ireland) presided, Prof. K. Venkataraman (University of Bombay) gave an account of some naturally occurring γ-pyrone derivatives. He discussed the synthesis of muningin (6 : 4′-dihydroxy-5 : 7-dimethoxy*iso*flavone). Pinoquercetin and pinomyricetin, which occur in *Ponderosa* pine bark, have been shown to be, respectively, 6-methylquercetin and 6-methylmyricetin. The structure of a new, yellow, colouring matter (artocarpin) from the heartwood of *Artocarpus integrifolia* and of morellin (from the seeds of *Garcinia morella*) were discussed.

Dr. W. B. Whalley (University of Liverpool) suggested that the abnormal resinification of 2′-methoxy*iso*flavones when demethylated by hydriodic and hydrobromic acids (Whalley, *J. Amer. Chem. Soc.*, 75, 1059 ; 1953 ; and Baker *et al.*, *J. Chem. Soc.*, 1853 ; 1953) could be explained by postulating a rearrangement of 2′-hydroxy*iso*flavones to the acid-sensitive 2-unsubstituted-3-aroylbenzofurans, under the influence of the demethylating reagent. A series of such 3-aroylbenzofurans has now been synthesized and the properties, including various transformation reactions, examined. Several other potential routes to these benzofurans have been explored. It has been found that 2′-hydroxydeoxybenzoins (prepared from *iso*flavones) undergo spontaneous cyclization to the corresponding 2-arylbenzofurans. Cognate reactions were discussed in the light of these and other transformations.

Dr. T. H. Simpson (Torry Research Station, Aberdeen) spoke on the use of *iso*propyl groups for protection of phenolic hydroxyl groups in the synthesis of flavones by selenium oxidation of the appropriate chalkones. The use of the *iso*propyl group permits the synthesis of compounds such as acacetin, diosmetin, chrysoeriol, oroxylin-A, pectolinearigenin, in excellent yield.

The second morning session (chairman, Prof. P. O'Colla, University College, Galway) was opened by Prof. Wilson Baker (University of Bristol), who outlined recent developments in the synthesis of *iso*flavones. A method evolved in Bristol in recent years employs the reaction of 2-hydroxydeoxybenzoins with ethoxalyl chloride in pyridine to yield 2-carbethoxy*iso*flavones. Mild alkaline hydrolysis of these esters, followed by thermal decarboxylation of the resulting acids, gives *iso*flavones. Good yields are obtained and it is unnecessary to protect hydroxyl groups.

Prof. H. Erdtman (Royal Institute of Technology, Stockholm) described studies on the flavones and flavanones present in the heartwood of conifers, especially the genus *Pinus*. These studies were undertaken as part of a systematic investigation of the conifer group to obtain chemical evidence relating to the phylogeny of the class Coniferae. About 75–80 per cent of the pines have been examined by preparative or chromatographic methods, and ten flavonoids and three stilbenes have been isolated. These compounds have one unsubstituted phenyl nucleus, so that it is possible that these nuclei are ontogenetically identical. The botanical subdivision of the genus *Pinus* into two sections, *Diploxylon* and *Haploxylon*, is favoured by the chemical results. Flavone derivatives have also been isolated from the heartwood of some conifers botanically related to the pines. Together with other chemical evidence, the flavone derivatives provide useful indications of taxonomic relations between various conifers, especially those belonging to the natural order *Pinales*. In other orders other compounds appear to be equally significant as 'taxonomic tracers'. Examples are terpenic and tropolonoid constituents in the natural order *Cupressales*.

Prof. S. Hattori (University of Tokyo) spoke on the seasonal changes of flavone and flavanone glycosides in the leaves and fruits of *Poncirus trifoliata*. The leaves in the middle of May when in full development contain approximately equal quantities of poncirin (7-rhamnoglucoside of 5 : 7-dihydroxy-4′-methoxyflavanone) and rhoifolin (7-rhamnoglucoside of 5 : 7 : 4′-trihydroxyflavone). At the end of the month only a small quantity of poncirin remains. Poncirin predominates in the middle of April when the leaves are just developed from the buds. The percentage of poncirin in the fruits falls during the summer and autumn.

The fourth session, which was held on the morning of July 14, had Dr. R. G. R. Bacon (The Queen's

University, Belfast) as chairman. Prof. H. Schmid (University of Zurich) surveyed the components of *Ammi visnaga*. He discussed the chemistry of visamminol, a chromone present in the plant. The structure of athamantine, which is present in *Athamanta oreoselinium* L., and which is related to compounds in *Ammi visnaga*, was described. Prof. Schmid also spoke on other compounds from tropical plants.

Prof. K. Freudenberg (University of Heidelberg) gave an address on catechins and related compounds. The number of known catechins has been enlarged, by syntheses, and by the discovery of new naturally occurring members of the series. The explanation of the sensitivity of catechins towards acids lies in the presence of hydroxyl groups in both the 4′- and 7- positions. The possibility of acid polymerization was discussed, as was the relation of catechins to the phlobatannins and to the flavylium salts.

Dr. W. D. Ollis (University of Bristol) described work relating to the synthesis of diploicin. This compound is a member of the group of natural products termed depsidones and, as yet, no synthesis of a member of this group has been reported. Depsidones may be regarded as lactones derived from various 2-carboxy-2′-hydroxydiphenyl ethers, and the dehydration of this acid and related acids was discussed. An interesting feature of these reactions is an effect of hydrogen bonding which promotes intermolecular reaction and inhibits intramolecular reaction. This intermolecular reaction leads to certain macrocyclic compounds the formation of which is facilitated by the presence of rigid assemblies of atoms in the reactant molecules. The synthesis of depsidone and progress towards the synthesis of diploicin were discussed.

Prof. Joseph Algar (University College, Dublin) was chairman of the final session, which was held on the afternoon of July 14. Dr. E. C. Bate-Smith (Low Temperature Laboratory, Cambridge) discussed the chromatographic identification of phenolic constituents of plants and their systematic distribution. Phenolic substances occur in living plant cells almost exclusively in the form of glycosides or esters. As a first step in the recognition of these compounds, it is necessary to ascertain the nature of the phenolic residues. Practically every commonly occurring phenolic residue can be recognized by chromatography employing four or five solvent systems. Using such procedures, a systematic survey is being made of the phenolic constituents of the leaves of vascular plants. Particular phenolic compounds tend to be associated with particular systematic groups, and a number of such associations was discussed.

Dr. R. G. R. Bacon (The Queen's University, Belfast) reported the results of investigations on the Elbs persulphate reaction, which has been widely used in the preparation of hydroxyflavones. He presented data for the process to illustrate the effects of varying the nature and the relative proportions of the reactants. Reaction-rates were discussed and examples were given of the competition which occurs in the reaction between the desired effect, namely, nuclear sulphation, and other modes of oxidation.

Prof. T. S. Wheeler (University College, Dublin) described studies in the synthesis of γ-pyrones. For many years the Auwers method of synthesizing flavonols from aurone dibromides provided the only known example of ring expansion of an aurone to a flavone derivative. Recently two further methods of effecting this ring enlargement have been developed in Dublin. Treatment of certain aurones with ethanolic potassium cyanide gives the corresponding flavones. Oxidative ring enlargement of aurones to flavonols is obtained with hydrogen peroxide. This latter reaction was independently observed by Prof. T. A. Geissman, of the University of California, Los Angeles. A new synthesis of flavonols involving the action of an aromatic aldehyde on an ω-chloro-*o*-hydroxyacetophenone was discussed.

At an evening meeting during the symposium, under the chairmanship of Prof. T. Dillon, president of the Institute of Chemistry of Ireland, Dr. W. D. Ollis lectured on the total synthesis of strychnine. He described this recent achievement of the Harvard group, who worked under the direction of Prof. R. B. Woodward, and of which Dr. Ollis was a member. During the symposium receptions were given by Their Excellencies the President of Ireland and Mrs. O'Kelly, and by the President of University College, Dublin, and Mrs. Tierney. A successful symposium dinner was also held.

This symposium was probably the first to be devoted mainly to the chemistry of flavonoids and related compounds. The papers and discussions covered both the chemical and biochemical sections of the subject and showed the increasing interest which since the War has been taken in this field of chemistry. The development of the method of paper chromatography has greatly increased our knowledge of the occurrence of these substances in plants. Apart from their importance as natural products, flavonoids are of therapeutic interest. They are effective in treating capillary fragility and may have value in rheumatic fever and poliomyelitis. They are, of course, no longer used as dyestuffs.

T. S. WHEELER

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# AMERICAN PHYSICAL SOCIETY AND AMERICAN ASSOCIATION OF PHYSICS TEACHERS

## ANNUAL MEETINGS

THE 1955 annual meeting of the American Physical Society and the twenty-fourth annual meeting of the American Association of Physics Teachers were held simultaneously in New York City, during January 27–29, but not, as formerly, in the buildings of Columbia University. The various scientific sessions of the Society's meeting were distributed over several centres, including the Hotel New Yorker, the Hotel McAlpin, the Manhattan Center and the Vanderbilt Hall of New York University. Not all of the halls proved adequate; nevertheless the regrettable but inevitable dispersal was not, on the whole, unsatisfactory. The registration for the meetings was 1,987, about 5 per cent less than for the 1954 meetings, but the number of contributed papers presented to the Physical Society was about 10 per cent higher.

At the joint ceremonial session of the two bodies during January 28 in the great theatre of the Manhattan Center, the retiring presidential address of the Physical Society was delivered by Prof. H. A. Bethe (Cornell University), who took as his subject "Pi-Mesons and Nucleons"; the Oersted Medal of the Association was presented to Prof. V. E. Eaton (Wesleyan University), who responded by discussing physics as an art; and the thirteenth Richtmyer Memorial Lecture was delivered by Prof. E. P. Wigner (Princeton University), who spoke on "The

Development of the Compound-nucleus Model". The after-dinner speakers at the joint banquet which followed, held in the ballroom of the Hotel New Yorker, were Prof. H. D. Smyth, and Mr. G. Bell, who gave an interesting description, illustrated by a film, of the 1954 expedition up the Himalayan peak, K-2. The banquet was also the occasion of the presentation of the third O. E. Buckley Solid-State Physics Prize to Dr. LeRoy Apker.

Twenty-four invited papers, in addition to the three hundred and thirty ten-minute papers, were contributed to the scientific sessions of the Physical Society. There were also two symposia: one of the Division of Fluid Dynamics, on fluid-dynamics problems in astrophysics; and the other of the Division of Electron Physics, in which three papers were read by R. E. Fox, M. G. Inghram and J. Kaplan, respectively, on measurements of ionization probabilities of mono-energetic electrons, mass-spectrometric analysis of ions produced in the field ion microscope, and upper-atmospheric studies during the International Geophysical Year. A group of four invited papers was devoted to hyperons and heavy mesons, in which investigations of the Bristol (England), Indian and Italian schools were described by M. G. K. Menon (University of Bristol), Y. Pal (Tata Research Institute, Bombay) and N. Dallaporta (University of Padua), respectively; and E. O. Salant (Brookhaven National Laboratory) discussed heavy mesons produced in the interactions of 2–3 BeV. particles. There were two papers on nuclear polarization, given by E. Segrè (University of California) and B. Rose (Atomic Energy Research Establishment, Harwell), and three papers on nuclear instrumentation, including one by D. A. Glaser (University of Michigan) on bubble chambers for use in experiments in high-energy nuclear physics. Papers on nuclear physics predominated, but there were sessions devoted also to discharges and ions in gases, metals, the liquid state and cryogenics. The complete list of papers, together with abstracts and minutes of the Physical Society meeting, are given in the May 15 issue of the *Physical Review* (98, 1144; 1955), where it is also reported that at the business meeting of the Society, the following were elected to hold office for 1955: *President*, R. T. Birge; *Vice-President*, E. P. Wigner; *Secretary*, K. K. Darrow; and *Treasurer*, G. B. Pegram.

The programme of the meeting of the American Association of Physics Teachers (*Amer. J. Phys.*, 23, 306; 1955) consisted of a conference on the role of physics in engineering education; a symposium on visual aids, including an address by Lynn Poole (Johns Hopkins University) on science demonstrations on television; a film session in which two films, one on the properties of liquid helium near the transition point and the other on superconductivity, produced by the United States Bureau of Standards, were shown; a session, consisting of five speakers, devoted to the problem of physics in the secondary school curriculum; a business meeting; and the joint sessions, already mentioned, with the Physical Society. There were nineteen contributed papers. At the business meeting, citations for meritorious service to the Association were voted to W. S. Webb and M. W. Zemansky, and it was reported that a new directory of the Association is to be compiled and distributed this year. The following were elected to hold office for 1955: *President*, R. R. Palmer; *President-elect*, W. C. Michaels; *Treasurer*, F. W. Sears; and *Secretary*, F. Verbrugge.

# COLONIAL TERRITORIES OF THE BRITISH COMMONWEALTH

## REPORT FOR 1954–55

A RECENT Colonial Office report, "The Colonial Territories 1954–55"*, retains its general title of previous years, although, as from October 1, 1954, effect was given to the proposals of the White Paper, "Reorganization of the Colonial Service", and existing unified branches of the Colonial Service became merged in H.M. Oversea Civil Service. During the year, thirty new appointments were made to the Research Branch of the Oversea Civil Service, and thirteen research studentships were awarded to train candidates for research appointments, while two research Fellows are making investigations on behalf of the Colonial territories. The total number of appointments to Colonial territories made through the Colonial Office again decreased, from 1,227 in 1953 to 1,135 in 1954, due to a reduced demand for recruits for some of the smaller branches and special types of appointment. The demand for recruits for administrative appointments was considerably higher. During the year 2,081 men and women employed by Colonial Governments went to the United Kingdom, as against 2,090 in 1953 and 2,013 in 1952, and 673 of them were of Colonial domicile.

The report follows the pattern of previous surveys; it provides an admirable conspectus of political, economic, financial and social developments in the Colonial territories and, apart altogether from the chapter on research and surveys, gives the man of science the essential background against which the achievements recorded in greater detail in another report, "Colonial Research 1954–55", are to be considered. In like manner it provides the essential background for discussion of other particular topics such as the provision of technical assistance to these under-developed areas, the development of higher education, and the recommendations of the East Africa Commission; while its clear presentation, the diary of outstanding events and summary of events and developments in individual territories, with the list of Parliamentary and non-Parliamentary papers of Colonial interest published in 1954–55, go far to make it an indispensable reference work for all interested in Colonial affairs. Indeed, all the essential information seems to be collected here for that popular exposition required to remove the alarming indifference and ignorance among the British people of their Colonial territories upon which Political and Economic Planning commented so strongly in its recent inquiry into Colonial students in Britain.

Nor is matter of scientific interest confined to the chapter on research and surveys. That headed "Constitutional and Administrative" refers to the expansion of the activities of the Falkland Islands Dependencies Survey at bases in the Dependencies in the Antarctic to include *inter alia* geophysical observations at the most southerly base, and for the year 1954–55 a grant of £85,650 was made from United Kingdom funds. The account of economic and financial developments, which reports a more favourable financial year than was expected, as the forecast drop in revenue did not occur, records a rise in expenditure of Colonial Development and Welfare Funds from £14 million in 1953–54 to £15·6 million in 1954–55. Colonial Governments have continued efforts to improve agricultural efficiency by surveys, research, development work, and especially by spreading a knowledge of modern techniques among their peasant farmers. The staffs of Departments of Agriculture are being steadily strengthened, and in territories such as Cyprus, Nigeria, Nyasaland and Zanzibar research work has reached the point where definite recommendations for the use of fertilizers by farms can be made and schemes to encourage their use have been initiated. Much, however, remains to be learned about the best use of fertilizers and of trace elements, and research work continues in all territories. Much attention is also being given to the development of water supplies and of irrigation, where possible. Both in the Gold Coast and in Nigeria the campaign against swollen-shoot disease continued. Staff shortages were no longer a limiting-factor, and good progress was made with cutting-out and with the periodic re-inspection of the affected areas. In Nigeria the sealing-off policy continued to be only partly successful, with new foci of infections being discovered in the disease-free belt around the area of mass infection. It has been decided to inspect all cocoa farms in Western Nigeria once every six months, and the establishment of field overseers has been increased from 143 to 603. Increasing attention is also being paid to the depredations of the capsid bug and of the fungus disease known as black pod, which between them are estimated to destroy up to 20 per cent of the crop each year. In Nigeria, the control of epizootic diseases, such as rinderpest and pleuro-pneumonia, has been most effective, and more than 4·5 million vaccinations were carried out during the year. In the north some 250,000 cattle were treated for trypanosomiasis. Rinderpest control has been a major duty in East Africa, and production of rinderpest vaccines for the East African territories has been transferred to the East African Veterinary Research Organization Laboratories in Kenya. Effective disease-control measures in Uganda gave the main stock-rearing areas an exceptionally productive year in 1954. Interest in fish farming is growing. The preservation of fish is of prime importance in tropical areas. The usual techniques of smoking, drying and salting are practised, and successful pilot experiments in the production of edible fish-meal have been conducted in the Gold Coast and Uganda. Uganda has also been experimenting with killing of 'weed' trees by spraying with hormone preparations instead of the toxic sodium arsenite.

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* Colonial Office. The Colonial Territories 1954–55. (Cmd. 9489.) Pp. ix+186. (London: H.M.S.O., 1955.) 6s. net.

There was an appreciable increase in the assistance given to Colonial Governments under the Expanded Programme of Technical Assistance: in 1954 the Technical Assistance Board approved projects in fourteen territories providing sixty-four experts and twenty-three fellowships at an estimated cost of 528,000 dollars. Technical assistance from the United States included American specialists giving technical assistance to British Guiana and a programme of grassland and pasture research in West, Central and East Africa. Under the 1953–54 Mutual Security Act, a sterling sum not exceeding the equivalent of five million dollars has been set aside for financing projects for economic development in British territories in Africa. Experts provided by the Food and Agriculture Organization of the United Nations have been working during the year on surveys of the Rufiji Basin in Tanganyika and the Accra Plains in the Gold Coast, while other experts from the Organization are engaged on livestock research in British Guiana and on irrigation problems in Trinidad and Jamaica. Projects initiated or carried forward during the year in co-operation with the regional offices of the World Health Organization include malaria control in Northern Nigeria, North Borneo, Dominica and East Africa, insect control in St. Vincent, yaws control in Jamaica, Grenada, St. Vincent and Fiji, and tuberculosis control in the Somaliland Protectorate.

In December the International Federation of Workers' Educational Associations, in conjunction with Unesco, held a seminar on "Adult Education in a Changing Africa" at the University College of the Gold Coast, while under the Expanded Programme for Technical Assistance Unesco provided the Government of Trinidad with the services of a principal for the San Fernando Technical Institute and the Government of Sierra Leone with an expert on teacher-training. The Commission for Technical Co-operation in Africa South of the Sahara set up a new Inter-African Committee for Social Sciences and convened during August 1954 the second session of the Inter-African Soils Conference at Leopoldville, Belgian Congo. Under the Colombo Plan, thirty-six experts were provided in 1954 and a hundred and seventy traineeships, while requests for forty-eight more experts and seventy-seven more traineeships were under negotiation. Progress in the international co-ordination of the campaign against the desert locust (*Schistocerca gregaria*) in the Arabian peninsula was much slower than expected, and locust swarms produced in Arabia spread to East Africa and reached Nigeria in the west. By the end of 1954 Kenya and Tanganyika were very heavily invaded, the resources of the Desert Locust Control Organization and of the local administration were strained to the utmost, and the further outlook was very grave. The African migratory locust and the red locust continued to be kept under control in their outbreak areas.

Under social services the report records encouraging academic progress in the four Colonial university colleges, the opening of new library accommodation at the Royal University of Malta and an increase in university students from 3,639 to 4,010. Contracts were signed for the erection of most of the major buildings of the Nigerian College of Arts, Science and Technology at its headquarters at Zaria, while the third branch was being built at Enugu in the Eastern Region. Good progress was also made towards the completion in Nairobi of the new buildings of the Royal Technical College of East Africa. In Malaya a six-year programme of controlled expansion of education is expected to bring expenditure to £16,800,000 by 1960, when there will be more than a million children in all types of school; and a second training college for Malayan teachers in the United Kingdom was being established at Brinsford Lodge in Staffordshire. The most spectacular event of the year in education was the provision of primary education for all who desire it in Western Nigeria, and some four hundred thousand children were registered; a large number of secondary schools was also opened in January. In the Gold Coast the emphasis of expansion is now on secondary rather than on primary education, while large-scale educational development in Uganda included the expansion of technical education as well as of primary and secondary schools. Educational exchanges under the Fulbright Act included two lecturers, six research scholars and one graduate student from the United

States to institutions in Colonial territories, while five awards to teachers from the United States working at schools in the Colonial territories were renewed.

Generally, there is evidence of growing mastery in the Colonies over preventable diseases and of increased public understanding of their causes and the logical basis of measures taken against them; but the freedom from major epidemics was marred by outbreaks of acute anterior poliomyelitis in Jamaica and Trinidad, both of which have also had to combat typhoid in endemic form. Abnormal social conditions caused by overcrowding increased the incidence of communicable disease in Hong Kong, and falling infantile mortality and general death-rate, together with a high birth-rate, make it difficult to provide a medical service in Singapore adequate for the needs of a rapidly increasing population. Famine conditions were again present in the Mayoni, Dodoma and Mpapwa districts of Tanganyika, an invasion of the army worm destroying crops which had survived the drought. A striking feature of the year was the extent to which large-scale operations of the health departments was assisted and promoted by the World Health Organization and the United Nations Children's Fund, the scientific backing, financial support and material aid of which permitted many schemes to be carried out that would have been beyond the unaided resources of the territories. Malaria has ceased to be a public health problem in Cyprus and Mauritius, and for the first time the total number of deaths from malaria in the Federation of Malaya fell below a thousand, attributable to the protection in rural areas alone of more than half a million persons by house spraying. The death-rate from malaria in Trinidad is also steadily falling, but the hyperendemic areas of tropical Africa still constitute a great challenge. Research and experiment have continued extensively, and in western Sokoto in Northern Nigeria control is being attempted in an area of six hundred square miles containing a population of 124,000, with a controlled residual spraying technique which has already been used in eighty thousand huts and houses. Recruitment of nursing sisters from the United Kingdom and Commonwealth countries remained difficult; but many more Colonial student nurses are now in training in hospitals in the United Kingdom, and the training of nurses in the Colonial territories is developing rapidly.

The chapter on research and surveys deals with work and investigations which are covered more fully in "Colonial Research 1954–55", and it is unnecessary here to refer to more than a few outstanding features of the year. It is expected that some £8 million will be available for expenditure on research during the period 1955–60; but there is still a shortage of scientific staff both in the United Kingdom and in the Colonial territories, and a very definite improvement in recruitment will be needed if the new annual ceiling of expenditure is to be approached. During the year fifty-two research schemes, estimated to cost £533,548, were approved, and increased assistance to Colonial research projects was also given by extending the arrangements for visits overseas by specialists from the United Kingdom and by strengthening the pools of entomologists, plant pathologists and soil surveyors whose members are available for short-term assignments. The East African Agriculture and Forestry Organization is well established, and its investigations into maize rust-resistance promise early control of this disease. The work is closely linked with that of the Maize Rust Research Unit in West Africa. The second of a series of Anglo-French Research Conferences was held at Bambey, Senegal, to discuss work on groundnuts and millets. The research team of the Joint Fisheries Research Organization for Northern Rhodesia and Nyasaland continued the survey of Lake Nyasa from the Nkata Bay base and has revealed remarkable formations on the lake floor. A site in Malacca was selected for the Fish Culture Research and Training Institute, and it is hoped that the building will be complete by the end of 1956. In the Federation of Malaya intensive investigations into filariasis were in progress in the State of Pahang, and heavy doses of dieldrin were effective for six months against the *mansonia* species of mosquitoes, the main vectors in this region. Notable progress was made by the Regional Virus Laboratory, Trinidad, in the study of the viruses of the East Caribbean region. The Central Trypanosomiasis Laboratory at Sukulu, Uganda, was completed and partly occupied, and at Mariakani in Kenya cattle exposed to attack from tsetse but treated with injections of 'Antrycide' pro-salt every two months for more than two years acquired and maintained resistance to strains of *T. congolense*. The review includes some strong criticism of the attempts at the United Nations General Assembly to discredit the work of the Trusteeship Council and castigate the administering authorities, and its clear factual statements amply indicate the unrealistic nature of such attempts.

# ROYAL GREENWICH OBSERVATORY

## ANNUAL REPORT FOR 1954–55

THE annual report of the Astronomer Royal for the period May 1, 1954–March 31, 1955*, deals with the Royal Greenwich Observatory under the headings of Greenwich, Abinger, Herstmonceux and Hartland.

The main mirror of the Yapp 36-in. reflector was removed during the winter and sent to Messrs. Cox, Hargreaves and Thomson for a test of its figure, but none of the suspected 'patchy errors of figure' or astigmatism was found. If, however, colour-temperature work is resumed, re-figuring would be an advantage.

The instruments and equipment of the Physics and Optics Laboratory at Abinger are in course of transfer to Herstmonceux. The Admiralty Civilian Hospital at Feldemore, Holmbury St. Mary, which provided accommodation during the past nine years for many of the Abinger staff, was closed on February 13. It is intended to use some of the rooms for stores and other official purposes.

At Herstmonceux, repairs to the west tower of the south gateway are nearing completion, and portions of the stonework which had been badly weathered have been rebuilt. The unsafe upper portion of the tower was dismantled and has been rebuilt. In the Meridian Group of buildings, the painting of the Cooke reversible transit circle building is completed and entrance steps have been provided. The small pavilion to house the Bamberg small transit and the pavilion for the photographic zenith tube have been erected. A new pavilion for the Melbourne reversible transit circle is to be erected, and will be generally similar in design and dimensions to the Cooke building. In the construction of the equatorial group, the steel frameworks of the domes of the 30-in. reflector, the Schmidt reflector and the 26-in. refractor have been erected, and, as soon as the domes have been completed, it is planned to commence the erection of the telescopes.

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* Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory. Pp. 33. (Herstmonceux: Royal Greenwich Observatory, 1955.)

The ground at Hartland, North Devon, the future site of the Magnetic Observatory, has been purchased, and the civil engineer-in-chief has prepared detailed drawings of the buildings which, it is expected, will be completed in time for observations to be commenced before the beginning of the International Geophysical Year (July 1957–December 1958). One of the buildings to be used for testing magnetic instruments will contain a system of large coils designed to provide artificial horizontal and vertical fields, comparable with those at any point upon the surface of the earth.

Cosmic-ray recording with the Clintel apparatus was continued until February 9, 1955, when one-half of the sensitive area was modified. This was done in accordance with the recommendations of the Cosmic Ray Commission of the International Union of Pure and Applied Physics, with the object of detecting only the flux of mesons capable of penetrating 10 cm. of lead, and entering from a smaller solid angle around the zenith than the previous arrangement would accept. The other half will soon be similarly modified. These modifications are required to make the data comparable with those obtained by many other stations, thereby facilitating the study of world-wide distribution and changes of this flux.

Full-scale meteorological observations have been maintained on a routine basis, and monthly reports have been submitted to the Meteorological Office. Those who remember the conditions last summer will not be surprised to learn that, during the four months May–August 1954, there was a deficiency of sunshine of about two hundred hours as compared with the mean of the preceding four years. The total amount of clear sky at night during the same period was also well below the totals for the preceding years, but the cloudiness was less marked at night than during the day-time. Unbroken trails of δ Ursae Minoris were recorded on twenty nights, while no records were shown on seventy-nine nights.

It was mentioned in the report for 1953–54 and is again referred to in the present report, that the first part of the "Nautical Almanac" for 1960 has been re-designed to meet the recommendations of the International Astronomical Union. Beginning with the 1960 editions, "the American Ephemeris and the Nautical Almanac shall be, apart from a few introductory pages, identical publications". H.M. Nautical Almanac Office will be responsible for the first part of the "Almanac", and the U.S. Nautical Almanac Office for the second part. While no substantial change of content or arrangement will be involved, there will not only be a considerable reduction in price, but the scheme should also lead to wider international co-operation in the field of astronomical ephemerides.

Further tests of the figure of the 98-in. disk of the Isaac Newton telescope were made by Prof. R. O. Redman at the works of Sir Howard Grubb, Parsons and Co. during the works holiday period in August. While the figure was found to be appreciably free from astigmatism, the tests showed some differences from those previously made, and the mirror has been put aside for further tests, for which there is ample time as the telescope will not be constructed for some years.

At the end of the report reference is made to the participation of the Observatory in the general programme of work to be undertaken during the International Geophysical Year, which will require additional staff at the Observatory. The removal from Greenwich to Herstmonceux has reached a stage at which full observing programmes can shortly be commenced, and for these the present staff of the Observatory is seriously inadequate. In a separate memorandum proposals for the adequate staffing of the Observatory will be submitted to the Board of Visitors. If the Board of Admiralty approves, the additional staff required for the special programmes during the International Geophysical Year can be provided for this increase and afterwards absorbed into other observational programmes.

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# WORK STUDY AND SOME RESULTS

Work study methods are quite common in American industry and have proved their efficacy. In Britain, industrial organizations have been slow in introducing these techniques, and this is one of the reasons why productivity lags so much behind that of the United States. Were it not for chemical manufacturers in Britain, the rate of introducing work study would have been even slower than it has been. Once more they have placed the whole of British industry in their debt by producing two most practical booklets (Association of British Chemical Manufacturers. 2*s*. 6*d*. each). The first describes effective ways of introducing work study into individual firms, and the second gives an account of some of the results which have been achieved.

The first booklet describes the nature of work and the benefits accruing from it; the kind of man who should be appointed as work study officer and the way in which he should be trained; the organization and content of work study appreciation courses for senior, middle and junior management; the means of obtaining co-operation with the trade unions; the kind of jobs which should first be investigated; and the employment of consultants.

The results obtained by using work study methods in fourteen chemical firms differing in size, complexity and the goods they produce are described in the second booklet and form a valuable series of case histories which should encourage the lagging and give succour to the faint-hearted. In the case of Hardman and Holden, Ltd., for example, the labour cost of one product was reduced by 50 per cent; output in one plant increased by 40 per cent by a change in procedure, with an increase in labour force of 12 per cent over the original. In one process there were seventeen handling operations in the finishing stage of the product. These have now been reduced to one—with a resultant saving of 30 per cent in man-power and the elimination of the use of two machines. Because of the building up of intermediate stocks between two processing operations it was originally thought it would be necessary to increase the capacity of the second plant; work study demonstrated that by a change in operation the second unit could deal with the whole of the output of the first unit—and this has been effected.

In Imperial Chemical Industries, Ltd., four examples testify to the improvements which have been made by the introduction of work study. Thus, a drum washing plant team was reduced from five to three men and the total output increased by 50 per cent, representing a saving of £1,200 a year.

A procedure for bagging powder had been operated for several years, during which time there had been minor changes in the requirements of sieving and blending, and the material of the bags had changed. No obvious improvement of the long-established method appeared possible, but careful study of method indicated the possibility for a better flow of materials. As a result, the distance the powder was moved was reduced by almost 60 per cent and the distance the operator moved for each bag of powder was reduced by nearly 50 per cent. With no change in the level of production, it was possible to reduce from two operators to one. In the third example, cast-iron cooling-water pipes have to be tested under pressure and checked for straightness. By the original method used, two men could test 180 pipes in a day. Method study showed various possible improvements, and the one selected involved changes in equipment which cost only £25. One man can now test two hundred pipes in a day, and no incentives are involved in this case.

In another works, the inspection and servicing of cars and lorries was changed to a carefully worked out basis of incentive. As a result, the four shift operatives increased their output by 48 per cent and earned 26 per cent more, with a reduction in labour cost per unit of output of more than 15 per cent.

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# IMMUNOLOGICAL DISCRIMINATION BETWEEN THE BLOOD OF NORMAL AND OF TUMOUR-BEARING RATS

By Dr. D. A. DARCY

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USING the gel diffusion technique of Ouchterlony[1], it has been found possible to distinguish the blood plasma (or serum) of rats bearing transplanted or induced tumours from the plasma of normal rats or rats bearing homografts of normal tissues.

The method was, first, to prepare antisera of high precipitin titre in rabbits by injecting them with the plasma or serum of (*a*) normal rats or (*b*) rats bearing the transplanted Walker tumour. Other rabbits were inoculated with the cells of the Walker tumour; but the antisera so obtained had only very weak discriminatory power, no more than would be expected from the incidental contamination of the inoculated cells with plasma. When antisera of satisfactory strength had been obtained, they were allowed to diffuse through an agar gel to meet and react with the antigens (rat plasma) diffusing in the opposite direction. In this way a series of bands or lines of precipitate was formed in the gel giving a 'spectrum' characteristic of the antigenic structure of the plasma in question, the antigen structure being determined by the proteins, and possibly other soluble substances. It was found that the precipitin spectrum of the cancer plasma differed from the normal in a characteristic way.

A variety of transplantable rat tumours was employed, namely, the Walker tumour, the Yoshida sarcoma, the *R*48 sarcoma, the *GD*-1 tumour, the August tumour and a sarcoma induced by means of xanthine. The induced tumours were a series of sarcomas of various sizes arising at the site of implanted pellets of benzpyrene, and one hepatoma induced by feeding butter yellow. The rats used throughout both for controls and for tumour-bearing were from a colony of non-inbred white rats originally derived from the Wistar strain, the only exceptions being that the August tumour and the Yoshida tumour were grown in the August and *BD*-1 strains, respectively. The control plasmas came from rats which were either untreated or which bore homografts of normal tissue (liver and skin) at various stages of evolution.

Agar diffusion plates were prepared with three wells as shown in Figs. 1 and 2. The bottom well was charged with antiserum and the left and right wells with cancer and normal plasma, respectively. The lines of precipitate are composed of the various antigenic components in combination with their corresponding antibodies. When a line on one side fuses with one on the other side to form an arc, the antigenic components in question are identical[1]. When an arc is displaced to one side, this indicates a lower concentration of the antigen on that side. When a line crosses to the opposite side without fusing or without deviating, the substance in question is either absent or in negligibly low concentration on that side.

The antiserum prepared against normal rat plasma (A.N.P.) was used in a large number of plate tests to compare the different cancer plasmas with the plasmas of the normal or grafted controls. Both pooled and single control plasmas were tested. It was found that the cancer plasmas differed from the controls in having a group of rather faint lines (labelled *K* in Fig. 1) advancing towards the antiserum in front of the strong line which is the leading line (*A*, Fig. 1) of the normal spectrum. The *K* group was composed of two lines at first, but later others which may be 'immunological artifacts'[2] appeared among them. The *K* lines were shown most strongly by the blood of animals bearing advanced tumours; but the antigens were clearly demonstrable in the blood as early as six days after implantation of the Walker tumour. The lines appeared to fuse with an unidentified group in the normal spectrum; the simple interpretation of them would be that they represent substances which are in higher concentration in the cancer blood than in the normal. However, it was found that a similar group of *K* lines could be produced by autolysed whole normal rat blood, and occasionally by normal rat plasma that had been stored for a very long time. It is suggested, therefore, that the *K* lines may represent partially broken-down substances (probably protein) which can diffuse faster than the parent substances

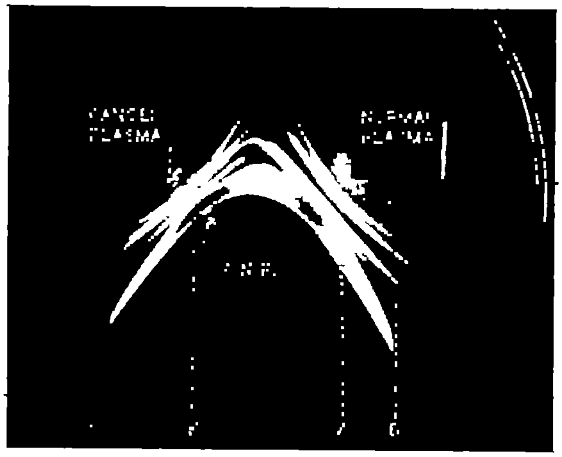

Fig. 1. A plate after nine days diffusion at room temperature. The cancer plasma comes from a rat bearing a 13-day old Walker tumour. The normal plasma was a pooled mixture from untreated controls. Both plasmas were diluted one part in ten with citrated saline. The antiserum (A.N.P.) had been prepared against normal rat plasma

while retaining their original antigenicity. Atypical single *K* lines were also occasionally found in the plasmas of control rats described as 'bandaged and fed' (see below). A second difference observed was that the line *A* was actually farther from the antibody well in the cancer plasma than in the normal, indicating a lower concentration of the antigen in question in the cancer blood. Certain other antigens in the cancer plasma appeared to be in lower concentration, often to a striking degree (for example, line *B*, Fig. 1) than in the normal. The reverse was also found, namely, an antigen or antigens in the cancer spectrum much stronger than in the control.

When the antiserum employed in the gel plates was that prepared against the plasma of animals bearing the Walker tumour, a more striking distinction was obtained. In addition to a *K* group and a weaker *A* antigen, the cancer plasmas now showed a line which was absent entirely from the pooled normal plasma (Fig. 2). If the antiserum was then absorbed to exhaustion with normal plasma, it still reacted with the cancer plasma either in the 'ring' test in glass tubes, or in the gel plates to give a band of precipitate. The blood plasmas of all animals bearing well-established tumours, including most six-day old Walker tumours, were found to give strongly positive ring tests with the absorbed antiserum, whereas the great majority of controls were negative. Blood plasmas of other species (man, mouse, hamster) bearing induced or spontaneous tumours were also negative.

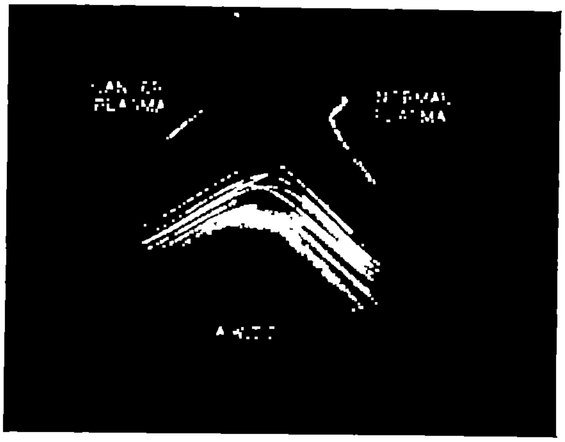

Fig. 2. A plate after ten days at room temperature. The cancer plasma was from a rat bearing a 12-day old Walker tumour. The normal plasma was a pooled mixture from untreated controls. Both plasmas were diluted one part in fifteen with citrated saline. The antiserum (A.W.T.P.) had been prepared against the plasma of animals bearing Walker tumours

A small percentage of control plasmas, all coming from a group of rats which had received skin homografts, however, was positive. Further investigation of this point showed that the skin grafting itself was not responsible, but that the effect was caused by the tight plaster bandage on chest and upper abdomen (such as is commonly used for skin grafting in rats and mice[3]) acting in conjunction with insufficient fasting of the rats before bleeding. The bandage alone had no effect, and complete lack of fasting produced, at best, faint or doubtful positives. The two acting together produced strong positives. This antigen, therefore, cannot be regarded as cancer-specific; but it is interesting that it should be absent from blood of normal fasting rats. It was present in the blood of tumour-bearing animals even when they were starved for a day before bleeding, and even when the tumour was inoculated in the hind leg so as to avoid any possible 'corset' effect such as might occur when the tumour was grown in the usual way in the animal's side.

From this evidence it seems likely that the antigen in question is a lipid or lipoprotein. Lipids are found in relatively high concentration in the blood of tumour-bearing rats[4]. It was an easy matter to distinguish the plasma of the rats which had been bandaged and fed before bleeding from true cancer plasmas by means of the characteristic *K* antigens and the weaker *A* antigen of the latter.

None of the above antigen-lines has been identified chemically. However, special methods are becoming available for this purpose[5], so that a complete characterization of the precipitin spectrum should eventually be possible. It may be speculated, for example, that the line labelled *A* in the spectrum represents serum albumin; this protein has a smaller molecule than the globulins and would be expected to diffuse ahead of them; it is, furthermore, reported to occur in lower concentration in cancer blood than in normal[6].

In conclusion, it may be said that while the present results represent only a preliminary survey, the determination of the precipitin 'spectrum' of blood and other body fluids offers interesting possibilities clinically for diagnostic and other purposes, and experimentally in a wide variety of fields.

This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

[July 11

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Ferroverdin, a Green Pigment containing Iron produced by a Streptomycete

DURING a search for antifungal antibiotics, a streptomycete was isolated from a sample of soil from Leopoldsville (Belgian Congo) which produced an intense green non-diffusible pigment on yeast agar. The streptomycete producing this pigment is not identical with any of the following species stated to produce green pigments: *S. verne*, *S. viridans*, *S. virgatus*, *S. flavovirens*, *S. viridis*, *S. viridochromogenes*. Its morphological and cultural characteristics indicate that it may be a new species.

The green pigment can be produced in submerged culture in shake flasks and in stirred fermenters on a medium containing 0·5 per cent yeast autolysate and 1 per cent glucose, *p*H 7; good aeration is essential for its production.

The pigment is extracted into ethanol from the wet mycelium, transferred into butyl acetate and the butyl acetate solution percolated through a column of alumina (Merck). The column, which retains the pigment adsorbed at the top, is developed with 95 per cent ethanol followed by absolute ethanol.

Three green bands separate, one remaining immobile at the top, one moving quickly down the column and one, representing the main fraction, following the fast-moving band. The pigment from the main fraction has been obtained in the crystalline state after repeating the chromatographic procedure and concentrating the final ethanolic solution. The yield of the crude crystalline product is about 100–200 mgm. per kgm. (wet weight) of mycelium. After recrystallization from methanol, elementary analysis showed a composition in good agreement with the formula $C_{30}H_{24}O_8N_2Fe$ (found: C, 60·0; H, 4·1; N, 4·7; Fe, 9·3 per cent; calculated: C, 59·8; H, 4·05; N, 4·73; Fe, 9·3 per cent). In view of its colour and its iron content, the pigment has been named 'ferroverdin'.

Ferroverdin is insoluble in water, benzene, petroleum ether, chloroform and carbon tetrachloride, but is soluble in methanol (about 5 mgm./ml.), ethanol (about 2 mgm./ml.), acetone (about 15 mgm./ml.) and glacial acetic acid (about 15 mgm./ml.). It is readily reduced by hydrogen gas, in the presence of a palladium – barium sulphate catalyst, absorbing 6 mol. of hydrogen. The reduced solution is colourless and does not develop colour on shaking with air.

In the visible spectrum ferroverdin absorbs at 4300 and 6700 A. ($\varepsilon_{4300} = 1·10 \times 10^4$, $\varepsilon_{6700} = 1·10 \times 10^4$; it also absorbs strongly in the ultra-violet region with peaks at 2765 and 3000 A. ($\varepsilon_{2765} = 6·18 \times 10^4$; $\varepsilon_{3000} = 5·12 \times 10^4$. After reduction it shows peaks at 2340, 2710 and 3125 A. ($\varepsilon_{2340} = 3·33 \times 10^4$, $\varepsilon_{2710} = 1·37 \times 10^4$, $\varepsilon_{3125} = 7·2 \times 10^3$ (solvent methanol).

The iron is firmly bound in ferroverdin, but appears in ionic form after catalytic reduction. It is gradually released by hydrolysis at 100° C. in 2 *N* hydrochloric acid and in 2 *N* sulphuric acid. Investigations of its chemical structure are in progress.

We thank Dr. G. Gualandi and G. Serlupi for the spectrophotometric measurements and acknowledge with thanks the collaboration of Dr. A. Ballio in the initial stages of this work. We also thank Mr. F. Zanchi and the staff of the fermentation pilot plant of this Institute for their co-operation in the production of ferroverdin, and Mr. J. Daymond for technical assistance.

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July 26.

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## A Brain Factor influencing the Viability of Neurotropic Rift Valley Fever

DURING experiments on the viability of Rift Valley fever it was noticed that crude extracts of virus-infected brain tissue in 10 per cent rabbit, sheep or human serum were less stable than the virus partially purified by differential ultra-centrifugation and suspended in the same diluents. In Fig. 1 this difference in viabilities is shown. Curve (*a*) shows the survival at 37° C. of virus in a crude or unpurified suspension of four virus-infected adult mouse brains in 40 ml. of 10 per cent rabbit serum saline. Curve (*b*) shows the survival of partially purified virus stored under the same conditions. It will be noticed that the disappearance of the virus in the partially purified material followed the exponential law, whereas the unpurified material showed an increasing rate of inactivation with time.

The factor responsible for the rapid inactivation of the virus is present not only in emulsions of virus-infected tissues but also in 10 per cent serum saline extracts of uninfected or normal mouse brain. In Fig. 2, viability curves are shown of purified virus suspended in normal brain extracts (4 brains in 40 c.c. rabbit serum saline) in two separate experiments (*a*), and that of purified virus in 10 per cent rabbit serum saline (*b*).

The factor is probably not a protein as no fraction capable of inactivating the virus was precipitable from brain emulsions by ammonium sulphate between 0 and 100 per cent saturation.

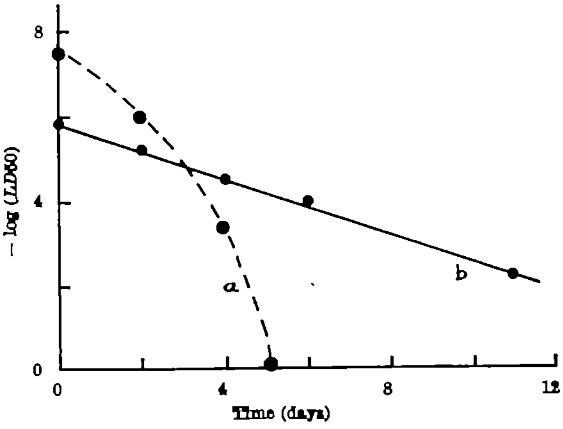

Fig. 1. Survival or viability curves of neurotropic Rift Valley fever at 37° C. (*a*) Crude infected brain suspension in 10 per cent serum saline; (*b*) partially purified virus in 10 per cent serum saline

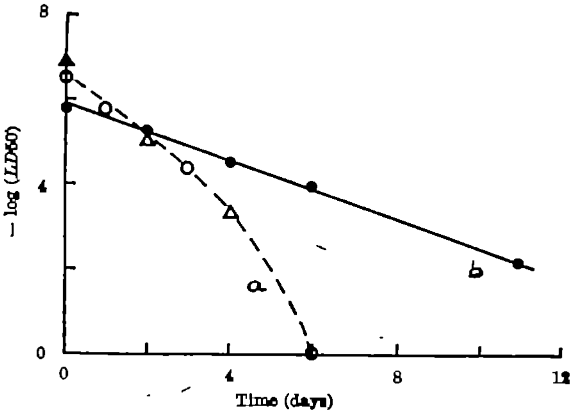

Fig. 2. Survival or viability curves of neurotropic Rift Valley fever at 37° C. (*a*) Partially purified virus in normal brain extracts in 10 per cent serum saline; (*b*) partially purified virus in 10 per cent serum saline

The virus-inactivating factor could be separated from brain emulsions by dialysis through 'Cellophane' membranes. In a typical experiment thirty-two normal brains were emulsified in 32 ml. 10 per cent rabbit serum saline and dialysed for six days at 37° C. against 32 ml. 10 per cent rabbit serum saline in the presence of penicillin and streptomycin. At the end of this period both the contents of the 'Cellophane' bag as well as the dialysate were free of aerobic and anaerobic bacteria. Virus purified by differential centrifugation was mixed with the dialysate, and the period of survival at 37° C. determined. Purified virus in 10 per cent rabbit serum saline stored in the same incubator served as control. The results are recorded in Fig. 3; ($a_1$) and ($a_2$) are the viability curves for the virus in brain dialysate in two experiments, and (*b*) that for the purified virus in serum saline. The rapid inactivation of the virus suspended in the dialysate indicated that the factor responsible is of low molecular weight and dialysable.

Because of the non-linear relationship between the titres expressed as negative log $LD_{50}$ and time of incubation in the cases where the inactivation factor is present, it would appear that either this factor was produced during autolyses of the brain tissue, or it was a substance that becomes more toxic for Rift Valley fever on storage at 37° C.

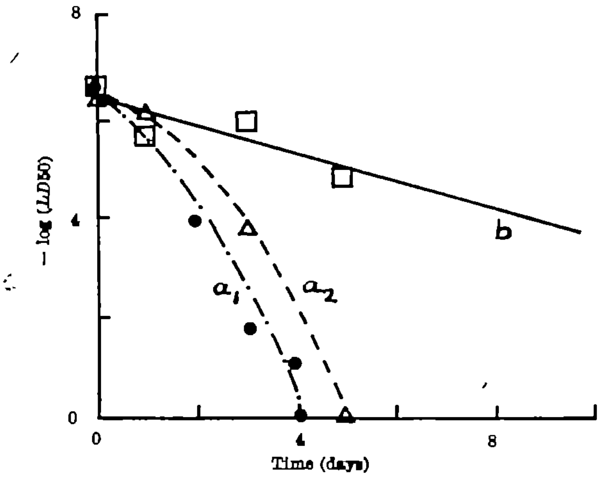

Fig. 3. Survival or viability curves of neurotropic Rift Valley fever at 37° C. ($a_1$) and ($a_2$) Partially purified virus in dialysate from normal brain emulsion in 10 per cent serum saline; (*b*) partially purified virus in 10 per cent serum saline

This factor might also play a part in determining the viability of such unstable neurotropic viruses as rabies and yellow fever. It is probably different from the antiviral substance or substances extracted with organic solvents by Casals and Olitsky[1] from normal mouse and sheep brains, as tests have shown that it is insoluble in chloroform.

We would like to thank Prof. M. van den Ende for his interest in this work and Dr. R. A. Alexander for generous supply of virus.

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## Ramnacin: a New Antibiotic from a *Streptomyces* sp.

In the course of an investigation on antibiotics from micro-organisms of East Pakistan soils, a *Streptomyces* sp. producing a new antibiotic was isolated. The cultural and other characteristics of the organism are being described elsewhere[1]. The organism was surface-cultured on the medium shown in Table 1; 500-ml. quantities of the medium were used in 1,000-ml. fermentation flasks and sterilized at 15 lb./sq. in. steam pressure for 20 min.

Table 1

| | | | |
|---|---|---|---|
| Glycerine | 30 00 gm. | KCl | 0 50 gm. |
| Gram extract (chick pea) | 2·50 ,, | $CaCl_2$ (anhydrous) | 0 30 ,, |
| $MgSO_4.7H_2O$ | 0·50 ,, | $FeSO_4.7H_2O$ | Trace |
| $K_2HPO_4$ | 1·00 ,, | Agar | 1·50 gm. |

The above was dissolved in tap water and the calculated amounts of KI, $MnSO_4$, $ZnSO_4.7H_2O$ were added to supply 2 p.p.m. of iodide, manganese and zinc in the medium, which was made up to 1,000 ml. The *p*H was adjusted to 7·4.

The medium was then inoculated with spores from test-tube slants (Czapek–Dox medium, *p*H 7) and incubated at room temperature, 21–25° C. The maximum antibiotic activity was found after 30 days incubation. The activity was measured in terms of inhibition zones in the usual cup plate assay[2] with *Bacillus subtilis* N.C.I.B. 3610 as the test organism.

When the maximum activity had been obtained, the culture fluid was filtered through a wire net (as used in filtering tea). The *p*H of the filtrate was adjusted to *p*H 8 and then it was extracted with an equal volume of ether. The mycelia, which held most of the antibiotic, were crushed with mortar and pestle under sand and extracted several times with ethanol. The latter was removed *in vacuo* and the residue suspended in water adjusted to *p*H 8 and extracted with ether with a little alcohol to break down an emulsion that formed occasionally. There was little antibiotic left in the aqueous suspension after extraction with ether. The ether extract was then added to that already obtained from the culture filtrate. The combined ether extract was evaporated to dryness on a water-bath and the residue chromatographed in chloroform on activated alumina (B.D.H.). The active material moved almost with the solvent front, accompanied by a small amount of colouring matter which was, however, easily eliminated during crystallization of the antibiotic from petroleum ether–alcohol mixture. It melted at 235° C. (Kofler hot stage) and contained only carbon, hydrogen and oxygen (analysis[3]: C, 64·51; H, 8·97 per cent; molecular weight, 499 (Rast, camphor)). The molecular formula as calculated on this basis is $C_{26}H_{44}O_{8}$.

The crystalline material is sparingly soluble in water. It is highly soluble in alcohol, acetic acid, ethyl acetate, chloroform, ether and to a lesser extent in benzene and petroleum ether (80–100° C.). It does not decolorize bromine in carbon tetrachloride, and gives a positive test for benzenoid structure[4]. Paper chromatography of the combined extract of culture filtrate and mycelia with *n*-butyl alcohol/acetic acid/water (4 : 1 : 5) revealed only one active substance with an $R_F$ value of 0·92. The position of the active material in the paper was determined by plating on a nutrient agar medium seeded with the test organism and developed after overnight refrigeration. Counter-current distribution analysis with an improvized apparatus made of twenty separating funnels using petroleum ether (b.p. 80°–90° C.), 95 per cent alcohol and water (4 : 3 : 1) gave only one peak of activity.

The antibiotic is highly stable. Autoclaving at 15 lb./sq. in. steam pressure for 20 min. at *p*H 2–10 left all activity practically unimpaired. The melted substance (m.p. 235° C.) also retained its activity. It is, however, destroyed, presumably by contaminant micro-organisms, if the culture broth is left exposed.

The antibiotic was tested for activity against a number of micro-organisms, with the results shown in Table 2.

Table 2. ANTIMICROBIAL SPECTRUM OF 'RAMNACIN'

| Organism | Activity |
|---|---|
| Bacteriae: | |
| 1 *Bacillus cereus* var. *mycoides*, NCIB 926 | + |
| 2 ,, *subtilis*, NCIB 8610 | + |
| 3 *Proteus vulgaris*, NCIB 8261 | + |
| 4 *Streptococcus pyogenes*, NCIB 8190 | + |
| 5 *S. lutea*, NCIB 8553 | + |
| 6 *Micrococcus pyogenes* var. *aureus*, NCIB 6571 | + |
| 7 *Staphylococcus aureus* | + |
| 8 *Pseudomonas aeruginosa*, NCIB 8296 | − |
| Fungi: | |
| 10 *Helminthosporium* species | + |
| 11 *Penicillium notatum*, NRRL 1249 B-21 | − |
| 12 ,, *chrysogenum* Q 176 (Wis.) | − |
| 13 A *Penicillium* species | + |
| 14 An *Aspergillus* species | − |
| Yeasts: | |
| 15 *T. utilis*, NRRL y-900 | − |
| 16 *Candida guilliermondii* | − |
| 17 *Saccharomyces cerevisiae* Hansen | |
| 18 ,, ,, var. *ellipsoides* Hansen Dekker | − |
| 19 ,, *carlsbergensis* Hansen | − |

The substance is being tentatively named 'ramnacin' after Ramna, the place where the organism producing the antibiotic was isolated. Further work is in progress.

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April 28.

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## Tetrazolium Salts as Viability Indicators: Radiation-catalysed Reactions

TETRAZOLIUM salts have found various uses in both plant and animal tissues, and in the past six years more than seventy papers as well as several reviews[1] have appeared. But one of the most commonly used of these salts, 2,3,5-triphenyl tetrazolium chloride, can be reduced in various ways, as, for example, by certain naturally occurring compounds carrying —SH groups, if the *p*H[2] is greater than 9, by glucose[3] at temperatures exceeding 40° C. and by water[4] if exposed to strong radiant energy of wavelengths shorter than 450 mμ, especially at high *p*H[5]. Also extracted dehydrogenases and oxidases have caused reduction of triphenyl tetrazolium chloride *in vitro* (see, for example, ref. 6), and reducing agents like sodium hydrosulphite reduce it readily. Radiation can also cause some other curious effects, which I wish to report briefly.

I have verified the findings of Brown[7], namely, that suspensions of various oils could catalyse the light-induced reduction of triphenyl tetrazolium chloride, some oils being more active than others. Linseed oil and cedar wood oil, for example, were more effective than mineral oil (paraffin oil). A 750-watt mercury-vapour lamp was used and the suspensions, buffered to *p*H 7, were kept 1 ft. away in glass vials immersed in a 'Lucite'-walled water-bath maintained at 16° C. However, these reductions did not occur in the dark, and this is of considerable importance to seed testing and cytological work, a point to which Brown does not refer.

Brown also inferred that the results of Dyar[8] with blue tetrazolium (a ditetrazolium salt with 2-methoxy groups) were at fault in view of Brown's results with triphenyltetrazolium chloride. But I found blue tetrazolium was not affected by radiant energy including ultra-violet radiation, whether in aqueous solutions or in the presence of oil suspensions, even at *p*H up to 9. This seems to strengthen Dyar's conclusion that blue tetrazolium may be taking part in the Hill reaction in the presence of illuminated chloroplasts.

I also found that yeast (*Saccharomyces cerevisiae*) could further catalyse radiation-catalysed reduction of triphenyl tetrazolium chloride, so that this radiation-induced reaction was more rapid than with yeast in the dark or radiated aqueous solutions of the salt. In fact, even weak light from the window accomplished this acceleration of reduction in yeast–water suspensions to which equal amounts of 0·5 per cent triphenyl tetrazolium chloride buffered to *p*H 7 and 3 per cent glucose had been added. This proved to be a property of the cells themselves and not the substrate. However, dead cells (boiled), which would not reduce triphenyl tetrazolium chloride in the dark, did further catalyse the radiation-catalysed reduction of that salt, although not to such an extent as living yeast cells. It was also found that ground-up cells from which an extract was obtained by filtering through a bacterial filter could also further catalyse this radiation-catalysed reduction of triphenyl tetrazolium chloride. This reaction was largely inhibited by monoiodoacetate or sodium fluoride at $1 \times 10^{-3}$ *M*.

Perhaps this helps to explain the rapid reduction noted by Gunz[9] in yeast with triphenyl tetrazolium chloride, since he did not mention light. Gunz states that yeast was not inactivated [would still reduce the salt] by suspension in acetone or absolute alcohol for two periods of half an hour and subsequent drying, or air drying. Also, according to his table, air-dried yeast did not cause fermentation but did reduce triphenyl tetrazolium chloride. These results are rather puzzling. Drying yeast in the air and then re-suspending it in water with substrate may result in no fermentation at first, but there is nothing to prevent the yeast from growing from a spore stage and eventually causing fermentation. Also I found that soaking yeast in either acetone or ethyl alcohol solutions of more than 50 per cent concentration for 1 hr. with subsequent drying and re-suspension in water resulted in complete inactivation of the reduction of triphenyl tetrazolium chloride, while soaking the cells in 16 per cent acetone or alcohol for 24 hr., followed by drying and re-suspension, did not inactivate them. Cells of onions soaked in concentrated acetone for 1 hr. with subsequent washing and immersion in 0·5 per cent triphenyl tetrazolium chloride did not show the reduction reaction in the dark.

It appears, therefore, that although reduction of triphenyl tetrazolium chloride may not always be a good indication of viability in the sense that the entire respiratory mechanism is still functional, the lack of reduction in cells normally reducing it is a fairly certain sign that death has occurred. Avoidance of light is especially important in the case of triphenyl tetrazolium chloride, but not in that of blue tetrazolium. Oxygen tension must not be excessive.

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## Maximum Likelihood Calculation of *Rh* Gene Frequencies in Pacific Populations

In general, the calculation of maximum likelihood[1,2] estimates of gene frequencies requires the preliminary calculation of trial values, followed by the computation of corrections to the trial values, by a method which is essentially Newton's method of successive approximations for getting a root of an equation. In many Pacific populations (Gilbertese, Fijians, etc.), only four or five *Rh* types $CDe/C$ ($R_1R_1$), $CDe/c$ ($R_1r$), $CDE/c$ ($R_1R_2$), $cDE$ ($R_2$), and occasionally a little $cDe$ ($R_0$) are present[3], and the composition of the population can be explained by assuming that only three genes, $R_1$, $R_2$, and $R_0$, are present. For such cases the maximum likelihood equations can be solved explicitly, and the best estimates of the gene frequencies obtained without any process of successive approximations. If we designate the frequencies of the five phenotypes, in the order just mentioned, as $\overline{H}$, $\overline{K}$, $\overline{P}$, $\overline{T}$ and $\overline{Q}$, the solution of the maximum likelihood equations gives the following formulæ:

$$R_1 = \overline{H} + \overline{K}/2 + \overline{P}/2$$

$$R_2 = \frac{4(1-R_1) + \overline{P} - \sqrt{[4(1-R_1)+\overline{P}]^2 - 16(\overline{P}+\overline{T})(1-R_1)}}{4}$$

$$R_0 = 1 - R_1 - R_2$$

If desired, standard errors can be calculated in the usual way.

The derivation of these formulæ, and illustrative calculations, will be published elsewhere.

If the gene $R_z$ is present, as in Indonesians[4], an additional phenotype, $CDE/C$ ($R_1R_z$), whose frequency we may designate as $\overline{J}$, is present, and the above formulæ will not work. Williams[5] has published a modification of Fisher's method of free parameters which is applicable to such data. The same results can be obtained a good deal more simply by using the formulæ published[6] for dealing with the *MNS* system, to which this particular *Rh* system is exactly similar. It is only necessary to make use of the following equivalences:

| Short symbol | Phenotype | Equivalent *MNS* phenotype |
|---|---|---|
| *H* | *CDe/C* | *M* |
| *J* | *CDE/C* | *MS* |
| *K* | *CDe/c* | *MN* |
| *P* | *CDE/c* | *MNS* |
| *Q* | *cDe* | *N* |
| *T* | *cDE* | *NS* |

Taking $R_z = m_S$, $R_1 = m_s$, $R_2 = n_S$ and $R_0 = n_s$, trial frequencies which may be found by Mourant's methods[3] may now be inserted into the formulæ given for the *MNS* system and corrections found so as to obtain the maximum likelihood estimates.

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## Release of Histamine in Hepatectomized Dogs during Anaphylactic, Peptone and Tryptic Shock

It is well known that in dogs the liver is the main source of the histamine released during certain types of shock, such as anaphylactic and peptone shock[1]. However, shock can be obtained in hepatectomized dogs[2] and some evidence, particularly recent work by Feldberg and Schachter[3], indicates that under certain conditions tissues other than the liver release relatively large amounts of histamine.

I have found that histamine occurs in the blood of hepatectomized dogs during anaphylactic, peptone and tryptic shock. Studies have also been made of the blood coagulation time, the amount of platelets and the hæmatocrit during shock.

The histamine in blood was estimated according to Code's method. Hepatectomy was carried out by

Table 1. HISTAMINE RELEASE DURING SHOCK IN HEPATECTOMIZED DOGS

| Dog No. | Type of shock | Time (min.) | Blood clotting time (min.) | Hæmatocrit | Histamine (μgm./ml.) | Platelets* | Observations |
|---|---|---|---|---|---|---|---|
| 1 | Anaphylaxis | 0<br>5<br>10 | 1·30<br>2·45<br>4·30 | 49<br>48<br>46 | 0·070<br>0·100<br>0·350 | 0·30<br>0·05<br>0·00 | Recovery after 60 min. |
| 2 | Anaphylaxis | 0<br>4<br>8 | 4·30<br>8·30<br>6·30 | 25<br>25<br>24 | 0·00<br>0·04<br>0·150 | 1·25<br>0·40<br>0·60 | |
| 3 | Anaphylaxis | 0<br>2<br>10 | 3·20<br>5·00<br>incoag. | 18<br>17<br>16 | 0·025<br>0·330<br>0·220 | —<br>—<br>— | |
| 4 | Peptone† | 0<br>2<br>10 | 4·25<br>4·00<br>incoag. | 48<br>40<br>42 | 0·025<br>0·600<br>0·400 | —<br>—<br>— | |
| 5 | Peptone | 0<br>2<br>10 | —<br>—<br>— | 51<br>49<br>50 | 0·060<br>0·480<br>0·400 | 0·35<br>0·40<br>0·05 | |
| 6 | Peptone | 0<br>2<br>10 | —<br>—<br>— | 27<br>24<br>0·45 | 0·000<br>1·000<br>0·450 | 0·50<br>0·35<br>0·30 | |
| 7 | Trypsin‡ | 0<br>3 | 4·5<br>incoag. | 55<br>45 | 0·000<br>0·040 | —<br>— | Death 60 min. after injection |
| 8 | Trypsin | 0<br>2<br>8 | 2·0<br>6·0<br>6·30 | 24<br>21<br>21 | 0·040<br>0·350<br>0·100 | —<br>—<br>— | |
| 9 | Trypsin | 0<br>3 | 4·0<br>incoag. | 32<br>24 | 0·000<br>0·000 | 0·10<br>0·00 | Death 60 min. after injection |

* Given as c.c./100 ml. of blood. † 300 mgm./kgm. of Witte peptone. ‡ 3 mgm./kgm. of crystalline trypsin.

the Firor technique. Dogs were sensitized with horse serum by the Waters and Markowitz potassium alum method. Blood samples were taken from the carotid artery after hepatectomy and at 2–10 min. after the beginning of shock. Platelet volume was measured by the Van Allen thrombocytocrit. Table 1 summarizes the results of typical experiments for each type of shock.

In hepatectomized dogs, histamine is released in great amounts during peptone and anaphylactic shock. Considering Code's[4] observations for normal dogs, extra-hepatic release of histamine can explain the observed fall of blood pressure in hepatectomized animals during shock, although other depressor substances may be liberated as well. A rise of histamine in the blood was obtained in two out of eight hepatectomized dogs during tryptic shock. Death occurred frequently as a result of massive intravascular coagulation.

Hæmodilution was observed in almost all experiments during the first minutes of shock, in contrast to the classical hæmoconcentration observed during shock in normal animals. Hæmoconcentration occurred, however, in some hepatectomized animals after 30–60 min.

Increase of the blood-clotting time was the rule. In confirmation of other workers[5], fibrinolysis following blood coagulation was observed also in hepatectomized, shocked dogs, and the platelets decreased or disappeared from the blood.

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## The Photonuclear Effect and the Complex Potential-Well Nuclear Model

THE recent success of the complex potential-well nuclear model applied to neutron and proton scattering from complex nuclei[1–3] led me to investigate this model for the photonuclear process.

The so-called 'giant resonance' for the photonuclear effect has long been known; however, of the most successful models[4–6] to date, that of Goldhaber and Teller[4], while explaining many of the general features of the $(\gamma,n)$ cross-section, fails to account in any detailed manner for the width of the resonance. On the other hand, the more detailed treatment of this general hydrodynamical model by Steinwedel and Jensen[5] does give the large resonance width only at the expense of the *ad hoc* introduction of a 'coefficient of viscosity' or damping coefficient. (A more serious defect of all these hydrodynamic, harmonic oscillator models is the theoretical prediction of similar 'giant resonances' at higher energies which, of course, have not been observed.)

The present work assumes that the incident photon is absorbed by one nucleon giving rise to one of two effects. In one of these the nucleon leaves the nucleus directly, carrying with it all the available energy (and angular momentum)—this can be termed the 'direct' effect. In the other, or 'indirect', effect, the nucleon is unable to escape with the total energy available and some sort of compound nucleus results which decays in the usual fashion. It is this latter process which may be thought of as being caused by the imaginary part of the potential, as this part represents the nuclear absorption.

Since the 'square' potential-well lends itself best to numerical computations, use has been made of it in which the potential is

$$\begin{aligned} V &= -V_0(1 + i\epsilon) \quad & r < R \\ &= 0 & r > R. \end{aligned}$$

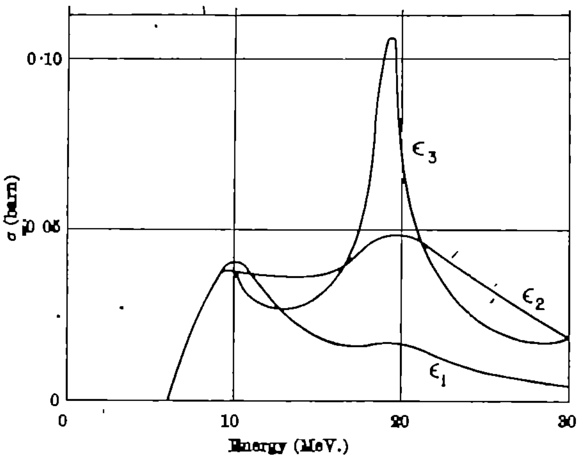

Fig. 1. The total photonuclear cross-section as a function of energy for three different forms of ε, the imaginary part of the square-well potential. For $\varepsilon_1$, $\varepsilon_2$, $\varepsilon_3$, ε is a constant (0·05), Gaussian, and linear with energy respectively

Feshback, Porter and Weisskopf[2] obtain a striking fit for neutron scattering of incident energy less than about 3 MeV. with ε constant and equal to 3 per cent; for 18-MeV. protons[3] ε is of the order of 25 per cent; while for high-energy neutron scattering ($\gtrsim$ 90 MeV.) values of 100 per cent or even higher seem necessary[7]. It thus seemed advisable to investigate the dependence of the (γ,*n*) cross-section on the form[8] of ε, and in this preliminary calculation three different forms of ε have been used:

$$\varepsilon = 0{\cdot}05 \qquad (1)$$

$$\varepsilon = 0{\cdot}330 \exp -(2{\cdot}473 - \hbar\omega/10)^2 \qquad (2)$$

$$\varepsilon = (1{\cdot}05\hbar\omega - 6{\cdot}58) \times 10^{-2} \qquad (3)$$

with $V_0 = 40$ MeV.; $R = 1{\cdot}40\ A^{1/3} \times 10^{-13}$ cm.; and $\hbar\omega$, the incident photon energy in MeV. The constants in (2) and (3) have been obtained by requiring ε to fit the values used in the initial neutron-scattering calculation[1] and in the proton-scattering calculations[3].

The results of a calculation of the total cross-section ($\sigma_d + \sigma_{ind}$) assuming an average nucleon binding-energy of 8 MeV. and with $A = 125$ are shown in Fig. 1. Only for the case where ε is linear with energy (labelled $\varepsilon_3$ in Fig. 1) does a marked resonance appear; however, none of the curves bears very close resemblance to the experimental photonuclear cross-sections in the neighbourhood of antimony.

Table 1 presents a comparison of the various parameters of the photonuclear cross-section curves for the different forms of ε, and also the experimental results of Montelbetti, Katz and Goldemberg[9] for antimony. Examination of the table also shows that the case of ε linear with energy most nearly approximates to the experimental values, even though the integrated cross-section is almost an order of magnitude too low. However, no further resonances appear at higher energies, as is shown by calculations above 30 MeV. (not shown in Fig. 1).

Table 1. COMPARISON OF SEVERAL PARAMETERS OF THE GIANT PHOTON RESONANCE FOR SEVERAL FORMS OF THE IMAGINARY PART OF THE SQUARE-WELL POTENTIAL, ε, WITH EXPERIMENTAL VALUES

| ε | Γ (MeV.) | $E_m$ (MeV.) | $\sigma_m$ (barn) | $\int_0^\infty \sigma dE$ (MeV.-barn) |
|---|---|---|---|---|
| Constant ($\varepsilon_1$) | 5·10 | 10·0 | 0·040 | 0·204 |
| Gaussian ($\varepsilon_2$) | 8·65 | 19·7 | 0·048 | 0·415 |
| Linear ($\varepsilon_3$) | 3·80 | 19·3 | 0·105 | 0·408 |
| Experimental (ref. 9) | 7·2 | 15·2 | 0·44 | 3·1* |

* Cross-section integrated to 23 MeV.

Further calculations are in progress and a detailed discussion of this model will be submitted for publication shortly.

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## Quantal Nature of the End-plate Potential

THE liberation of acetylcholine from the motor nerve endings in skeletal muscle is believed to take place in a quantal manner. The arrival of the action potential at the nerve terminals elicits the release of a number of packets of acetylcholine molecules of fairly uniform size, each of them producing a unit of depolarization in the post-synaptic membrane. This view is derived from the statistical analysis of the random step-wise fluctuations in the amplitude of successive end-plate potentials recorded from single neuromuscular junctions blocked by excess magnesium ions or lack of calcium ions[1]. The average magnitude of the steps was found to be identical with the mean size of the miniature end-plate potentials recorded from the same junction and due to the spontaneous extrusion of single acetylcholine quanta from the resting nerve endings.

At ordinary room temperature all the acetylcholine packets released by one nerve impulse act practically simultaneously on the end-plate membrane. Therefore the end-plate potential resulting from the sum of a number of units has usually a smooth rising phase, even in preparations blocked by magnesium ions, where the quantum content of the response has been considerably decreased. Sometimes, however, the rising phase shows notches that indicate a small degree of asynchronism in the liberation of the units (cf. Fig. 3, $C_1$ of ref. 1). It has been found that lowering the temperature greatly accentuates these discontinuities. In extreme cases the leading edge of the end-plate potential is made up of a number of steps arising with slightly different, and apparently random, latencies after the stimulus artefact. This is clear in the records shown in Fig. 1. They illustrate in a simple way the quantal nature of the process of neuromuscular transmission.

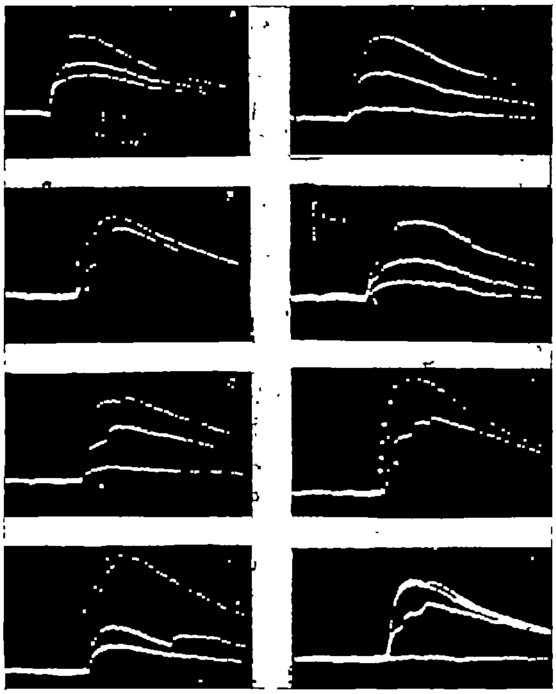

Fig. 1. End-plate responses of single neuromuscular junctions of the M. ext. l. dig. IV of the frog recorded with intracellular micro-electrodes. The Ringer's fluid contained 15 m.mole/l. of magnesium in order to block transmission and $10^{-6}$ prostigmine to increase the size of the unit response. All the records were taken at 6·3° C., except *B* (5° C.) and *F* (9·4° C.). The voltage calibration of *A* applies to all records but *F*. Time calibration is the same for all the records. The rising phase of the end-plate potential, normally smooth, is made up by steps the positions of which are marked by arrows in some of the records

Below about 10° C. some degree of asynchronism was observed in most of the end-plates examined. As the release of acetylcholine is caused in some way by the nerve action potential, the time course of which lengthens as the temperature is lowered, one may assume that the period during which transmitter quanta can leave the nerve terminals would also become longer at lower temperatures. The chances of observing random delays between the release of different units would, therefore, become greater.

The differences existing among end-plates of the same muscle examined at constant temperature seem to indicate that morphological or 'geometrical' factors have some influence on the asynchronism of the end-plate response. For example, one might expect small differences in the time of arrival of the action potential at different spots of the nerve terminals at which the release of the transmitter can take place.

The possibility had to be considered that the steps in the end-plate potentials might be due to a multiple innervation of the end-plate. It is known that end-plates of the frog muscle may receive innervation from two or more axons[2]. If these fibres have different diameters, and in consequence different thresholds and conduction rates, the end-plate potential may show two or more steps depending on the stimulus strength (Castillo and Katz, unpublished observations). In the present experiments, however, no evidence of such multiple innervation could be obtained when the intensity of the nerve stimulus was varied.

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## An Interference Optical Alinement Method

An interference method for the centring of optical systems with one and two surfaces has been described by Harle[1]. In the same paper, a number of principles applicable to more general alinement problems were enunciated. In the present communication, the extension of these principles to the alinement of co-axial optical systems with a large number of surfaces is discussed.

In applying interferometry to the alinement of co-axial optical systems, the spatial distribution of non-localized interference patterns is utilized. Thus the necessity of image location is eliminated and a technique combining the advantages of aperture sight and image alinement methods is provided.

The general optical arrangement is shown in Fig. 1. Light from a coherent source *A* forms an interference pattern distributed spatially in the axial direction of the components to be alined, *C*. Observation of the fringe pattern is made in one of an infinite number of planes of observation *B*. Then, since the interference pattern observed is, in effect, an image of the fringe pattern, real or virtual, formed in a plane conjugate to *B*, alinement may be achieved by arranging the components *C* in turn, in a selected order, until the centres of the direct and the secondary fringe patterns, as observed with the viewing microscope *D*, are coincident in the plane *B*. For alinement by reflexion, the transmission arrangement is modified as shown in the dotted portion of Fig. 1. Here, a reflecting surface is included as a component of *C*, and light from a half-reflecting mirror *E*, designed to give no displacement of the transmitted light-path, is directed to a new plane of observation $B^1$.

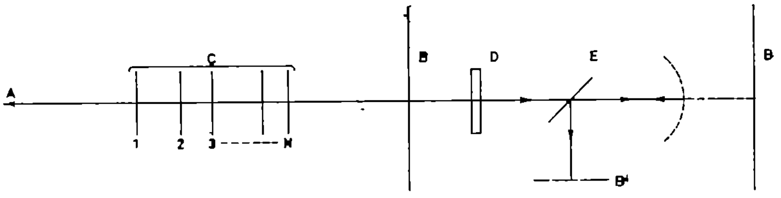

Fig. 1

For each class of observation, the interferometer requirements are in principle the same. In the first instance, the fringes must be distributed spatially in the direction of alinement. Secondly, the intensity distribution of the fringe pattern must be sufficiently sharp to permit precise detection of the centre fringe displacement.

Several interferometers, which are adaptations of well-known interferometer arrangements, have been developed for this purpose. The first of these utilizes a bi-prism and slit. The components of *A* thus produced are displaced laterally with regard to the axis of alinement and straight-line fringes result. For alinement in two dimensions, rotational methods or a double bi-prism having two individual prisms crossed at right angles and a cross-shaped slit of the same orientation are used. The resultant fringe pattern appears in the form of a series of cross-shaped fringes. For both arrangements a white-light source is required to identify the centre fringe. A second instrument employs a point source and the Michelson interferometer with its mirrors adjusted for parallelism. The components of $A$ are now displaced in the axial direction of the system, and the resultant fringes are circular in nature with an intensity distribution resembling that of similarly shaped localized Michelson fringes. This arrangement eliminates the necessity of identifying the centre fringe. In an improved version of the apparatus, the Michelson interferometer is dispensed with and a Fabry–Perot étalon substituted. The fringes produced, which are now much sharper and of the multiple-beam variety described by Tolansky[2], permit increased precision of alinement.

The theory of the method is similar to that of the image alinement method, in which an object is moved to a series of mechanically alined positions in planes conjugate to $B$. Now, however, the errors due to mechanical alinement are eliminated. The interference method therefore yields, as well as a high operational convenience, a previously unattained precision when any reasonable number of components are alined. In the experiments performed, alinements of as many as twenty components to a common axis have been made. Moreover, the component surfaces need not be surfaces of revolution and may include asymmetrical arrangements such as sphero-cylinders and torics. Such cases are characterized by different fringe magnifications in different meridional planes.

Details of this work will be published in full elsewhere. Accounts of applications of the method in a number of related fields of investigation will also appear in due course.

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## Brightening of the Solar Limb in the Far Ultra-Violet

DURING an eclipse of the Sun, the obscuration of the disk causes a corresponding fall in the electron density in the lower layers of the ionosphere. This fall, and the subsequent recovery, have recently been used to locate the sources of ionizing radiation which were responsible for the electron production in the *E*- and *F*1-layers during the eclipse of February 25, 1952, in Central Africa[1]. At this epoch the level of solar activity was fairly high, and it was found that 36 per cent of the total ionizing radiation was emitted near the east and west limbs from well-defined sources which were additional to the uniform background radiation from the disk. These sources coincided in position quite closely with areas from which the coronal line at 5303 A. was emitted strongly, and they were assumed to be associated with short-lived centres of chromospheric activity. Their intensities were so great that any permanent limb brightening which may have existed at the time would have been masked unless it was very pronounced.

The eclipse of June 30, 1954, coincided with a period of extremely low solar activity, and the astronomical data suggest that the Sun's disk was almost completely devoid of any features indicating the existence of even local centres of activity. Measurements of electron density were made at Inverness and Slough, about 700 km. apart, and the detailed correlation between the changes which were observed in the *E*- and *F*1-layers strongly suggests that the locations of the respective sources of ionizing radiation must have been the same for both layers. Methods of analysis similar to those described earlier[1] have been used; but, in spite of the absence of any visible centres of solar activity, only 92 per cent of the ionizing radiation can be accounted for in terms of a uniformly radiating disk.

The locations and relative intensities of the residual sources cannot be determined very accurately because of small anomalies in the behaviour of the ionosphere and also because the recombination coefficients of the layers are not accurately known. However, for both the *E*- and *F*1-layers at Inverness and at Slough, the experimental evidence points to the existence of brightening of the limb near the equator and darkening of the limb at the poles, extending in both cases over arcs of 40°–60°. It is also necessary to assume the existence of a small bright spot at $P = 255°$, $r = 0 \cdot 95\, R_{\odot}$, and in this connexion it is interesting to note that faint coronal radiation at 5303 A. was observed on the same day by Müller[2] in the arc $P = 232°–247°$.

The provisional locations and relative intensities of the sources controlling the *E*- and *F*1-layers are given in Table 1. Although the radiation in question is in the far ultra-violet, it may be significant that a similar intensity distribution has been reported recently by Christiansen and Warburton[3] for solar radio noise on 21 cm.

Table 1. SOURCES OF *E*- AND *F*1-LAYER IONIZING RADIATION, JUNE 30, 1954

| Source | Position angle ($P$) | | Intensity (per cent) both stations |
|---|---|---|---|
| | Inverness | Slough | |
| Disk | — | — | +92 |
| W. limb | 240–280 | 240–300 | + 6 |
| E. limb | 60–120 | 60–120 | + 4 |
| N. pole | 330– 30 | 330– 30 | − 2 |
| S. pole | 150–210 | 150–210 | − 4 |
| Spot | 252<br>$r = 1 \cdot 0\, R_{\odot}$ | 258<br>$r = 0 \cdot 9\, R_{\odot}$ | + 4 |
| | | Total | 100 |

$P$ = degrees east from the north point; $R_{\odot}$ = radius of photosphere

In view of the unusual quietness of the Sun during this eclipse, it seems possible that the observed departures from a uniformly radiating disk may be a permanent feature and that they indicate brightening of the limb near the equator equal to about + 5 per cent and darkening of the limb near the poles equal to about − 3 per cent of the total radiation. If the isolated bright spot is assumed to be a temporary feature, the permanent uniform disk radiation contributes 96 per cent of the total.

This work was carried out as part of the programme of the Radio Research Board, and this communication is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

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## Sensitivity of Alpha- and Beta- Lead Azide

LEAD azide, $PbN_6$, exists in two allotropic forms[1,2], one (α) orthorhombic and the other (β) monoclinic. α-Lead azide is readily prepared by mixing in the normal way solutions containing azide and lead ions; β-lead azide crystallizes as needles when aqueous solutions of sodium azide and lead nitrate inter-diffuse slowly[1]. Table 1 summarizes the crystallographic relations[1,3]. Both forms are explosive and α-lead azide is in common use as a detonator. It is said[1,2] that β-lead azide is much more sensitive and dangerous than α-lead azide.

Table 1. PROPERTIES OF THE TWO CRYSTALLINE MODIFICATIONS OF LEAD AZIDE, $PbN_6$

| Species | Unit cell size and shape (A.) *a* | *b* | *c* | No. of molecules in unit cell | Enthalpy of formation $\Delta H_f$ (kcal. gm.mole$^{-1}$) |
|---|---|---|---|---|---|
| Orthorhombic α-$PbN_6$ | 6·628 | 11·312 | 16·246 | 12 | 115·5 |
| Monoclinic ($\varphi = 90° 10'$) β-$PbN_6$ | 5·090 | 8·844 | 17·508 | 8 | 115·8 |

In the course of extensive studies of azide thermochemistry (to be published), the standard heats of formation of both explosive and non-explosive azides have been measured. A strong correlation between the heats liberated on explosive decomposition on one hand, and both sensitiveness to impact or friction and speed of detonation[4] on the other, has been found[5]; there is no similar correlation of heats of decomposition with speed or ease of slow thermal decomposition. Although it has not been possible to assess sensitiveness to impact or friction in completely satisfactory terms, and although true detonation velocities have still to be measured with precision, the principal reason why this simple correlation has not been stressed hitherto is the very unreliable nature of previous thermochemical data.

It was thought interesting to examine the thermochemistry of the two forms of lead azide and to ascertain whether β-lead azide is thermodynamically less stable than α-lead azide. The standard enthalpy of formation of crystalline α-lead azide was found to be + 115·5 kcal. mole⁻¹ from a precipitation experiment[5]. Determination of the heat of formation of β-lead azide in this way is not possible. To derive this quantity an electrical method was devised in which the changes of the thermodynamic functions in the reaction (1) could be measured:

$$\alpha\text{-PbN}_6(\text{cryst}) \rightarrow \beta\text{-PbN}_6(\text{cryst}) \qquad (1)$$

Two cells, *A* and *B*, were constructed with lead amalgam – lead azide electrodes and sodium azide electrolyte. The reproducibility of metal–metal azide (including both Pb-$PbN_6$ and Ag-$AgN_3$) electrodes has been well established[6]. In cell *A* the two electrodes lead-α-lead azide, lead-β-lead azide were connected by a sodium azide (*M*/10) salt bridge; in cell *B*, by a pair of silver–silver azide electrodes back-to-back:

Cell *A*: $\overset{-}{\text{Pb}} \mid \alpha\text{-PbN}_6 \mid \text{NaN}_3 \mid \beta\text{-PbN}_6 \mid \overset{+}{\text{Pb}}$.

Cell *B*: $\overset{-}{\text{Pb}} \mid \alpha\text{-PbN}_6 \mid \text{NaN}_3 \mid \text{AgN}_3 \mid \text{Ag} \mid \text{AgN}_3 \mid \text{NaN}_3 \mid \beta\text{-PbN}_6 \mid \overset{+}{\text{Pb}}$

At 25° C. both cells gave an electromotive force $E = 0·0136$ V.; thus for reaction (1), $\Delta G = 314$ cal. mole⁻¹. The temperature coefficient of the electromotive force was zero within the limit of experimental error ($dE/dT$) $< 10^{-5}$ V. deg.⁻¹, corresponding to $\Delta S < 0·23$ cal. deg.⁻¹. These values lead to an enthalpy change for reaction (1) of $\Delta H \sim 0·30 \pm 0·05$ kcal. mole⁻¹, and the value 115·8 kcal. mole⁻¹ for the enthalpy of formation of β-lead azide. Over a period of several days, especially at higher temperatures, the e.m.f. of the cells at 25° C. diminished slowly from the initial value, probably owing to the slow growth of α-$PbN_6$ at the β-electrode. For this reason very precise values of $dE/dT$ and $\Delta H$ were difficult to obtain.

The difference, 0·3 in 115·5 kcal. mole⁻¹, in enthalpies of formation is very small compared with the differences between other azides of differing sensitivity[5]. This result, together with the fact that β-lead azide gave no trouble in manipulation, raises doubts about the much greater sensitiveness it is said[1,2] to possess. A re-examination of its behaviour during mechanical initiation of explosion, and a redetermination of its detonation velocity would be valuable.

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## Unit-Cell Dimensions of γ-Lauric and γ-Myristic Acids

Thibaud and Dupré La Tour[1] discovered the polymorphism of the fatty acids and observed that only in the case of myristic acid did the γ-form appear, and that infrequently after recrystallization of this acid at 0° C. This form was characterized by a 'long spacing' of 37 A., and could be converted to the more common α-form by heating to within a few degrees of its melting point.

Samples of α-lauric acid and α-myristic acid were stored in this laboratory for a period of two years at room temperature and were then ground prior to taking their X-ray powder diffraction photographs. The lauric acid had changed to a different form but the myristic acid was still in the α-form. However, after standing for a further few days in the ground state, the myristic acid also had become transformed to a new structure giving a diffraction pattern almost identical to that of the transformed lauric acid. This new form is thus the stable one at room temperature, although the α-form is normally obtained on recrystallization both from solvents at room temperature and from the melt.

The diffraction patterns of the new form are unusual in that no 'long spacings' are immediately apparent, as they are on the diffraction patterns of all long-chain aliphatic compounds previously studied. The absence of these spacings makes the interpretation of the powder patterns difficult but, by a slight modification of Vand's[2] method, the photographs were indexed and the unit cell dimensions determined. For lauric acid $a = 22·1 \pm 0·1$, $b = 5·24 \pm 0·05$, $c = 32·0 \pm 0·1$ A., $\beta = 99° 58'$, $\alpha = \gamma = 90°$, observed density $= 1·09 \pm 0·01$ gm./cm.$^{-3}$, calculated density 1·09 gm./cm.$^{-3}$ (assuming twelve molecules per unit cell). For myristic acid $a = 22·2 \pm 0·1$, $b = 5·14 \pm 0·05$, $c = 37·2 \pm 0·1$ A., $\beta = 100° 50'$, $\alpha = \gamma = 90°$, calculated density 1·09 gm./cm.$^{-3}$ (assuming twelve molecules per unit cell). The transformed myristic acid has a 'long spacing' ($c \sin \beta$) of 36·5 A. and is easily reconverted to the α-form by heating to within a few degrees of its melting point, and so is identified with Thibaud and Dupré La Tour's γ-form.

The distance between alternate carbon atoms in the plane zig-zag hydrocarbon chain in α-lauric acid is 2·52 A.[3], while the corresponding distance in potassium laurate is 2·59 A.[4]. It is thus to be expected that a myristic acid molecule will be longer than a lauric acid molecule by between 5·0 and 5·2 A., depending on its crystallographic environment. The difference in length of the $c$-axis in the two acids is 5·20 A. and the difference in long spacing is 5·00 A., so that in the γ-form the molecules must lie approximately parallel to the $c$-axis of the cell, that is, approximately perpendicular to the (001) plane. With such large unit cells, the indexing of the powder photographs is ambiguous except for a relatively small number of reflexions, so that the detection of systematic absences is difficult and uncertain. However, on both photographs it appears that $\{h\,0\,l\}$ reflexions with $(h + l)$ odd are absent. The probable space group of the γ-form is thus either $Pn$, $P2/n$ or $P2_1/n$.

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## Rainfall and Biennial Bearing in Tung (*Aleurites montana*)

Examination of past records of yields of tung trees and rainfall in corresponding periods has given rise to a hypothesis to explain the cause of biennial bearing, to which this crop is prone.

Harvesting of the tung crop in Nyasaland begins about May of each year, and for six consecutive harvests up to 1954, an alternating rhythm of high and low yields was produced. Had the biennial rhythm been maintained, the tung crop due to be harvested in 1955 would have been low; but field observation on immature fruit predicts that the crop will in fact be on the high side and the rhythm broken.

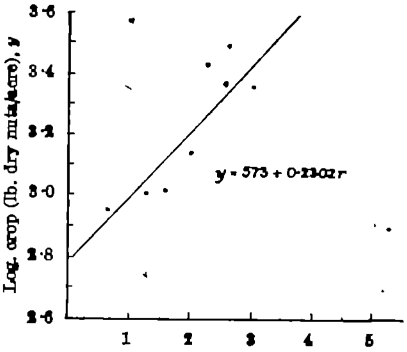

Fig. 1. Response of subsequent yield per acre to rainfall at flower primordial stage. Correlation coefficient, rain/yield, is + 0·8421 ($P = 0·01$, $P = 0·001$)

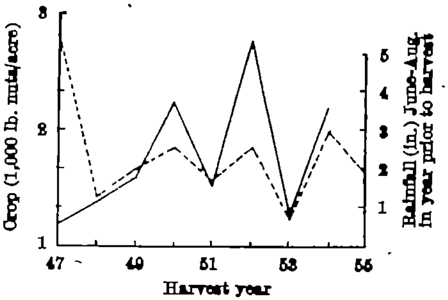

Fig. 2. Seasonal sequence of rainfall at flower primordial stage and subsequent crop. ———, yield; – – – –, rainfall

An examination of rainfall totals coinciding with various stages of the growth sequence, and subsequent crop data taken from one field at the Tung Experimental Station, yielded no significant correlation coefficients for any of the following stages: (*a*) rainfall for the sixteen months period from initiation of flower primordials to fruit maturation; (*b*) rainfall for the period of flower opening and pollination correlated with the resulting crop; (*c*) rainfall during period of fruit-set and the resulting crop; and (*d*) rainfall during fruit maturation period correlated with the resulting crop.

However, a positive correlation coefficient of + 0·8421 between total rainfall for the months June–August and crop for the following year reaches significance between $P = 0·01$ and $P = 0·001$. The rainfall for this period refers to the time at which flower primordials are being formed and is between nine and twelve months before the resulting crop is harvested. The correlation is illustrated in Figs. 1 and 2.

The poor correlation with the 1946 rain and 1947 crop can probably be explained by the fact that the tung had not yet come into full bearing. The rainfall for June–August 1954 totalled 1·93 in., which is the mean for the period under review; thus the crop to be harvested in 1955 may be expected to be rather more than the mean for previous years, taking into account the increased age and size of the trees.

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## Photo-reactivation of *Botrytis fabae* Sardiña measured by a Local-lesion Technique

WHEN leaves of broad bean (*Vicia faba* L.) are sprayed with suspensions of spores of *Botrytis fabae* Sardiña they develop chocolate-coloured lesions[1]. By rubbing suitably diluted spore suspensions over the upper surfaces of leaves of the variety Seville Longpod with the forefinger, and then keeping the inoculated plants at about 20° C. in a saturated atmosphere, we find that the discrete lesions are uniformly distributed and, after 24 hr., can be easily counted. The lesions provide an assay method comparable with counting the local lesions that are produced in plants by many viruses, and we have used them to measure how ultra-violet radiation affects the infective capacity of the spores.

Ultra-violet radiation, more than 95 per cent of wave-length 2537 A., was provided by a Hanovia XII lamp. Spore suspensions (0·3 ml. samples contained in cavity slides) were exposed at 40 cm. from the lamp, where the radiation intensity was 173 μW. per sq. cm. After exposure for various times, the irradiated suspensions were inoculated to halves of bean leaves, the opposite halves of which were inoculated with unirradiated spores, and the plants were then placed in a saturated atmosphere and kept in darkness for 24 hr. In these conditions, about 90 per cent of the original infectivity of the spore suspensions was destroyed by exposure for 3½ min. to the radiation. The spores of *B. fabae* are multinucleate and the rate of inactivation did not correspond to a first-order reaction (that is, it is a so-called 'multiple-hit' curve).

In studying the rate of inactivation, inoculated plants were kept in the dark because the effects of ultra-violet radiation on some biological systems can be mitigated if the systems are later exposed to visible light, a phenomenon that has been called photo-reactivation[2]. For example, when irradiated suspensions of bacteria or some fungi are cultured on agar in the light, more grow than if the cultures are kept dark. Similarly, irradiated preparations of some viruses[3,4] can be photo-reactivated; but with these the phenomenon does not occur if the viruses are exposed to light *in vitro*, but only when infected host cells are illuminated. No previous tests seem to have been made to see whether the pathogenicity of irradiated fungi is influenced by visible light, and we have therefore made some with *B. fabae*. Table 1 records the results of two experiments in which spores were irradiated for 3½ min., and then exposed to light for 0, 2, 4 or 8 hr., before all lots were inoculated to plants 8 hr. after irradiation. Plants with four sets of paired leaves were inoculated, and the different treatments were arranged on half-leaves in a 4 × 4 latin square design. Half the inoculated plants were then placed in daylight and half in darkness.

The half-leaves inoculated with spores exposed to visible light produced more lesions than those inoculated with spores kept for 8 hr. in the dark, and the magnitude of the difference usually increased with increases in the length of time the spores were exposed to light. Regardless of the time of exposure to light before inoculation to plants, plants kept in daylight after inoculation always produced significantly more lesions ($P > 0{\cdot}01$) than those kept in darkness (for statistical analyses[5], the numbers of lesions, $n$, were transformed to $\log (n + 10)$). As plants inoculated with unirradiated spore suspensions produce the same numbers of lesions whether they are kept in the light or dark, this increase with irradiated suspensions when inoculated plants were in the light is again attributable to photo-reactivation. The results show that some spores can still be photo-reactivated after 8 hr. in darkness, and they suggest that spores on the leaves of a host respond more readily to light than when they are *in vitro*, for the inoculated plants were in daylight for only about three hours.

Table 1. EFFECTS OF DIFFERENT LENGTHS OF DAYLIGHT ON THE INFECTIVITY OF ULTRA-VIOLET IRRADIATED SPORE SUSPENSIONS OF *Botrytis fabae* (SARDIÑA)

| Post-inoculation treatment (hr. in daylight after ultra-violet treatment) | Mean lesion count/half-leaf | | | | |
|---|---|---|---|---|---|
| | 0 | 2 | 4 | 8 | Mean |
| Exp. 25 | | | | | |
| Plant in darkness | 20 | 105 | 204 | 185 | 100 |
| Plant in daylight | 214 | 426 | 407 | 480 | 362 |
| Exp. 27 | | | | | |
| Plant in darkness | 25 | 46 | 105 | 194 | 93 |
| Plant in daylight | 50 | 145 | 241 | 397 | 208 |

As with other biological systems, the amount of photo-reactivation increases with increasing amounts of exposure to ultra-violet radiation. After exposure for 4½ min., the ratio of numbers of lesions on plants in the light to those in dark was 1½ times as great as after exposures for 3½ min.

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## Physiological Races of *Puccinia polysora* Underw.

OUR early studies on the resistance of maize seedlings to this rust in East Africa led to the hypothesis that a dominant major gene controls the hypersensitive type of resistance[1]. During the past two years, we have bred many lines of maize that are pure for this gene, by selfing resistant plants selected from Central American types and by selfing first crosses between resistant Central American types and East African susceptible types. In seedling-inoculation experiments, variation occurs in the manifestation of the hypersensitive reaction, from necrotic lesions without development of sori (up to eighteen days) to necrotic lesions with well-developed small sori. On a system of recording based on, but modified from, that employed by the wheat breeders (see ref. 2), we have classed the former as 01 (no sori) and the latter as 1 (small sori), the fully susceptible reaction, with large sori and little or no surrounding chlorosis, being class 4.

From the start of this work we had in mind the possibility that more than one physiological race of *P. polysora* might exist in East Africa. Collections of uredospores were made in three separate regions—

Zanzibar, Northern Tanganyika and Uganda. Each was established in a separate glasshouse and has been so maintained since; although owing to the great production of spores and the movement of attendants between houses we cannot be sure that contamination has not occurred. Every maize family tested in the course of our breeding studies has been inoculated in two and usually all three houses. Through nearly two years and 1,600 family tests, the reaction of each individual maize family was identical, within the expected errors of experiment, in each house.

The position at the end of 1954 was therefore that we had no reason for thinking that more than one physiological race of *P. polysora* had become established in East Africa. This was supported by observations on our maize lines when tested during 1953 and 1954 in the field, in such widely separated sites as southern Tanganyika and Uganda; in general, the field behaviour corresponded with the juvenile reactions recorded in our glasshouses.

Table 1

| Origin of maize lines | No. of separate families tested | Juvenile reaction to original race | Juvenile reaction to new race |
|---|---|---|---|
| Selfs of AFRO 29 (Colombia 2) | 3 | Class 01 | Class 4 |
| Second selfs from cross, AFRO 29 × Katumbili | 2 | Class 01 | Class 1 |
| Second selfs from cross, AFRO 29 × Durum | 2 | Class 01 | Class 4 |
| Self of AFRO 250 (Amarillo Caryotepe ex Nicaragua) | 1 | Class 01 | Class 4 |

In January 1955, however, during routine testing of certain maize lines in our glasshouses, we obtained a reaction strongly suggesting a mixture of two physiological races of the fungus; the expected hypersensitive lesions were interspersed with a few large sori characteristic of full susceptibility. Isolations were made from the large sori and the suspected new race established. The new race was then inoculated to a number of maize lines known to behave uniformly to the original race; and simultaneous control inoculations with original-race spores were made.

In the course of these experiments we encountered some anomalies that require further study. A number of pure lines gave identical reactions to both races of the fungus. In Table 1 are shown results of experiments in which a clear differential reaction has been recorded.

The conclusion that a new race of *P. polysora* has appeared in our glasshouses seems inescapable. How it has arisen cannot be decided; but since the nearest known field occurrence of this rust is more than a hundred miles from Muguga and no newly collected material has been introduced into our houses for more than two years, it is unlikely that the new race has accidentally entered our houses from outside.

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## A New Method for counting Live and Dead Bull Spermatozoa

When bull semen is diluted in a buffered (pH 7·0) solution of sodium chloride which is isotonic with bull seminal plasma (Δ, − 0·54° C.) and is filtered through a layer of small glass balls, the dead spermatozoa are retained by the filter while live ones pass through; it is therefore possible to estimate the percentage dead spermatozoa in bull semen by comparing the opacity of diluted semen before and after filtration.

Estimations were made on twenty-six untreated samples of bull semen and on three samples which contained different proportions of killed spermatozoa. The spermatozoa were killed by rapidly pipetting semen at 37° C. into tubes pre-cooled to 5°, 0° and − 10° C.

For filtration, the semen was diluted by adding a few drops (0·1–0·2 ml.) of semen to 20 ml. buffered saline. In the test, 10 ml. of the suspension was pipetted gently on to the dry filter bed and the entire filtrate used for measurement. The filter bed consisted of 1·0 ml. dried acid-washed glass balls ('Ballotini', Chance Bros.; mean diameter, 200μ); these were held in place in a 1½-in. filter funnel by a single large glass ball (5 mm. diameter). The upper surface of the filter bed was protected by a thin layer of large glass balls (3 mm. diameter) so that the bed was not disturbed when the suspension was poured on to it. The optical density of the suspensions before and after filtration was measured in a Spekker photometer (Hilger and Son) in 1-cm. cuvettes.

Estimates of the proportions of dead spermatozoa in undiluted semen were made by counting the number of eosinophil spermatozoa in a total of a hundred spermatozoa from each of two smears stained with nigrosin-eosin[1].

Statistical analysis shows a highly significant correlation ($r = 0·7$; $p < 0·001$) between the percentage eosinophil spermatozoa and the percentage difference in opacity between filtered and unfiltered portions of the same sample of semen; the analysis was made by Dr. R. C. Campbell, A.R.C. Unit of Reproductive Physiology and Biochemistry, Cambridge.

Further, microscopical examination showed that the proportion of motile spermatozoa was uniformly greater in the filtrates than in the unfiltered suspensions.

Because a relationship is known to exist between the proportion of dead spermatozoa in bull semen and its fertility[2], we believe that the technique we have described may form the basis of a practical test for the evaluation of bull semen used for artificial insemination.

We are grateful to Mr. L. E. A. Rowson, Cambridge Cattle Breeders, Ltd., for supplies of bull semen.

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## Lunar Rhythm in the Emergence of an Ephemeropteran

In a paper published in 1927, Hora[1] suggests that the swarming of some Ephemeroptera is related to the lunar cycle. Evidence has been obtained which suggests that *Povilla adusta* Navas, a mayfly widely distributed in Central and Southern Africa, shows uch a rhythm of emergence in Uganda. The interest of this lies in the fact that very few examples are known of lunar rhythms in non-marine animals (see Caspers[2]).

It was suspected late in 1953 that adults (subimagines and imagines) of *Povilla adusta* appeared in large numbers only at about the period of full moon, and analysis of the dates of twenty-two swarms observed between March 1953 and April 1955 at Kaazi (twelve miles from Kampala) and Jinja, both on Lake Victoria, and on Lake Albert, shows that such swarms only occurred within five days of full moon, with the greatest number of swarms on the second night after full moon Fig. 1). On three occasions swarms were recorded simultaneously at Jinja and Kaazi, which are fifty miles apart.

The adults come to light between 7.30 and 9.30 p.m. (East African Standard Time) and are not seen at other times: individuals only live for about one hour. A light-trap technique was therefore used when sampling at Kaazi during August 10–21, 1954. Of the 1,521 specimens obtained on these twelve nights, 680 (44 per cent) came on the second night after full moon (Fig. 2).

Examination of the specimens in the British Museum (Natural History) showed that fourteen specimens (some dating from 1900) were labelled with the date. Analysis of these dates and of the dates of three specimens recorded by Navas[3] relative to full moon showed a different distribution in which there was no marked peak, which may perhaps be attributed to the following circumstances: (1) The records are of single specimens (except for one record from Lake Albert which relates to a swarm on the fourth night after full moon), and thus do not necessarily correspond to the peak emergence period. (2) The specimens are from localities ranging from 17° S. to 11° N.: it is possible that a lunar rhythm is only maintained near the equator, where the annual variation in day-length and temperature is low. The evidence for this is very meagre but, of the eight specimens the dates of which fall outside the full-moon emergence period of eleven days, only one was caught in the field within 5° of the equator.

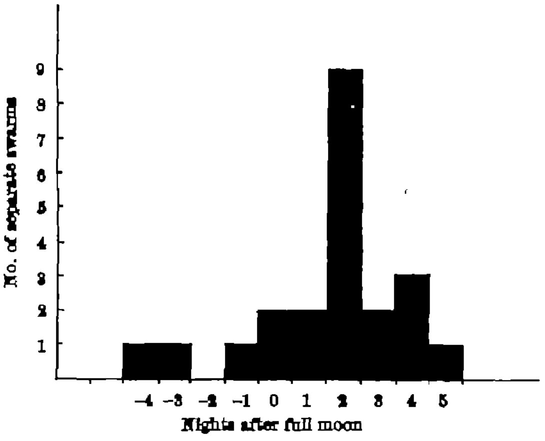

Fig. 1. Dates of twenty-two *Povilla* swarms relative to full moon

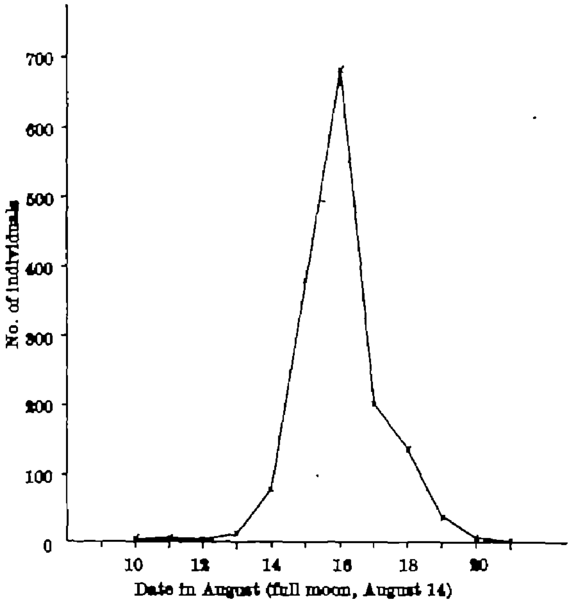

Fig. 2. Numbers of *Povilla* adults caught at Kaazi relative to full moon

Experimental work has been limited by the difficulty of keeping larvæ in the laboratory for more than two or three weeks, but some interesting results have been obtained and further work is in progress.

It has been found that the larvæ show a marked diurnal rhythm, remaining in their burrows during the day and swimming freely at night. This rhythm is maintained in darkness for at least two weeks.

Twelve adults have emerged in the laboratory from larvæ kept under various lighting conditions. Eight of these emerged within three days of full moon. Two emerged seven days before full moon when the aeration supply broke down. The remaining two individuals emerged eleven days before full moon, possibly having been influenced by being collected in the field the previous day.

I am indebted to Dr. P. S. Corbet, of the East African Fisheries Laboratory, Jinja, for his observations made on Lake Albert and at Jinja, some of the latter in conjunction with Mr. A. Tjönneland, of the Zoological Laboratory, University of Bergen.

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## Placentation in the Adder, *Vipera berus*

Placentation has been described in a number of viviparous lizards and snakes, but has not been previously reported in the adder.

The relationships between the extra-embryonic membranes and the maternal tissues have been studied in five adders taken in the later stages of pregnancy. In each case the histological appearances suggest that a placenta is present. The chorio-allantois, which contains large patches of vacuolated tissue, is thrown into numerous villi. The oviduct is also villous, and the maternal and fœtal villi interdigitate. Both contain capillaries. The oviducal epithelium is thinner at the placental site than elsewhere; it is also thinner than it is in non-pregnant specimens. Between the fœtal and maternal tissue there is a thin fibrous membrane which is probably an egg-membrane, for it completely surrounds the embryonic and extra-embryonic structures.

From this preliminary survey it appears that the condition in the adder agrees fairly closely with that described by Weekes[1] as her type III of reptilian chorio-allantoic placentæ.

Little critical work has been done on the functions of the placentæ of reptiles. Weekes suggested that certain types of reptilian placentæ are mainly respiratory organs, others supply water to the embryo, whereas the most specialized (type III) have a nutritive function. More recently, Clark *et al.*[2] have suggested that some amino-acids pass across the placenta to the embryo in the snake *Thamnophis sirtalis*.

Weekes claimed that chorio-allantoic placentæ in reptiles are invariably associated with relatively small-yolked eggs. This, however, is not the case in the adder, where the amount of yolk is large, being comparable with that in the oviparous grass snake, *Natrix natrix*. Furthermore, all the yolk in the adder is not utilized during development, since the yolk-sac is still substantial at the time of parturition, representing some 8 per cent of the body-weight of the embryo.

Work in progress shows that the yolk-sac, which is retracted into the body-cavity at birth, provides a source of energy for the young adder during its first eight months or so of life. After birth in the early autumn, the young snakes undergo about four weeks of activity followed by hibernation until the spring. They can, and probably always do, survive for the whole of this period without feeding. Indeed, it has been shown experimentally (Griffiths, I., and Smith, M. A., work in progress) that the yolk-sac can provide enough nourishment for up to seven months of continuous activity.

It seems, therefore, that in the adder the yolk-sac has taken on a post-partum function. It is suggested that this has been rendered possible by the transfer of some of the prenatal functions of the yolk-sac to the chorio-allantoic placenta. The relative roles of the yolk-sac and placenta during embryonic life are now being investigated.

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May 16.

---

[1] Weekes, H. C., *Proc. Zool. Soc. Lond.*, 625 (1935).

[2] Clark, H., Florio, B., and Hurowitz, R., *Copeia*, 9 (1955).

## Skull Development in Chick Embryos after Ablation of One Eye

THERE is in birds a thin vertical plate of bon between the eyes known as the interorbital septum In the chick embryo this originates from the fusion c two pairs of cartilaginous primordia (the orbita cartilages above and the trabeculæ cranii below) with each other and with a median cartilaginous bar, th intertrabecula. At around seven to eight days o incubation, these structures lose their identities and merge into one another to form the high thin septum of the fully formed chondrocranium. At about th same time the lateral unfused parts of the anterio orbital cartilages regress and disappear almos completely.

The skull in animals such as the chick, where th trabeculæ fuse between the orbits and contribute t an interorbital septum, are termed tropitrabic. This condition, at least as it is seen in birds, has been correlated with the relative proportions of the eyes and brain at mid-orbital level, and especially with the large size of the former[1]. It therefore seemed possible that the developing eyes might exert some influence, mechanical or otherwise, on the form of the cartilaginous skull.

Ablation of one eye was carried out through a window in the egg-shell after two or three days incubation, either by dissection or by the use of a hot needle. The window was then covered with adhesive cellulose tape and the eggs incubated for varying periods; after this the embryos were fixed and sectioned. The operative mortality was high, but eight specimens developed successfully and were fixed at periods of between five and nine days of incubation. Some regeneration of the ablated eye always took place, but the rudiment so formed never approached the size of the undamaged eye.

Essentially similar conditions were found in all eight specimens. The appearance of the interorbital septum (Fig. 1) was virtually normal and did not differ significantly from that of controls of the same age. It seems, therefore, that the fusion of orbital cartil-

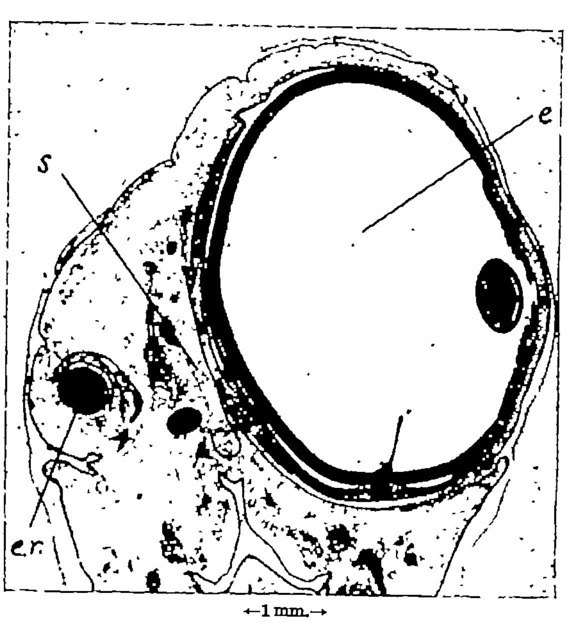

Fig. 1. Transverse section through head of operated 8½-day chick embryo (Masson's trichrome). *e*, normal eye; *e.r.*, regenerated eye rudiment; *s*, interorbital septum

ages, trabeculæ and intertrabecula and the regression of the lateral parts of the orbital cartilages are not affected by severe damage, resulting in drastic reduction of size, to one eye, performed about 48 hr. before the cartilages of the skull become foreshadowed as visible condensations of mesenchyme. The scleral cartilage, on the other hand, conformed to the size and shape of the regenerated eye rudiment, though parts of it were thicker than the cartilage on the undamaged side.

It is of interest that a naturally occurring anomalous chick embryo of seven days simulated the experimental specimens very closely; the left eye was rudimentary and malformed, with a thick but appropriately shaped scleral cartilage. The interorbital septum was essentially normal in appearance, and no abnormalities elsewhere in the head were detected. Comparable conditions have been observed in a microphthalmic embryo of the lizard, *Lacerta vivipara*, another tropitrabic form.

The results of these experiments seem to agree closely with those of Weiss and Amprino[2], and Amprino[3], who were, however, concerned with the effects of eye reduction on the sclera and other accessory orbital structures rather than on the skull proper.

A. d'A. Bellairs

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May 10.

[1] de Beer, G. R., "The Development of the Vertebrate Skull" (Oxford, 1937).

[2] Weiss, P., and Amprino, R., *Growth*, 4, 245 (1940).

[3] Amprino, R., *Acta Anat.*, 10, 38 (1950); *J. Exp. Zool.*, 118, 71 (1951).

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## "Work Study"

The article on "Work Study" in *Nature* of July 23* may, I fear, raise quite unwarranted prejudice in the minds of readers. The term 'work study' is now commonly accepted in British industry as being very much wider in scope than the mere application of financial incentives based on time study.

Work study may be defined as "the systematic and objective examination of all the factors which directly govern the productive or operational efficiency of any specified activity in order to effect improvement". It is thus founded on scientific analysis and measurement in order to determine the facts of the situation and to eliminate guesswork and the dead hand which past custom can exert in the face of changing circumstances.

The first, indeed the most effective, of the techniques involved in work study is method study applied in a strictly logical and scientific manner. From this angle, it may truly be said that work study aims first at improving the efficiency of management, and thereafter, as a result, at obtaining more effective (not necessarily harder) work from all concerned.

In order to carry out method study effectively, and to determine the true facts of any activity which is under examination, it is indeed necessary to apply measurement to all the factors, including machine utilization and human activity. Such work measurement is a means of establishing a realistic basis for costs, for production planning and labour allocation. Experience shows that it is amply justified for these reasons alone by providing data on which efficiency can be improved and progress be measured.

Should it be desired to institute monetary incentives for the operatives in order to encourage the highest reasonable level of individual interest and effort, work measurement does indeed offer an appropriate basis. It must be stressed, however, that incentives of this or any other kind will only be effective if their application is made after full consultation and by arrangement with the trade unions and the operatives directly concerned. It is essential to ensure their understanding of what is proposed and the beneficial results to themselves, to the organization in question, and ultimately to the community as a whole, which should accrue.

If individual incentives are to be offered, it is desirable that these should be founded on careful work measurement with its insistence on finding the facts in an objective manner, rather than an outmoded system, such as the price-list, or even piece-rates, which tend to be based on rule-of-thumb and bargaining methods, with inevitable anomalies and the likelihood of disputes. It is true that work measurement and time studies, like any other technique, may be badly applied; but such cases are due to lack of training or objectivity on the part of those responsible, and not to any fundamental failure of the techniques themselves.

Lord Kelvin truly said, "When you can measure what you are speaking of, and express it in numbers, you know that on which you are discoursing. But when you cannot measure it and express it in numbers, your knowledge is of a very meagre and unsatisfactory kind".

It is surely high time that we attempted to apply the scientific method not only in the laboratory but also in the day-to-day conduct of affairs where it is so desperately needed but is all too often absent.

There is now overwhelming evidence of the benefits which can accrue from the wide application of work study principles, whether or not these include the final step of individual incentives based on measured work. It is clear, too, that where management exercises its function with proper human understanding coupled with a critical scientific approach based on fact-finding and thorough analysis, the psychological atmosphere as well as technical efficiency can be greatly improved.

The British Productivity Council is representative of the national employers' organizations and of the trade unions through the T.U.C. Among its other activities, it has set up a Work Study Unit to act as an interpreter of the best current practices in this field. This Unit is in great demand and is proving highly successful.

For the above reasons, I consider the note in *Nature* to be defeatist and not in accord with the facts. It is also wrong to suggest that work study is so limited in its aims and ineffective in its results.

Experience shows that work study does in fact provide one of the most valuable means of improving production efficiency. Not least, it stresses the community of interest between operative, management and customer alike, and encourages understanding, interest and pride on the part of all concerned in effecting continuous improvement so that all may benefit.

T. J. Hutton

British Productivity Council,
21 Tothill Street,
London, S.W.1.

* The article in *Nature* is a comment on Occasional Paper No. 6 published by the Institute of Personnel Management.—Editors.

# FORTHCOMING EVENTS

## Monday, October 3

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. Cosler: "Electronics in Industry".

British Ornithologists' Union (in the Lecture Hall of the British Museum (Natural History), Cromwell Road, London, S.W.7), at 6 p.m.—Annual Scientific Meeting.

Royal Institute of Chemistry, London Section (joint meeting with the London Section, Society of Chemical Industry, in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. R. Barrington Brook: "The Production of Scientific Apparatus".

## Tuesday, October 4

Institution of Chemical Engineers, and Society of Instrument Technology (in the Assembly Hall, Church House, Great Smith Street, London, S.W.1), at 9.45 a.m.—Joint conference on "Automatic Control in the Process Industries".

Bone and Tooth Society (at the Institute of Orthopaedics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Organic Components and Bone and Teeth". Dr. J. E. Eastoe: "Some Chemical Aspects of the Organic Components of Bone"; Dr. Maurice V. Stack: "The Chemical Nature of the Organic Matrix of Dentin and Enamel"; Dr. H. G. B. Slack: "The Turnover of Collagen and Mucopolysaccharide".

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. Dolman: "Radio Aids to Marine Navigation".

## Wednesday, October 5

Society for Analytical Chemistry (in the Meeting Room of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

## Thursday, October 6

Physical Society, Low Temperature Group (in the Lecture Theatre, Royal School of Mines, Prince Consort Road, London, S.W.7), at 3.30 p.m.—Résumé of Papers Read and Discussed at the Ninth Congress of the International Institute of Refrigeration and the International Union of Physics held in Paris. Speakers: Dr. Brewer, Dr. Cooke, Dr. Parkinson, Dr. Din and Dr. Powell.

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Sir George H. Nelson, Bart.: Inaugural Address as President.

## Friday, October 7

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. W. Gerrard: "The Reactions of Alcohols with Halides".

## Friday, October 7—Sunday, October 9

Institute of Personnel Management (at The Royal Hall, Harrogate)—National Conference, 1955.

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Advisory Officer (with a degree in agriculture or botany) in the Department of Agricultural Botany (Grassland Section)—Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (October 8).

Chemist (with degree in chemistry or equivalent qualification, with experience of investigational and research work and preferably with knowledge of modern instrumental techniques) at the National Coal Board Central Laboratory, Pendlebury, Manchester—Establishment Officer, National Coal Board, N.W. Division, 40 Portland Street, Manchester 1 (October 8).

Social Development Officer (with a degree or diploma in social science and with experience of community development work) with the Government of Tanganyika, to help initiate development plans and instruct local staff—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.178/8/08 (October 14).

Assistant (with a good qualification in chemistry with some knowledge of biology) in the Chief Engineers' Department, Chemistry and Metallurgy Sub-Branch, Bankside House, London, for administrative and theoretical work concerned with water treatment, effluents, timber degradation and in general with problems in which chemical engineering and chemistry are blended with biology—Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting AB/618 (October 15).

Demonstrator or Tutorial Student (preferably with an interest in organic chemistry, particularly that of natural products) in the Chemistry Department—Registrar, University College of North Staffordshire, Keele, Staffs. (October 15).

Lecturer (with training and experience in the bio-physical aspects of physiology) in Physiology—The Secretary, The University, Aberdeen (October 15).

Assistant Lecturer (with a science degree, with special qualifications and postgraduate experience in entomology or helminthology) in Zoology—Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (October 17).

Lecturer (with good honours degree and preferably with some teaching experience) in Economics at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 17).

Lecturers (2) (with good honours degree and preferably with teaching experience) in Mathematics at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 17).

Mechanical Engineers (2) in the Department of Irrigation, Ceylon—High Commissioner for Ceylon in the U.K., 13 Hyde Park Gardens, London, W.2 (October 17).

Senior Lecturer and Lecturer in Pathology at the Royal Infirmary, Glasgow—The Secretary of University Court, Glasgow (October 17).

Engineer (with degree in civil engineering, membership of the Institution of Civil Engineers or equivalent professional qualification, with ability to formulate technical policies and procedures appropriate to civil engineering design, and to plan, direct and co-ordinate such work) in charge of Civil Engineering Design, Civil Engineering Division of the Snowy Mountains Hydro-Electric Authority, for duties including the final location and design of civil engineering works, including dams, pressure tunnels and shafts, power stations, mostly underground, aqueducts and associated hydraulic structures, mountain roads and buildings, preparation of specifications and co-ordination of design work being carried out by other agencies for the Authority—Chief Administrative Officer, Snowy Mountains Hydro-Electric Authority, P.O. Box 32, Cooma 48, N.S.W., Australia (October 19).

Senior Clinical Psychologist (with honours degree in psychology or equivalent qualification, preferably with psycho-analytic training and experience), for duties mainly in the Department of Child Psychiatry—Chief Psychiatrist, West Middlesex Hospital, Isleworth, Middlesex (October 24).

Lecturer in Soil Science in the Faculty of Agriculture, University of Sydney—Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 28).

Chair of Radiology (Diagnostic) at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (October 31).

Demonstrator in the Department of Chemistry—Registrar, King's College, Newcastle-upon-Tyne (October 31).

Demonstrator (honours graduate in metallurgy, physics or chemistry) in Metallurgy—Registrar, College of Technology, Manchester 1 (October 31).

Biologist (with an honours degree for which an adequate study of zoology or biology was necessary)—Secretary, Salmon Research Trust of Ireland, Inc., c/o St. James's Gate, Dublin (November 1).

Assistant (graduate in metallurgy, chemistry or physics, preferably with foreign language knowledge) in the Information Department, for abstracting, literature searching, editorial work, indexing and translating—Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

Assistant (with a British university degree, preferably in science, able to conduct correspondence and be methodical, dependable and sociable; a knowledge of foreign languages desirable) to the Director of the Ciba Foundation, London—Messrs. Swepstone, Walsh and Son, 3 Pump Court, Temple, London, E.C.4.

Assistant Conservator (with a university degree in forestry) of Forests, Sierra Leone—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.61/15/04.

Assistant Physicist (with good honours degree in physics and preferably with some experience of electronics), to assist in radioisotope and X-ray work, including rotational therapy—The Secretary, Newcastle Regional Hospital Board, Walker Gate Hospital, Newcastle upon Tyne.

Head of the Department of Chemistry and Biology—Registrar, The Technical College, Sunderland.

Lecturer (with teaching experience, and preferably with industrial experience) in Physical Chemistry at the West Ham College of Technology—Chief Education Officer, Education Offices, 95 The Grove, London, E.15.

Lecturer (with high qualifications in the general field of applied chemistry and chemical engineering, and preferably with some experience of teaching, research and industry) in Technical Chemistry—Secretary-Treasurer, Royal Technical College, Glasgow.

Physical Metallurgist (with a university degree or equivalent qualification, preferably with some postgraduate research or industrial experience), for work in a research group concerned with measurements of fundamental properties of iron and steel—Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting M.G.1.

Principal or Senior Scientific Officer (with first- or second-class honours degree in chemistry, with experience in chemical engineering and applied chemistry problems or in chemical engineering with additional research and development experience, or equivalent qualifications), to lead a team concerned with chemical process development and plant design studies—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks., quoting A.573/34.

Research Student (with a good honours degree in physics or metallurgy) in the Department of Physics, for research work on the physical properties of liquid metals—Professor of Physics, The University, Southampton.

Scientific Officer (with first- or second-class honours degree in chemistry, preferably with some research experience of physical chemistry and knowledge of high vacuum techniques as applied to gases and metals, distillation practice and theory, and radio chemistry) for basic research in inorganic and metallurgical chemistry—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting A.511/34.

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# EDUCATION AND THE UNIVERSITIES

LOOKING back over the programme of the meeting at Bristol of the British Association, the prominence of educational issues is noteworthy. They were specifically mentioned by Sir Robert Robinson in his presidential address, they were implicit in Prof. H. D. F. Kitto's evening discourse, and also in the presidential addresses of Mr. W. B. Mercer to Section M (Agriculture) and of Mr. Ritchie Calder to the Assembly of Corresponding Societies, and there were discussions on the training of the physicist and the teaching of chemical principles in school and university in which the appropriate section joined forces with Section L (Education). Of the discussions in the Education Section itself, that on "Man and his Machines", like the presidential address of Mr. J. F. Wolfenden and also Dr. J. Bronowski's address "The Educated Man in 1984" at the final session on September 7, were related also to this theme.

Broadly speaking, two main groups of issues were raised. The first relates to the training of the scientist himself, and the supply of trained scientists and technicians in sufficient numbers to meet the changing needs of society. The second relates to the interpretation of science and involves the general education of the scientist and the education of the community as a whole, so that it is competent to appreciate the scientific aspects of a problem when they are reasonably interpreted in non-technical language. The two sets of issues are interrelated, as was well shown in both Mr. Wolfenden's address and by Dr. Bronowski, as well as in the discussion on "Man and his Machines". Sir Ben Lockspeiser was emphatic that many more scientists and technologists are required than are available, as well as many more teachers of mathematics and science in the schools to supply them, and strongly disagreed with Dr. J. E. Richardson's view that no large increase in the number of technicians will be required by automation.

Although, however, we may succeed in attracting into careers in science and technology a sufficient number of those at present leaving school too early in order to enter on other careers, without detriment to the nation's proper requirements elsewhere, it would still appear that the balance between technologist or scientist and technician requires further investigation. It is likely to vary widely in different industries. Dr. J. E. Richardson's estimate could be reasonably correct for the electrical industry but wide of the mark elsewhere. Without, however, some rough idea of the quantitative demand, it is impossible to plan the expansion of technical or of technological education soundly.

At Bristol the qualitative issues, in the main, were discussed. It is true that if the quality of technical education and technological education in Britain is high, problems of adjustment to changes in demand for one category or another will be less acute, and all the more so if due attention is given to human aspects and to those liberal studies which were emphasized by Mr. H. A. Rée and in the recent report "Liberal Education in a Technical Age". None the less, the quantitative aspect requires greater attention than it has yet received, even in respect of university education. To read again in the light of to-day such an address as Mr. H. T. (now Sir Henry) Tizard gave to the Education Section of the British Association twenty years ago—with its reasoned argument that the universities were then too full, that we should concentrate not on increasing the number of university-trained scientists but on raising the standard, and aim at producing chiefly the leaders of the profession—is to be brought face to face with the questions: What is the real purpose of a university education in science, in technology or in any other faculty? And what are the real functions of the university in relation to the training of educated men and women or of the formation of informed opinion in society as a whole? How best and in what ways should a university serve society in the present times?

Sir Henry urged that it should be the function of a university school of engineering to send out from the university resourceful men whose education and outlook would enable them to attack with confidence the new problems perpetually arising in their chosen field. He urged also that science well taught could supply all that is best in the classical tradition, imparting accuracy and exactness and a discipline in clear thinking; that it could brace with its difficulties minds that are not afraid of obstacles and inspire with its beauty minds not insensitive to beauty. To-day, we find Sir Charles Morris, in his Joseph Payne Memorial Lectures at the College of Preceptors on the idea of university education, emphasizing that the primary educational duty of the university is to develop the power and habit of disciplined thinking and encourage the capacity to form good judgments. The most fundamental aim in education, he urges, is the development of the power of good judgment in answering the questions which cannot be answered by science but which must be answered in life—problems which no intensification of scientific training by itself will solve. Unless, however, the student acquires in his undergraduate years not only scientific understanding and skill in scientific method but also learns to practise and develop the powers of non-scientific judgment and decision, the university has failed in its task of producing an educated man or woman. On the other hand, in the measure in which it has developed that capacity and habit, it has largely solved the problem of education for citizenship.

Dr. Eric James put the issue in very much the same terms in his Science and Citizenship Lecture to the Science Masters' Association at King's College, Newcastle upon Tyne, when he argued that the education that produces scientists must be broadened and strengthened in such a way—at any rate for the best of them—as to supply the opportunity that the best arts courses provide of discussing the general questions of social organization and human conduct. If the problems of our present civilization are to be solved, we must produce men of science not only in greater numbers and of great technical skill, but also able and determined to take their place as responsible citizens. They must, he continued, understand the dangers and the opportunities that are provided by the discoveries they themselves are making, and be prepared and equipped to lead mankind to resist the temptations of purely material triumphs and to use science, not as a means of enslavement, but as a force for the liberation and enrichment of the human spirit.

The essence of Dr. Bronowski's lecture to the Education Section at the Bristol meeting of the British Association was that this, though good in itself, is not enough. We would still in the next generation create a slave world unless we make certain that science is a part of the cultural education of all, and that the language of science is understood by the ordinary citizen. It is in this sense that we have to make science a part of our culture, and to ensure that the ordinary citizen has the capacity to see through any kind of nonsense, scientific as well as political, economic or social, and recognize a duty to resist and expose such nonsense.

In large measure that capacity is a condition of the effective functioning of a democracy, as was indeed recognized by de Tocqueville more than a century ago; nor can it be contended that we have gone far towards achieving that objective. Pragmatic educational objectives have indeed been concerned much more with the acquirement of professional or technical skills than with the stability of the whole system, upon which in the end the economic and social and political order really depend. When the Duke of Edinburgh, in his opening address to the Conference of Vice-Chancellors and Rectors of more than a hundred European universities at Cambridge last July, spoke of the great responsibilities of the universities of Western Europe to-day, he emphasized that this task of turning out pupils capable of recognizing and resisting unsound views belongs primarily to the universities rather than to the general educational system.

That in some degree is inevitable, but it can only safely be conceded if the universities interpret their detachment and independence as involving some responsibility for independent criticism and outspoken comment on issues of the day when the people are being misled in matters of fact. For such guidance to be given effectively, there must be some considerable measure of public understanding of the work and purpose of a university, and thus it comes about that the universities can only fulfil their responsibilities to-day if that public understanding exists, just as in Britain their increasing dependence on public funds makes public understanding the final safeguard of their freedom. The very extent to which the British Association meeting focused attentio upon the education of the scientist and the educatio of the public in science suggests that the Associatio and its members are aware of the needs of to-day for the recent meeting has at least clarified some the issues which must be widely understood if th necessary changes in policy are to be made within without the universities.

The discussions at the British Association meetin received the wider publicity; those at the universitie conference, as would be expected, attracted muc less attention but went deeper. Moreover, the Conference in itself directed attention to a furthe function of the universities which Prof. A. Haddo mentions in his contribution to "The Bomb: Challenge and Answer". Scientists, says Prof. Haddow are troubled by doubts as to whether the universitie are using their resources most constructively i discharging their responsibilities not so much to thei countries as to the world. This is, of course, i contradiction to the view expressed by the Inter University Council for Higher Education Overseas which in reviewing recently developments betwee 1946 and 1954 commented that these development had appeared in a period in which the prestige o universities has never been higher, and in which the have been exceptionally responsive to their nationa and international responsibilities.

It was perhaps fitting that Prof. Haddow shoul give expression to any legitimate doubts on thi matter in that particular connexion, for no society o institution can bring men closer together than university; and the contribution which universitie could make in promoting international understanding, while it should not be overstressed, is indispensable It should not be forgotten, however, that though response to the suggestion which Mr. Robert Birley made six years ago in his Reith Lectures has been disappointing, and perhaps the universities migh have made more determined and constructive efforts to fashion a common culture in Europe, the hindrances to the interchange and migration of scholars and students are not of their making. If progress in the task of restoring some of the old international relations between universities and giving them a new significance, broader and more humane, than before, so that each nation is assisted to make its own special contribution to the common stock and absorbs much in return without losing its individual characteristics, the fault has lain rather with governments. The Conference at Cambridge demonstrated that universities are alive to the great importance of encouraging university study abroad in promoting the free exchange of ideas, and Sir Edward Appleton asserted that a university's function is pre-eminently to discover, or perhaps uncover, the spiritual and intellectual needs of society.

The Cambridge Conference at least encourages the hope that the universities will draw closer together not only in support of the free communication of knowledge by interchange of staff and students and by discussion and publication, but also in serving this function. In doing so, however, the universities must be no less careful to maintain their own academic standards of sound learning and scholarship than has been the Inter-University Council for Overseas Education in watching over the development of the Colonial universities and university colleges. Extramural activities must not be pursued in a way or on a scale that leads to the lowering of standards; and this needs to be remembered in considering the universities' contribution to adult education at any level, and in assessing the demands on the universities for particular courses and perhaps especially courses in general education.

Here again Sir Henry Tizard said some wise words in the address already mentioned, and they are as pertinent to-day as when they were uttered. If university authorities complain that students are lacking in general education, it is for them, he urged, to do their best, by altering the conditions of entry or the standard of scholarships, to help schoolmasters to remedy the defects. "If it is really the general view that the school education of a student of science is too narrow, then the best practical step is to reform the University Matriculation examination, and make it appropriate to the normal age of entry. . . . If it is not considered worth while, the criticism of the general education of the science student loses most of its point."

These observations are worth recalling in considering the report on university entrance requirements which has recently come from a sub-committee of the Committee of Vice-Chancellors and Principals of the Universities of the United Kingdom, if only as a reminder of the wide background in which such decisions should be taken. They do not affect simply the training to be given to the university student, or the maintenance of university standards. They affect equally the character of secondary education as a whole, even the outlook and attitudes which determine whether or not a student turns towards a career in science or technology. Indirectly, they bear closely on the promotion of public understanding of the work of the universities as well as of the scientist and, if not the way in which the universities must carry out their educational work, very largely the character and extent of that work as a whole. If indeed we ceased to allow sectional views to influence decisions which should be taken primarily in regard to the educational needs and policy of the country as a whole, it might well be found that an appropriate solution of the problems of university selection and of university entrance requirements might so react on the work of the schools and of adult education generally that the demands on the universities for extra-mural work were considerably eased and much more readily confined to those of appropriate academic character. It can at least be said that, without imagination and insight, without more readiness to experiment than has frequently characterized the relations between school and university during the past twenty years, it will be difficult indeed for the universities either to fulfil their full responsibilities to the community, or to ensure the public understanding and support which will safeguard the freedom and trust in which their work is most fruitfully done.

# LITERATURE OF THE SCIENCE OF THE PAST

## Scientific Books, Libraries and Collectors

A Study of Bibliography and the Book Trade in Relation to Science. By John L. Thornton and R. I. J. Tully. Pp. x+288+12 plates. (London: Library Association, 1954.) 24*s*.

It is an ambitious task that the authors of this book have undertaken, to give within 270 pages a well-documented citation of all the chief books in all branches of science from before the days of printing up to the end of the nineteenth century, supplemented by brief accounts of relevant bibliographic matters, such as the growth of scientific periodical literature (illustrated, incidentally, by a reproduction of the title-page of the first volume of *Nature*) and scientific publishing and bookselling. It is pleasant to be able to say that, considering the manifold difficulties, they have succeeded admirably. Where the more important authors are in question, a very short indication of what they accomplished is given, as well as the title, date and place of publication of their chief works; and even the lesser ones are given a few biographical lines. For those who want fuller information, the footnotes and the bibliography at the end give ample guidance as to whither to turn. This bibliography cites some 450 names, many with more than one publication to their credit, and this alone bespeaks long and expert work.

The first chapter, "Scientific Literature before the Invention of Printing", deals with authors, such as the Greeks and Alexandrians, writing in that period, but is chiefly concerned with printed editions of their works. Among the many odd facts that can be gathered in the next chapter, on "Scientific Incunabula", is that, whereas Italy has, according to one list, 1,445 such books to her credit and Germany not many less, England claims 23 only: the figures for incunabula of all kinds in the British Museum give England about a tenth the number set down to Italy. Apparently science was relatively unpopular with our early printers.

The seventeenth century, although not easy, was, perhaps, the simplest task. A grave omission is Guericke, and certain other German writers, such as Schott, might have been mentioned. Papin is another outstanding figure who is absent, as is Savery. The eighteenth century, with increasing publication, obviously demands careful selection: on the whole, the choice is very well made, but static electricity fares rather badly, both in authors and in the fact that one of the chief bibliographies is not cited. McKie's important work on the chemistry of the century is duly acknowledged. With the nineteenth century, the growth of scientific literature becomes, as the authors say, overwhelming. Much is done by citing bibliographies and other works, such as, in chemistry, those of Partington, to help the student without overloading the book. Anyone versed in the subject will note the absence of well-known names, especially in mathematics—Cantor's "Geschichte der Mathematik" is not mentioned—but clearly there is not room for everybody, even every distinguished body. When it is considered that all sciences, including, for example, conchology, are represented, it must be readily admitted that the authors have done well. The final chapter on "Scientific Libraries of To-day" is a valuable guide to the libraries of Great Britain.

This learned and laborious work will be of great use both to librarians and to students of the history of science. When a new edition is called for, no doubt certain omissions, including those to which passing reference has been made and others that have been noted, will be remedied. A citation of English translations, where they exist, of works in foreign tongues might be well. A desirable addition would be a list of the Latin names given to cities in Latin editions of the seventeenth and eighteenth centuries. There are frequent references in this book to editions at "Geneva and also Coloniae Allobrogorum", but Geneva and Colonia Allobrogorum are the same place. It is pleasant to be able to end this notice not with the reviewer's customary complaint of an inadequate index, but with grateful acknowledgment of a full and excellent one, which adds to the value of the book.

E. N. da C. Andrade

# A REFERENCE WORK OF HYDRAULIC ENGINEERING

## Irrigation and Hydraulic Design

By Dr. Serge Leliavsky. Vol. 1: General Principles of Hydraulic Design. Pp. xiii+492+13 plates. (London: Chapman and Hall, Ltd., 1955.) 126s. net.

THIS book is the first of three volumes dealing with the problems of irrigation engineering, and sets out the basic principles of design founded on the author's considerable experience of irrigation and hydroelectric systems of the Dnieper and Nile. The book is intended as a work of reference, and its length and the historical treatment adhered to throughout certainly preclude its use as a handbook.

The book is divided into three chapters. The first treats problems of flow through a pervious soil, as they affect the design of hydraulic structures. Starting from the basic concepts of flow in a homogeneous, porous medium, the author passes to discussions of uplift pressures, potential flow and the analytical methods of computing flow nets and base pressures for various foundation arrangements. This section, which is treated most exhaustively, is followed by a treatment of graphical and experimental methods for determining the flow net, approximate calculation by the method of independent variables, percolation in non-homogeneous soils, piping and finally percolation through earth embankments. In view of the limitation of the analytical methods to foundations, in which the geometry is fairly simple, more space might with advantage have been devoted to the more general, if less precise, methods.

The arrangement of the discussion of the theories of piping and uplift pressure is rather confusing. The Bligh creep-head theory is presented together with the earlier Terzaghi liquefaction theory, while Lane's weighted creep theory is reserved for a later section. Although he states that Lane's theory is but an extension of the earlier Bligh theory, the author fails to warn the reader of the dangers of their application to design. Modern practice in soil mechanics only admits the application of empirical design procedures when a more rational scientific approach is not available. Methods based on average soil coefficients must always be treated with suspicion. Also, the general problem of stability of weirs and failure due to shearing of the subsoil under conditions of upward seepage has unfortunately not been touched; neither has the potential instability at the toe due to vibration of the apron.

The second chapter deals with design methods for preventing or reducing scour downstream of hydraulic works. Early designs relied largely on a protecting apron downstream, and formulæ for the extent of the apron and the depth of scour to be expected were produced by Bligh and Khosla from an examination of existing weirs in India. The author shows that data for the depth of scour downstream of several barrages on the Nile confirm Khosla's findings, despite the approximate nature of the coefficients used. Later designs have been based almost exclusively on tests made with small-scale models, and a discussion of the underlying principles and the results occupies a large part of the chapter. As far as the motion of the water is concerned, the guiding principle of such tests is the conservation of the Froude number; but the parameter which controls the movement of bed material, and so is of paramount importance when relating scour in model and full scale, has not yet been settled. The author mentions the conflicting views of various authorities on the subject, without coming to any definite conclusion.

Apart from this question, models have been useful in revealing the flow patterns likely to occur in specific designs and have contributed largely to an understanding of the methods by which the standing wave can be used to reduce scour. One of the latest developments of this work referred to in the chapter is the production of a set of rules for the design of stilling basins to dissipate energy behind the wave in as short a distance as possible.

The last chapter consists of two sections. The first deals with uniform flow and traces the historical development of the subject from the early ideas of Galileo to the modern advances of Prandtl and his collaborators. The latter have succeeded in placing the subject on a rational basis, and the forms of the friction formulæ so deduced are rapidly supplanting the earlier purely empirical formulæ of Bazin, Ganguillet-Kutter and Manning. The second section is taken up with steady non-uniform flow and gives in considerable detail the various methods which have been used for integrating the basic flow equations, together with complete numerical tables and charts for their application.

The book is well illustrated and lucidly written and includes a good supply of references.

# ASPECTS OF THE ANIMAL CELL

## International Review of Cytology

Vol. 3. Edited by G. H. Bourne and J. F. Danielli. Pp. x+530. (London: Academic Books, Ltd.; New York: Academic Press, Inc., 1954.) 9.50 dollars; 76s.

THE thirteen articles which make up the third "International Review of Cytology" have in common a concern with some aspect or other of contemporary cell biology, the technical quality of their production, and the price one must pay to possess one or more of them. The first needs no comment, the second is good, and the third, by present-day standards, is not excessive. For the rest, each article should, but in a short space cannot, be treated separately on its merits. It would not be right, even were the reproach just, to complain of a lack of balance in the choice of articles in what is only one volume of a continuing series. In fact, however, the editors have ranged widely over the field of animal cytology, and one's only fear is that the plant cell, which had a foothold in the first two volumes, has been deliberately excluded and not simply temporarily overlooked.

In no other field of biology does the worker lean so heavily upon his techniques or have to use such care in assessing their reliability. Hence most of these articles are to some extent critical surveys of the technical procedures relevant to their problems, and three of them (Chr. de Duve and J. Berthet, on differential centrifugation in the study of tissue enzymes; A. G. Everson Pearse, on azo dye methods in enzyme histochemistry; Roy G. Williams, on transparent chamber methods for work on living mammals) have the results of particular techniques as their main theme. Three others take a particular tissue element (G. Asboe-Hansen, the mast cell; E. W. Dempsey and A. I. Lansing, the elastic tissue; S.-O. Brattgard and H. Hyden, the nerve cell) and survey the knowledge of its composition, structure and function revealed by classical and by recent methods of research.

The behaviour of living cells or of cell populations is treated by Charity Waymouth in a review of the nutritional requirements of cells in culture, by T. Gustafson in a survey of enzymatic aspects of embryonic differentiation, and by I. Cornman in a brief discussion of the action of urethane on mitotic division. The nucleus alone is the hero of the remaining four articles. O. Bucher reports the measurements, made in his laboratory, of nuclear and nucleolar size of cells in tissue culture, M. Alfert discusses the structure and composition of giant chromosomes, and R. A. Beatty variations in chromosome numbers in mammalian somatic cells. Finally, A. L. Dounce presents a critical survey of recent studies of the enzyme content of cell nuclei isolated by chemical means.

The reviewer of Vol. 1 pleaded for titles of papers to be given in the lists of references. If a reminder will strengthen the editors' hands in forcing this reform upon unwilling authors, it is gladly given.

D. R. Newth

# ADMINISTRATIVE CLASS OF THE CIVIL SERVICE

## Higher Civil Servants in Britain from 1870 to the Present Day

By R. K. Kelsall. (International Library of Sociology and Social Reconstruction.) Pp. xvi+233. (London: Routledge and Kegan Paul, Ltd., 1955.) 25s. net.

The scope and nature of this book are better indicated by the title of the article in the October–December, 1954, number of the *Political Quarterly*, in which Mr. R. K. Kelsall discussed the data obtained in a study of the social origins of members of the administrative class of the Civil Service above the rank of assistant secretary in three selected years at roughly ten-year intervals—1929, 1939 and 1950. It is concerned solely with the social origins of these senior Civil servants and, as a secondary issue, with promotion within the Service. It is not accordingly a book about the Higher Civil Service in the sense of Mr. H. E. Dale's earlier book. It is much more limited but contains an immense amount of data on the social background of the senior Civil servant from 1870 to the present day, covering the several routes of entry, the pattern of representation of schools and universities and the occupation of the fathers of the groups examined. There are also a brief review of the position of women in the Administrative Class and a comparison of the social characteristics of the heads of six departments in 1888, 1912, 1929 and 1950.

Mr. Kelsall's treatment of the data he has collected so carefully does not, however, match the assiduity with which it was assembled. His discussion is subjective rather than objective, and appears to be dominated, first, by the assumption that access to a post in the Administrative Class of the Service is a natural right of every citizen, and, second, that promotion from the ranks is intrinsically superior to examination entry as a method of recruitment. These assumptions are nowhere discussed, nor are their implications considered; but they colour Mr. Kelsall's discussion of the nature of the profession and thus rob it of any claims to be a serious contribution to the discussion of the adequacy of the Higher Civil Service to-day and what measures of reform are required.

These preconceived ideas prevent Mr. Kelsall from pausing to consider either the nature and limitation of the duties of the Administrative Class and the relation of such Civil servants to their Minister, or whether social background and traditions of certain groups may not give them certain inherent qualifications as public servants which are as much to the public advantage as to their own. That the Civil Service should be widely representative of the different sections of the community is all to the good. It is egalitarianism run mad, however, to suggest that the different sections should all be proportionally represented and to ignore the fact that a tradition of public service and political sense, at least as much as the resources to acquire a university education, have been responsible for generation after generation of certain classes or professions sending their sons into the Civil Service or Armed Services, just as it still supplies the great bulk of voluntary service.

In his essay in the *Political Quarterly*, Mr. Kelsall showed himself aware that recruits from certain classes might have their own faults and suffer from inherent disadvantages, but his obsession with egalitarianism and his conception of the ideal Civil servant as an imaginative, intelligent, forceful reformer, preferably trained in the social sciences, leads him to overlook the fact that if a Civil Service of high character and appropriate to the needs of to-day is to be recruited widely, the corollary to opportunity is a gradual raising of educational and cultural standards generally throughout the community which will even out not so much differences in wealth as in cultural outlook and standards. When the working class begins to provide voluntary workers in the way that the middle class has done for generations, we may expect it also to provide recruits for the Civil Service of the same calibre as the middle class has long been doing. The problem is not so much one of educational opportunity as of general education; nor has Mr. Kelsall really faced the difficulties inherent in the expanded promotion policy he advocates, and particularly the recruitment of the scientist to the Administrative Class.

R. Brightman

# THE GLASGOW 340-MeV. SYNCHROTRON

By DR. W. McFARLANE, S. E. BARDEN and DR. D. L. OLDROYD
Department of Natural Philosophy, University of Glasgow

THE electron synchrotron housed in the recent extension of the Natural Philosophy Department of the University of Glasgow was first operated at its maximum energy of 340 MeV. in April 1954. By the end of that year the gamma-ray output had been built up to a very satisfactory level, and the machine is now being employed for experiments on the photo-disintegration of nuclei and meson physics. A general view of the machine is shown in Fig. 1.

The magnet, a side view of which is shown in Fig. 2, was designed and constructed by Metropolitan-Vickers Electrical Co., Ltd., Manchester. It consists of a circular arrangement of twenty C-shaped units providing an annular gap of mean radius 125 cm., radial width 18 cm. and mean height 10·16 cm., within which the vertical guide field is established. Each unit is constructed from five parts: one vertical and two horizontal blocks of laminations, and two pole-shoes with a profile calculated to give the required field gradient. Two of the units have extended horizontal members in order to provide an air-gap for the passage of the gamma-ray beam. The magnet top, comprising the twenty upper horizontal members of the C-units, their attached pole-shoes and one of the exciting coils can, by means of a mobile crane, be raised in one piece weighing about 40 tons in order to provide access to the vacuum chamber. Induction acceleration is provided by twenty saturable flux bars placed within the electron orbit and clamped by means of wedges to the inner faces of the C-units.

The betatron flux and guide field are produced by the oscillatory current arising from the discharge of a condenser bank (860 μF.) through the twenty-turn coil situated within the C-units. One complete oscillatory cycle takes place during each pulse, the frequency of pulsing being adjustable up to five times per second. The original condenser bank failed to withstand the above operating cycle at the maximum potential of 17 kV., and almost a year was lost in the development of the project while new condensers of higher tolerance were manufactured. The switching is performed by an ignitron switch built by British Thomson-Houston Co., Ltd. This employs eight *BK* 56 ignitrons, four in parallel carrying each half-cycle of current. The ignitrons which conduct the first half-cycle are triggered by a pulse synchronized to a sub-multiple of the 50 c./s. mains, while those which conduct the second half-cycle are triggered by pulses from a biased peaking transformer in such a way

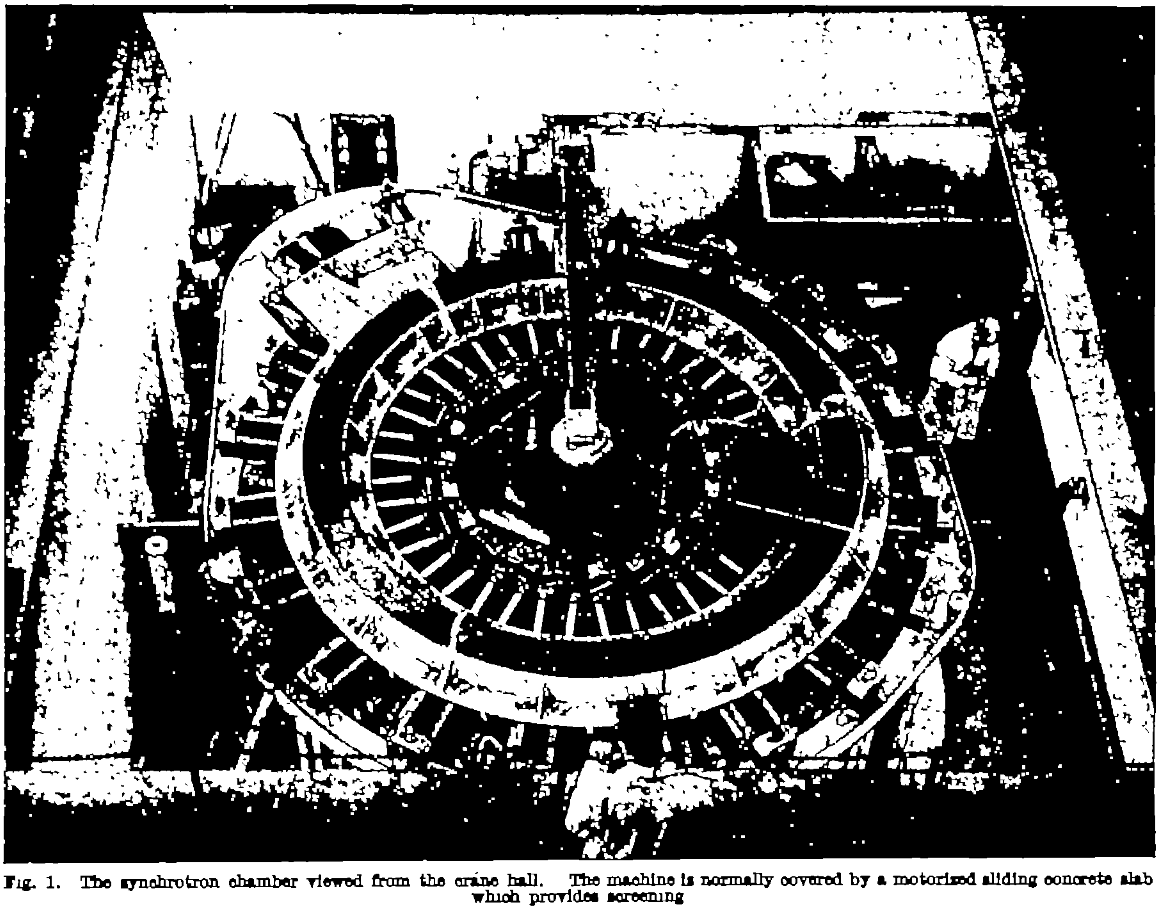

Fig. 1. The synchrotron chamber viewed from the crane hall. The machine is normally covered by a motorized sliding concrete slab which provides screening

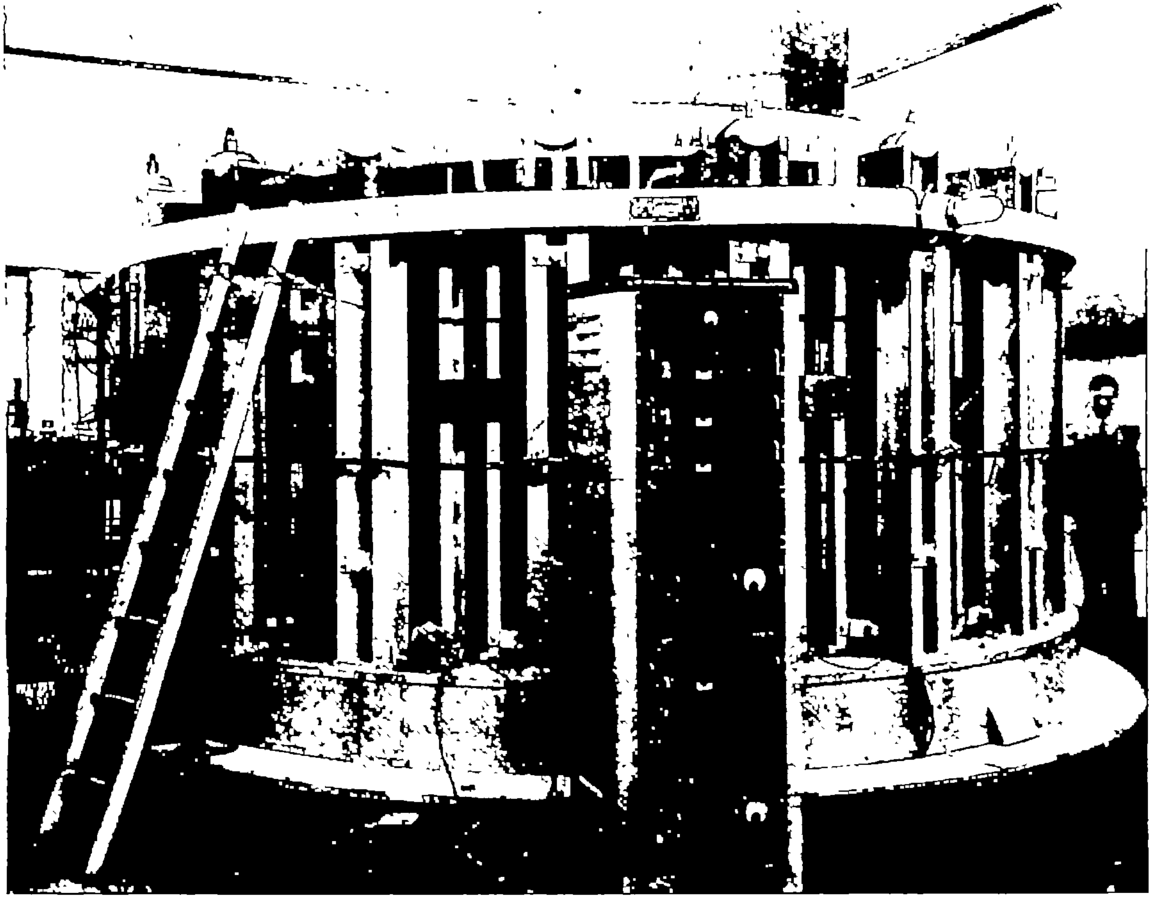

Fig. 2. Side view of magnet

that the magnet current passes smoothly through zero between the two half-cycles. At present the third quarter-cycle is the period during which electrons are accelerated. The average reactive power stored is 33 MV.amp., and the mean power-loss during pulsed operation is about 60 kW. The only cooling employed in the magnet is by forced air-draught upwards through the centre.

The charging current for the condensers is provided by a conventional three-phase hard-valve rectifier and passes through a series pentode valve (*E* 1807) which is used as a voltage stabilizer ; the maximum voltage permissible is 17 kV. Operation at 16·4 kV. provides a peak magnet current of 3,750 amp., which gives the guide field of 9,000 gauss necessary for electrons of energy 340 MeV. to move in a circle of radius 125 cm. The magnet inductance is about 40 mH. during betatron acceleration, but decreases to about 15 mH. when the flux bars are saturated. Thus $dB/dt = 0{\cdot}8$ gauss/μsec. at field zero, but increases to a maximum of about 2 gauss/μsec. The energy gain per revolution during the betatron phase is initially about 850 eV., adjustable to ± 1 per cent by remote control of flux-bar reluctance. When the bars are saturated, the energy gain per revolution is about 1,700 eV., which determines the minimum for the energy supply from the resonators.

Guide-field focusing is provided by the radial field gradient $\frac{dB}{dr} = n\frac{B}{r}$, where $0 < n < 1$ over the annular region $r = 125 \pm 6{\cdot}5$ cm. in the median plane. Three main sets of correction coils are employed. Control of the average value of $n$ around the complete orbit is provided by five concentric coils spaced 1 in. apart and attached to each pole face. The current through each of the ten coils is independently controlled so that median plane adjustments are also possible. Azimuthal variations of the radial gradient or the median plane can be removed, or introduced, by pole-face coils covering each of four quadrants situated at six radial positions 1 in. apart, alternating with the above set of circular coils. Azimuthal variations of remanent field or of rate of change of field associated with individual C-units are counteracted by resistance control of the currents induced in eight-turn coils around the vertical members of each unit.

The toroidal vacuum chamber (Figs. 3 and 4) is built up from moulded ceramic sections. There are nine plain sectors and eight with ports to provide access to the chamber, made of 'Frequentite'. The inner surface is coated with a thin continuous layer of platinum which has a resistance of 5–20 ohms per square. (The two resonators which complete the chamber will be described below.) The cross-section is roughly elliptical, with internal radial and axial dimensions 18 cm. and 6 cm., respectively, the wall thickness being about 1 cm. Adjacent sectors are spaced by 'Teflon' gaskets, the vacuum seal between them being provided by surrounding neoprene bands. Manufacturing tolerances reduce the clearance between the chamber and the pole-faces to about 0·5 cm. in places, leaving just sufficient space for the pole-face coils. The pumping system consists of a

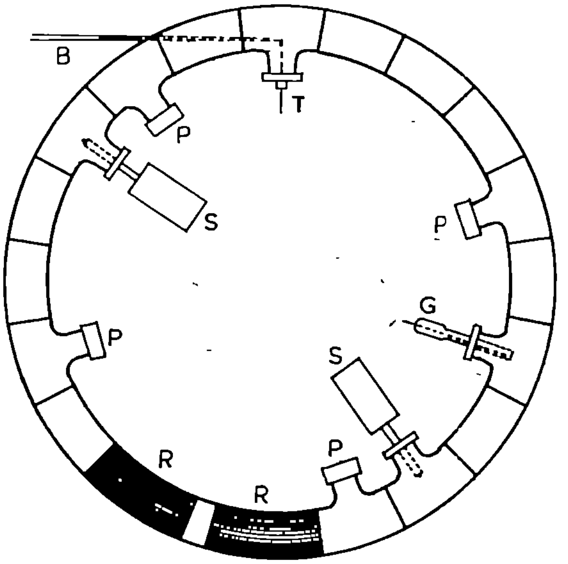

Fig. 3. Lay-out of vacuum chamber: *P*, pumping ports; *G*, electron gun; *S*, scintillator probes; *R*, resonator; *T*, target; and *B*, gamma-ray beam

Kinney rotary pump which provides the backing pressure for four 4-in. oil-diffusion pumps. The pressure in the vacuum chamber is usually about $2 \times 10^{-6}$ mm. of mercury.

Electrons are injected from a diode gun inserted through a port on the inner edge of the vacuum chamber. The anode is earthed, and the directly heated cathode is supplied with a negative trapezoidal pulse of duration about 5 μsec. and of amplitude about 70 kV. Up to 1 amp. of electronic current can be injected. Three motorized, remotely controlled adjustments permit the optimum disposition of the gun and its electrodes to be found during machine operation, these adjustments being radial movement, rotation and movement of the cathode relative to the anode. During the periods of rise and fall of the anode potential, a considerable number of low-energy electrons strike the inner wall of the sector housing the gun, ultimately causing sufficient damage to the metallized coating to produce erratic behaviour of the output. Repairs to this section are necessary at intervals of a few months. The timing of the injector pulse must be accurate to within 0·1 μsec. in order to maintain a steady output. This is achieved by feeding a pulse produced by a peaking strip mounted within the magnet gap into a multiar circuit which permits adjustment of timing within a selected limited range. The period during which electrons are accepted is about 0·4 μsec.

Synchronous electron acceleration is obtained by using two quarter-wave coaxial resonators. The conductor consists of a silver coating of at least 0·001 in. thickness, which is divided into strips about 1 cm. wide by longitudinal scribe lines in order to reduce eddy-currents. The lines on the inside are covered with a high-resistance film of 'Aqua-dag' to prevent charge accumulation. The resonators are fed, matched and tuned with the aid of two π-shaped slots in the outer silver coating. The gap across which the accelerating voltage is developed is located near one end. The two resonators with a small make-up sector between them occupy the same azimuthal angle as three normal sectors. They are placed with the accelerating gaps close together so that they must be fed approximately in anti-phase. Phasing is achieved by adjustment of the difference between the lengths of the two feed cables. The resonators are placed in a part of the vacuum chamber far removed from the point of electron injection in order to avoid the large direct beam from the gun which might cause accumulation of charge on the insulating gaps. The frequency range necessary is 38·2 ± 1·6 Mc./s., and the minimum total peak-gap potential is 1,700 V. The radio-frequency power source consists of a small master oscillator followed by two stages of frequency-doubling and power amplification, and a final push-pull output stage operated under class *C* conditions. The modulator pulse which is applied to the grid of the first doubler circuit is supplied from shaping circuits which provide control over the rate at which the radio-frequency voltage rises, its duration and the rate at which it falls. Timing is adjusted by means of delay circuits triggered from the instant of zero magnetic flux. It is found that betatron-synchrotron transition usually commences when the electron energy is about 4 MeV. with a radio-frequency of 38·3 Mc./s., the betatron orbit radius at injection being about 126 cm. The γ-ray beam is normally obtained by switching off the radio-frequency supply near peak field and allowing the circulating electrons to spiral inwards and strike a tungsten target. Sudden cut-off provides a beam of about 30-μsec. duration, but by shaping the trailing edge of the modulator pulse a duration of about 2 msec. can be obtained.

The comparison of the γ-ray outputs of electron synchrotrons working at energies of about 300 MeV. has been done in two ways. One method consists of measuring the number of 'roentgens' observed on the axis of the beam at a distance of several metres, using a Victoreen ionization chamber surrounded by a thimble of lead ⅛ in. thick and expressing the axial intensity in roentgens per minute at one metre. The Glasgow machine can produce a steady output of 2,000 r./min. The other method makes use of a large ionization chamber with walls of copper 1 in. thick, this thickness being chosen to provide maximum electron shower intensities for 300-MeV. γ-rays. Such a chamber has been calibrated at Cornell University in terms of the number of equivalent quanta per coulomb of collected charge. The number of quanta measured by this chamber depends on the angular width of the beam, which is controlled by an aperture in a lead collimator. On the basis of the Cornell calibration of an identical chamber, the synchrotron has an output of $2 \times 10^{9}$ equivalent quanta per minute through an aperture of diameter ¼ in. situated 125 cm. from the target.

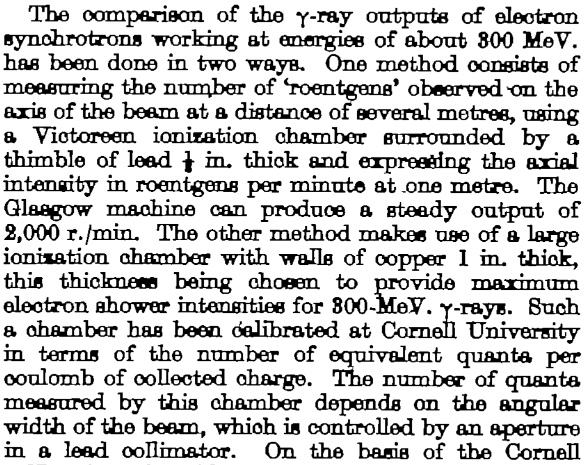

Fig. 4. Component parts of the vacuum chamber: a plain and a port sector fitted together, and a resonator

A project of this magnitude necessarily involves such a large number of workers that space permits an acknowledgment of only the principal contributors to the success of the installation. Throughout the development and constructional stages, the project was controlled by a committee under the joint chairmanship of Prof. P. I. Dee and of Mr. F. R. Perry, of the Research Department, Metropolitan-Vickers Electrical Co., Ltd. The members of the committee were drawn from the University, many departments of Metropolitan-Vickers, the Atomic Energy Research Establishment, Harwell, and several industrial firms responsible for the manufacture of different parts of the project. The magnet was designed by J. B. Hansell and the measurements and adjustments were supervised by E. A. Finlay. D. W. Fry, F. K. Goward and R. Carruthers, all of Harwell, who had been associated with the construction of the first successful electron synchrotron, were members of the committee. The ceramic vacuum chamber and resonators were manufactured by Steatite and Porcelain Products, Ltd., with the co-operation of R. Carruthers, who was also responsible for the design and manufacture of the radio-frequency and other electronic circuits. The electron guns, the prototype of which was designed at Harwell, have been modified and improved by A. C. Robb and J. T. Lloyd, of Glasgow. The task of designing the magnet corrections and of finding and improving the beam was the work of the authors of this article. A more complete report of this work will shortly be published elsewhere.

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# DEFINITION OF THE SECOND OF TIME

By Sir H. SPENCER JONES, K.B.E., F.R.S.

WITH reference to the letter by Sir Edward Bullard, published in *Nature* of August 13, p. 282, the General Assembly of the International Astronomical Union, held in Dublin in September, passed a resolution approving the definition of the second proposed by the Comité International des Poids et Mesures, as follows:

"The second is the fraction 1 : 31 556 925·975 of the length of the tropical year for 1900·0."

This fraction is sufficiently accurate for all practical purposes, but it should be noted that the more precise value required for exact agreement with Newcomb's Tables of the Sun is 1 : 31 556 925·97474.

The physicist and the radio engineer will desire to know how the mean solar second of to-day can be related to the second, adopted as the unit of time in the above resolution. The following explanation has therefore been prepared by Commission 31 (Time) of the International Astronomical Union:

Mean solar or Universal time, based on the rotation of the Earth, is obtained in practice from observations of stars. Ephemeris time, basically the independent variable of the equations of motion of celestial bodies, is the time argument of astronomical ephemerides. The second of Ephemeris time is the unit of time defined in the resolution passed by the International Astronomical Union. The comparison of ephemeris positions of suitable celestial bodies with observations recorded in Universal time serves to obtain the difference $\Delta t$, Ephemeris time minus Universal time.

In practice, Ephemeris time is determined as the time at which an observation of the Moon is in agreement with the lunar ephemeris constructed in conformity with the internationally adopted solar ephemeris. For the years 1952–59, this lunar ephemeris is published in the volume "Improved Lunar Ephemeris, 1952–1959"; from 1960 onward it will be published annually in the National Ephemerides.

In order to obtain a frequency $\nu_E$ corresponding to the invariable unit of time defined in the resolution, the following steps are required:

(*a*) The frequency $\nu_U$ is obtained by using as unit of time the second of Universal time provided by wireless time signals issued by the national time services.

(*b*) Corrections to these time signals, obtained afterwards from observations of stars, are published regularly by the time services. Inter-comparisons of the time signals transmitted by the various observatories are published annually by the Bureau International de l'Heure.

(*c*) Values of the difference $\Delta t$, Ephemeris time minus Universal time, applicable to the middle of each year, are being published with a lag of from two to three years. They are at present derived from observations of occultations of stars by the Moon, and meridian observations of the Moon. It is expected that in the near future a programme of observations with dual-rate Moon position cameras, developed by Markowitz at the U.S. Naval Observatory, will provide a method of deriving the difference $\Delta t$ more accurately and more promptly.

(*d*) Let $D\Delta t$ designate the change per annum in the value of $\Delta t$, derived by a suitable formula for numerical differentiation from a sequence of annual values of $\Delta t$. If $\Delta t$ is expressed in seconds, the frequency $\nu_E$ corresponding to the second defined in the resolution is then obtained by:

$$\nu_E = \nu_U\left(1 - \frac{D\Delta t}{31{,}556{,}925{\cdot}975}\right)$$

$$= \nu_U\,(1 - 3{\cdot}1689 \times 10^{-8}\,D\Delta t)$$

(*e*) After the frequency of an atomic frequency standard has been determined to sufficient accuracy with respect to the second of the resolution, the atomic standard may be used to make the second immediately available.

The astronomical determinations of time are complicated by seasonal variations in the rate of rotation of the Earth as well as by the polar motion. These causes contribute to the discordances among the determinations of time at various observatories. Definitive corrections for these effects can at present be effected only with a lag of several years. Provisional corrections can, however, be applied at once, with a resulting uncertainty in Universal time at most of the same order as the uncertainty in the annual values of $\Delta t$.

Laboratory determinations of frequencies corresponding to the varying second of Universal time may aid importantly in the study of the seasonal variations in the Earth's rate of rotation.

When the relationship between the mean solar second at the present time and the second defined in the resolution of the International Astronomical Union has been satisfactorily determined, the cæsium frequency standard developed at the National Physical Laboratory will enable the mean solar second in future years to be related immediately to the fundamental unit of time.

As Sir Edward Bullard remarks, the atomic frequency standard will provide a check within a few years whether or not there is any divergence between astronomical and atomic time, and will thereby provide a test of the theories of Milne, Dirac and Jordan.

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# WELSH PLANT BREEDING STATION

## NEW HEADQUARTERS AND EXPERIMENTAL GROUNDS

By PROF. E. T. JONES

Director

THE new headquarters and experimental grounds of the Welsh Plant Breeding Station at Plas Gogerddan were opened by H.M. The Queen, who was accompanied by H.R.H. The Duke of Edinburgh, on August 8 in the presence of more than one thousand guests.

Founded in 1919 as a research department of the University College of Wales for the investigation and improvement of farm crops, the Station owes its existence to foundation gifts to the College by Lord Milford of Llanstephan House, Radnorshire. Apart from these initial gifts, the research programme is supported financially by Treasury grants made by the Ministry of Agriculture, Fisheries and Food on the recommendation of the Agricultural Research Council.

The primary activities of the Station concern the breeding and development of new strains and varieties of grasses, clovers and oats. Valuable contributions to British agriculture have been made by the staff in the production of new varieties of farm crops, the development of new techniques in the establishment, manuring and management of grasslands, and the improvement of hill pastures. The Station has also carried out researches in seed-growing techniques, and has introduced seed-crop inspection and certification schemes. The aim of these is to ensure that the Station-bred strains are made available to farmers as authentic seed of the highest standard of purity. Much of this pioneer work has been of the greatest value in relation to the problems of grassland scientists in many parts of the world.

Plas Gogerddan became the new home of the Station when the University College of Wales purchased a major portion of the Gogerddan Estate in 1950. With the aid of funds provided by the University Grants Committee, the mansion (Fig. 1) has been renovated and converted into laboratories for chemistry and cytology, library, conference and common rooms, and offices for administrative and other staff. Residential quarters for the Director, or a senior research officer, and for a caretaker are also available.

Capital grants for the construction of greenhouses, field laboratories and the Lord Milford Plant Research Laboratories have been provided by the Ministry of Agriculture, Fisheries and Food. The new greenhouses, which are of cedar wood and of standard design, are in three separate blocks built to meet the needs of the Grass, Clover and Cereal Breeding Sections, respectively. A supplementary unit with lighting and heating equipment is provided in the Grass Breeding Section for the control of the flowering period in plants used for hand-crossing, and a central service block houses the boilers, soil sterilization units, potting benches and other ancillary equipment.

The heating of the greenhouses is by low-pressure steam raised in a locomotive-pattern boiler, which is automatically fired by a solid fuel underfeed stoker. Steam is carried by mains to pipe coils in the greenhouses and by branches from the mains to feed a calorifier in each of the laboratory blocks. The calorifiers consist of a cylinder with an inner heating coil, and by means of an electrically operated pump the steam-heated water in the cylinder is circulated through the laboratory radiators. These are arranged to give an internal room temperature of 60° F., with an external temperature of 30° F., and a low-pressure hot-water flow temperature of 180° F. Each calorifier is fitted with a thermostatic valve on the steam supply connexion, with steam trap, strainer and check valve. The steam boiler also provides steam to service two steam grids each 5 ft. square for soil sterilization, and steam jets for pot sterilization.

The field laboratories, which are adjacent to the greenhouses, consist of one-story units of simple and essentially functional design. In addition to office and laboratory rooms for scientific and technical

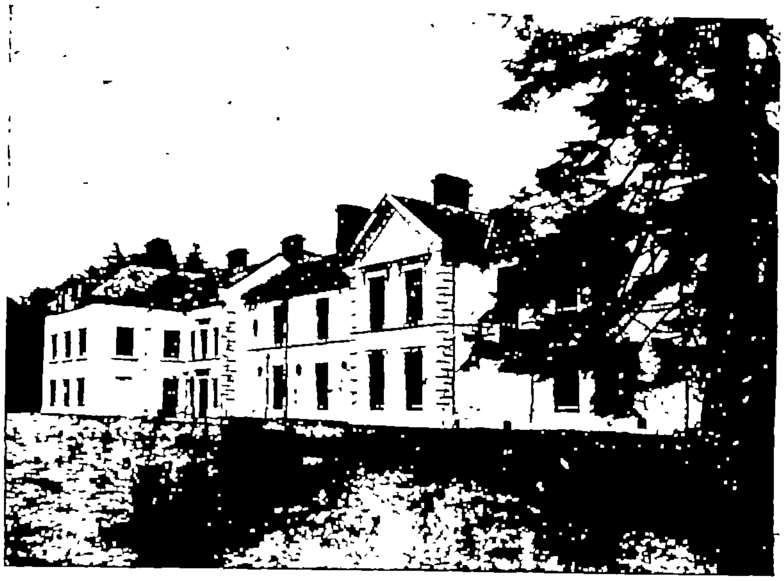

Fig. 1. Plas Gogerddan

Fig. 2. Lord Milford Laboratories

*Topical Press*

staff, there are facilities for students and overseas workers to pursue training in plant breeding or schemes of research in collaboration with the Department of Agricultural Botany for higher degrees of the University of Wales.

The Lord Milford Laboratories (Fig. 2) have two floors and a basement and provide a total floor space of about 12,000 sq. ft. This building is built of brick with a rough-cast exterior and reinforced concrete floors surfaced with 'Accotiles'. It provides storage for cereal breeding material and herbage seeds, as well as laboratories for the Cereal, Seed Multiplication and Grassland Agronomy Sections. In the basement there are rooms for the long-term maintenance under controlled low-temperature conditions of special stocks of breeders' material, rooms with controlled lighting for the study of plant reactions to light, a boiler room and facilities for the threshing of oats and other grains.

By arrangement with the University College Estates Committee, adaptation and repairs to the farm buildings are in progress for the housing of cattle required for the field experiments, and for the installation of a series of three 'Unitherm' driers for the determination of the dry matter content of herbage samples. The hunter stables and coach houses have been converted into shops for the carpenter and mechanics and to house farm implements and farm machinery.

The home farm of Plas Gogerddan extends over approximately 200 acres, which, with the retention of the Frongoch Experimental Farm of 96 acres and the release of Brynamlwg Farm to the University College, leaves a net gain of more than 120 acres highly suited to the development of large-scale field experiments.

Multiplication of foundation seed of bred strains will continue to be undertaken at Morfa Mawr, a farm of 460 acres on the coast eleven miles south of Aberystwyth. Apart from an initial grant for stocking and the installation of seed-cleaning machinery, this farm, which is let to the Station by the University of Wales for seed-growing purposes, receives no financial assistance in respect of maintenance and capital expenditure.

A new Hill Nursery of 45 acres recently made available will provide facilities for the study of the behaviour and relative growth of herbage, cereal and *Brassica* breeding material under semi-upland conditions, and for the comparison of plant growth under the latter conditions with that at a lowland centre.

The new headquarters and experimental grounds provide excellent facilities and make an ideal centre for the immediate and future development of the Station's research programme.

# FUNGI IN FORESTS

IN a joint session with Section K (Botany) of the British Association, Section K* (Forestry) organized a discussion, held on the morning of September 5 in Bristol, at which the subject of "Fungi in Forests" was considered. Prof. Lily Newton was in the chair. The first of the four papers, that by Dr. I. Levisohn (Bedford College, London) on ways of studying the activity of mycorrhiza-formers in the soil, emphasized the difficulty of proving the relationship between the fungal and tree partners in mycorrhizæ of forest trees and commented on the fact that few, if any, endotrophic mycorrhizal fungi of trees have been isolated. Isolation of the fungus from ectotrophic mycorrhizæ has been achieved in a number of instances: by isolation from the fungal sporophores; by direct isolation from the mycorrhizal roots; and from hyphal strands or rhizomorphs directly connected with the mycorrhizæ. Identification of the fungus can often be made through comparison of mycelial cultures taken from the mycorrhizal roots with those from sporophores of known species. Inoculation of isolates on to tree roots is also desirable.

A number of known mycorrhiza-formers have been studied in the free-living state in field and pot experiments, and lively growth has been observed on a variety of decomposing organic material. Certain mycorrhiza-formers, such as *Boletus scaber* and *Rhizopogon luteolus*, have been shown to be capable of influencing root morphology and shoot development of a variety of tree species even when contact, and consequent formation of mycorrhizæ, was prevented. Pine roots responded by forking, and monopodial systems developed in larch and spruce roots. These ectotrophic mycelia also stimulated seedling growth of certain species of tree in which the mycorrhizæ are normally endotrophic—for example, Lawson cypress, *Thuja* sp. and *Robinia pseudacacia*. *Robinia* normally has both endotrophic mycorrhizæ and root nodules inhabited by nitrogen-fixing bacteria. Inoculation with either crushed nodule material or *Boletus scaber* gave improved growth of the seedlings.

Dr. Lilian E. Hawker (University of Bristol) then read a paper on hypogeous fungi, in which she gave an account of the collection of truffles and other hypogeous fungi by members of the Department of Botany, Bristol. The Bristol area was well worked by Broome some hundred years ago, so that it is not surprising that few new British records and fewer new species have been added to the list. The mature fruit bodies of ascomycetous (Tuberales, Plectascales), basidiomycetous (Hymenogastrales) and phycomycetous (*Endogone*) hypogeous fungi are strikingly similar and consist of a central sporogenous mass, or gleba, and an outer rind or peridium. These give little clue to systematic position; but comparison with less complex species and, above all, developmental studies have established the relationships of most species. Nevertheless, development has been followed in a comparatively few species, and modern work, particularly in France, suggests that the hypogeous Basidiomycetes, in particular, may be a very heterogeneous collection containing both simpler and reduced forms of diverse relationship. Dr. Hawker illustrated this with a series of lantern slides and by a demonstration of drawings, specimens and microscopic preparations.

Owing to the great difficulty of culturing most of these fungi, direct proof of mycorrhizal relationships with higher plants is lacking, but constant association between certain species of hypogeous fungi and certain trees is suggestive. For a similar reason, no exact physiological experiments have been done with cultures proved to be of hypogeous fungi, but identical isolates from mycorrhizæ of beech and fruit-bodies of *Tuber* spp. have shown nutritional characters similar to those of known mycorrhiza-formers. Since well over a thousand separate collections have been made during the past five years, the commoner species have occurred many times. Data of tree cover, soil and weather conditions were recorded for each collection, so that some idea of the factors controlling distribution of the commoner species has been obtained. Thus, while the majority are favoured by alkaline soils, a few—such as *Elaphomyces granulatus* and *Rhizopogon luteolus*—are found mainly in more acid situations. A well-aerated soil is essential for all species, although some are more exacting than others. Fruit-bodies, however, frequently form in contact with hard surfaces such as roots, path edges or clay layers. Both temperature and soil moisture are important factors in fruit-body initiation and maturation, although some species are more tolerant of drought and cold than others.

Miss R. M. Godfrey (University of Bristol) discussed some woodland species of *Endogone*. Arising out of the work described in the previous paper, Miss Godfrey has made a special study of the interesting phycomycetous genus *Endogone*. This genus includes forms producing zygospores, as a result of conjugation between gametangia, in groups within a loosely constructed fruit-body, and others producing similar fruit-bodies containing only chlamydospores. A single example was described by Thaxter of a species in which the fruit-body contained both types of spore, thus justifying the inclusion of the chlamydosporic forms in the same genus. Miss Godfrey was able to show slides of a specimen found by her at Cleeve Coombe, Somerset, believed to be a fruit-body of the normally chlamydosporic *E. microcarpa* containing a number of zygospores scattered among the typical chlamydospores.

British records, hitherto, have been limited to the zygosporic *E. lactiflua* (with a single doubtful and unsubstantiated reference to the zygosporic *E. pisiformis*), and the two chlamydosporic species, *E. microcarpa* and *E. macrocarpa*. To these Miss Godfrey has added an undoubted specimen of *E. pisiformis* collected by Dr. J. Fraymouth in the New Forest and two species in which the chlamydospores show characteristic grouping, believed to be *E. fuegiana* and *E. vesiculosa*. The great variability of spore characters shown by *E. macrocarpa* was also pointed out. The genus *Endogone* is of interest both from the systematic and biological points of view. The zygosporic forms show affinity both with the Mucorales, with which they are provisionally classified, and the Hemi-Ascomycetes. If zygospores could be germinated the results would be of primary significance, since, if on germination they gave rise to a sporangium, their relationship with *Mucor* would be established; but if they should germinate by the formation of endogenous spores, they might be considered to have a closer affinity with the simple Ascomycetes. Unfortunately, no one has as yet succeeded in inducing germination of zygospores by any of a large number of techniques. Miss Godfrey, however, was able to report germination of chlamydospores of both *E. microcarpa* and *E. macrocarpa*. These germinate to produce a typical coarse mycelium with characteristic branching.

In conclusion, Miss Godfrey pointed out that a study of the mycorrhizæ of plants growing near the *Endogone* fruit-bodies (including yew and species of *Viola*) did not yield any conclusive evidence in support of Peyronel's thesis that *Endogone* spp. are the endophytes forming the vesicular-arbuscular type of mycorrhizæ with various flowering plants.

In the final paper, Prof. C. G. C. Chesters (University of Nottingham), speaking on the fungal population of bark of living trees, recalled the fact that when a branch of a tree is shed, either from natural causes or through forestry practice, it is rapidly colonized by one or more microfungi. Such fungi may be termed the flora of 'first incidence'. Whole saplings may be colonized with a single bark-inhabiting fungus such as *Diaporthe leiphemia* on beech, or a number of these may occur. Some are confined to a single tree species—for example, *Diatrype disciformis* on beech—while others may be termed 'plurivorous'—for example, *Valsa ambiens*. Such a constant association between certain species and the bark of dead tree branches suggests that the inoculum must already be present on the living tree before the branch is shed. Washings of bark of various trees yielded spores of these species, but there was a predominance of spores of such species as *Pullularia pullulans* and *Cladosporium herbarum*. With repeated washings the proportion of spores of these species increased. Examination of fissures in the bark and of lenticels showed the presence of chlamydospores and mycelium. It is of interest that Smit and Wieninga (1953) also obtained *P. pullulans* from washings of dead leaves, and it is likely that this fungus is concerned in pectin decomposition.

In the discussion, unfortunately limited by the time allowed, which followed each of these papers, Dr. J. Ramsbottom and others emphasized the change in our concept of 'symbiosis'. Modern work supports the idea of a precarious balance, or controlled parasitism, between the two partners of a 'symbiotic' system.

# LANGUAGE, MEANING AND MIND

At the Bristol meeting of the British Association, a symposium on semantics was organized by Section J (Psychology). In Great Britain semantics has tended to remain a topic of philosophical parlour conversation, except among linguists for whom it has been rather a technical discipline. Among empirically minded scientists, especially psychologists—who are more severely empirical than any to-day—semantics has come to be regarded as a rather fancy line of talk devoid of both rigour and content. The aim of this symposium, in which the disciplines of psychology, linguistics, neurology and mathematical logic were represented, was to demonstrate not only a measure of common ground among these disciplines, but also to indicate that semantics is now sufficiently developed to provide psychology with a much-needed methodological instrument. It is an instrument with applications as far-reaching and precise as those of statistics, and is, indeed, a necessary complement to the latter if figures are to have meaning. Moreover, it is not without its bearings on the hotly debated theme of the "Fragmentation of Science" so provocatively presented at Bristol by Mr. Ritchie Calder.

In the opening paper on "Semantics in Relation to Psychology", Prof. G. P. Meredith traced in outline the history of the 'theory of signs' from its early beginnings in Greek medicine down to its present systematic development in the hands of Morris and Carnap. The signifying function of words is seen as an instance of a much wider semantic phenomenon, namely, the interpretation of signs of all kinds. This communication of meanings is a fundamental biological process essential to animal societies. To clarify this study of 'semiotic', as it is called, Morris, following Charles Peirce, has divided it into three main branches: syntactics investigates the relations of signs among themselves; semantics deals with the relations of signs to the objects signified; and pragmatics is concerned with the relations of signs to interpreters. These divisions, which correspond with the famous triangle of "Thought, Symbol and Referent" of Ogden and Richards, are represented in Fig. 1. Thus relations are the essential theme of semiotic studies. A word bereft of relationship is a mere physical event.

Carnap has developed semantics in terms of symbolic logic. In a highly abstract system he has presented the pure mathematics of language. This system, though lacking immediate applicability, may well be needed in the future society of universal and virtually instantaneous polyglot communications. Carnap will play Riemann to some future Einstein of social space-time.

Meanwhile, the discipline of semantics as developed by linguists can provide psychology with valuable discriminations. Ullmann, in his "Principles of Semantics", provides a three-dimensional classification of the fields of linguistic inquiry based on: the level of complexity (as in phonology, lexicology and syntax); the transverse or longitudinal aspect of language in time (synchronistic or diachronistic); and forms or meanings (as in morphology and semantics). If we extend this treatment to visual as well as auditory signs, we have the 'semiotic cabinet' of Fig. 2.

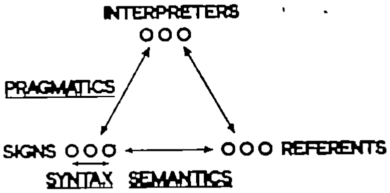

Fig. 1. The semiotic triangle

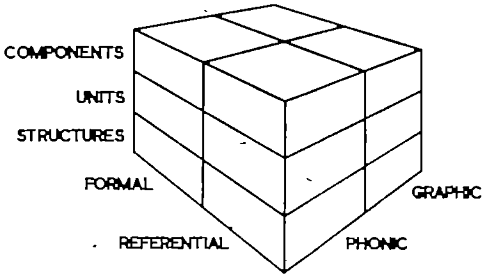

Fig. 2. The semiotic cabinet

Such schemes can suggest valuable frameworks for the design of psychological experiments and studies of such problems as aphasia as well as normal linguistic development in childhood. They can help to resolve the many terminological problems which beset psychology, and also to break down the barriers of jargon which hinder its relations with other sciences. Finally, the fundamental difficulties which arise from the categoreal diversity in thoughts, words and things, and from the 'systematically misleading expressions' discussed by Gilbert Ryle, may, through semantic analysis, give way to a system of empirical type-differences, a system urgently needed in modern psychological theory.

Prof. Stephen Ullmann, in his paper on "The Concept of Meaning in Linguistics", took his stand (appropriately enough in a psychological symposium) on the non-self-sufficiency of linguistics for resolving the nature of 'meaning'. Psychology and neurology, philosophy, anthropology and social science, all have a stake in this problem. He discussed two main approaches to the problem, the analytical and the operational, and showed that these are ultimately more complementary than contradictory.

Discussing the triangle of Ogden and Richards, in which the relations between the 'name', the 'sense' and the 'thing' are expressed, Prof. Ullmann simplified the issue by dismissing the 'thing' as non-linguistic. We thus are left with a binary and reciprocal relation between the name and the sense. The speaker starts with the sense. In him the sense calls up the name. The hearer starts from the name, and in him the name calls up the sense. The link between name and sense is severed only in the brain lesions studied by neurology. An over-simplified view which asserts some direct relation of designation between the name and the thing creates insuperable difficulties by ignoring the way in which language, in fact, works. The word 'atom' does not mean to-day what it meant to the Greeks, though the atom itself has not changed.

It is the concept which has changed. A more serious objection to the analytical dichotomy of sense and name is that it seems to imply a mysterious psychophysical relation. There certainly is an inherent duality in language or in any sign-system, between the sign and that which is signified; but name and sense are not, in fact, heterogeneous. The name is not the physical event but the mental impression of the word. Both name and sense are mental phenomena.

There are weaknesses in the analytical view. One is the fact of polyvalency. One name may have several senses. One sense may be expressed through several names. The view thus needs elaboration. More fundamental is the objection that the view is atomistic and fails to account for the all-important determination of context. Every word has its 'associative field'. There are associations between names and between senses, and the two may intersect. This complex phenomenon is being resolved into manageable parts by the notion of semantic fields—for example, the scale of colours. (It may here be pointed out that the effective semantic fields are, in fact, the various branches of science.)

As the analytical view widens to accommodate the facts of language in operation, it approaches the operational view. On this view the meaning of a word is not what we say about it, but what we do with it. Wittgenstein, not without some reservations, identified the meaning with the use of the word. On this view meaning is not revealed by use, it is itself the use. Thus the influence of context, which is embarrassing to the analytical view, is the very basis of the operational view. Words apart from context are abstractions. The operational view is thus closer to the facts of language in action. However, we do use dictionaries, and the lexicographer, though starting operationally from linguistic facts, finishes with an analysis of discrete meanings. Thus the analytical view has its part to play. Words have been likened by Wittgenstein to tools, and by de Saussure to chessmen. Both similes suggest a range of relationships, a 'field of force', facilitating a structural view of language. Such a view can do much to facilitate the relations between linguistics and the neighbouring disciplines.

Sir Russell Brain revealed the intricacy and subtlety of the problems thrown up by neurological disturbances in his paper on "The Semantic Aspects of Aphasia". The difficulty of the linguists in finding an adequate definition for the term 'word' is matched in neurology by the difficulty of finding a firm physiological substratum the behaviour of which, both in order and disorder, can account for all the elusive phenomena of aphasia. Here again, the determining role of context is in sharp evidence. Also the neurologist has to be on his guard against being misled by his own language in formulating both the symptoms and the problems.

In aphasia words become less available for use, in varying degrees. The patient may fail to produce a word on request, but may say it under stress of emotion, or in another context. Also, he may recognize it when presented to him and reject wrong alternatives. Or he may have very few words available and yet contrive to use them, with or without gestures, to convey a correct answer to a question. Formulating a proposition is thus partly independent of particular words; and thinking, though in the long run very much dependent upon command of language, may go on in spite of word-failure. In some cases the choice of words becomes 'liquid', one word masquerading for another—for example, a more general for a more specific word. Or again, the word may be heard as a meaningless sound. Analogous failures occur in speaking, reading and writing.

In every word there is a constant element and two variable elements. On one hand the word as heard may vary in pitch, volume, pronunciation or intonation; on the other hand, it may enter, through sentences, into many different contexts, having numerous associational meanings. Between these variables of sound and meaning there must exist a constant pattern, a fixed atomic element. The term 'auditory word-schema' is given to this fixed element. The schema is conceived as a physiological disposition: it does not itself enter consciousness, but it does determine verbal awareness.

From reading, again with its variety of visual forms, we similarly have for each word a 'visual word-schema'; and on the expressive side we have motor schemas for speaking and writing. These schemas functioning together give us a 'central word-schema'. This theoretical framework of the central schema related through receptive and expressive schemas to incoming and outgoing language, and, through associative links, to meaning and thought, provides a physiological basis for the very diverse disturbances of language, from the most specific and superficial to the most serious and far-reaching disorders. In these last the central word-schemas are disorganized, and the capacity to evoke meanings has gone. Thought is thus inevitably impaired. In the more superficial disorders, involving one channel of communication only, thinking may not be much affected. These verbal schemas, however, being physiological, and therefore unconscious, may, through their evocation of meanings, play a part in what, to consciousness, is 'non-verbal' thinking. When schemas are damaged, the effects may not, therefore, be confined to linguistic behaviour only. In the normal state they play their part in the facilitation of apparently non-verbal thought-processes.

In the concluding paper of the symposium, on "Semantics, Pragmatics and Behaviour", Dr. F. H. George made a plea for a more sophisticated view of semantics than the popular notion that identifies it with merely being careful to define our terms. Language can be reconstructed according to systematic rules. Taking a behaviourist point of view, he located the phenomena of 'meaning' firmly in the organism. Thus private introspective statements can be used scientifically only in so far as they are clearly associated with statements concerning public data. But the latter often misses the core of behaviour, whereas the former appears more relevant. The psychologist must reconcile the two worlds or, in other words, the two languages. Only through rigorous formalization can the inconsistencies between the two be eliminated. Statements within a theory must be distinguished from statements about a theory. Philosophical statements are statements by philosophers, that is, they are the linguistic behaviour of certain organisms. As such, they are subject-matter for psychology. Conversely, the statements of psychologists present formal characteristics which can be analysed and clarified by philosophers. Through this twin activity of pragmatics (studying the use of signs by organisms) and semantics (studying the reference of signs to objects), both under the formal discipline of logic, psychology can look forward to healthy progress.

G. P. MEREDITH

# NEWS and VIEWS

## Mr. G. A. Stewart, M.B.E.

MR. G. A. STEWART, assistant secretary and librarian of the Royal Society of Edinburgh, is retiring from his duties there on October 12 after more than fifty years of service. This service has been continuous except during the period of the First World War, when Mr. Stewart participated as a member of the Royal Scots in the campaigns in Gallipoli, Palestine and France, and was "mentioned in dispatches". Public recognition of the value of his work to the Royal Society of Edinburgh was afforded recently by the award of the honour of M.B.E. Only the senior officers of a scientific society, however, really know what a boon it is to have constantly at hand a capable and conscientious guide for every question, major or minor, on which decision must be taken. The devotion and experience of Mr. Stewart have indeed proved of inestimable assistance to the Council of the Royal Society of Edinburgh since the time of Lord Kelvin. Best wishes will be accorded him, not only by Fellows of the Society itself, but also by many members of other bodies whom he has cheerfully aided with loans of books from the extensive library under his charge, for happy years of well-merited leisure in his retirement and of success in his favourite sport of fishing.

## Virus Studies in The Queen's University, Belfast

AFTER the appointment of Dr. G. W. A. Dick to the chair of bacteriology (now called microbiology) at The Queen's University of Belfast, it was decided that virus work would be undertaken in the Department. The University undertook considerable alterations of the existing accommodation in order to provide a virus laboratory with a sterile room, hot room, etc., and also animal accommodation. In addition, a grant of £3,000 was made by the University to assist in equipping the Department for bacteriology and virus work. Since no virus work had previously been done in Northern Ireland, a considerable amount of basic equipment had to be obtained, and a grant of 21,000 dollars has been made for this purpose by the Rockefeller Foundation. This money is being used to purchase, among other things, a 'Spinco' centrifuge, an 'International' refrigerated centrifuge, a −70° C. storage box, a cage sterilizer, a water demineralizer and microscopes.

Two lines of virus research work are going to be undertaken. One of these is concerned with the problem of latent virus infections based on the mouse hepatitis model (Gledhill and Dick, *J. Path. and Bact.*, **69**, 311; 1955) and the other is on poliomyelitis. To assist with this latter study, the National Foundation for Infantile Paralysis has awarded a research fellowship to The Queen's University which is being filled by Dr. D. Surrey Dane, and a salary has been provided for a technical assistant, Miss M. Briggs. The poliomyelitis research has started with the co-operation of Dr. W. J. McLeod and county medical officers of health in an epidemiological study of the distribution of antibody to poliomyelitis in the north of Ireland. The latent virus studies are not yet commenced. When the above research projects are under way, it is intended that a diagnostic virus laboratory will also be established, which will assist in diagnosis and in epidemiological studies of virus diseases in the north of Ireland.

## British Colonial University Institutions

IN a pamphlet entitled "Foundations of Freedom: the New Universities Overseas" (British Commonwealth Affairs No. 10; pp. 19. London: Longmans, Green and Co., Ltd., 1955; 1*s*. 6*d*. net), Sir James Duff makes some interesting comments on progress since the Asquith Commission on Higher Education in the Colonies reported in June 1944. The pamphlet also supplements the recent review by the Inter-University Council for Higher Education Overseas. Sir James stresses the need for a balanced system and the way in which technical colleges, under the title of colleges of art, science and technology, are being fostered to bridge, for the present, the gap that exists in the Colonies between secondary school and university. So far, the Inter-University Council has succeeded in keeping a clear dividing-line between these colleges and the university institution; and at Fourah Bay College, Sierra Leone, where both university and technical work have been included, there seem to have been real advantages. The difficulty in recruiting worthy staff has not materialized, largely because very hard and effective work at the Council's London office has ensured the finding of good recruits and their subsequent promotion on return to Great Britain. The number of students is growing steadily, and most British universities tend to limit their quota of Colonial students to those seeking higher degrees or studying subjects not available locally. Sir James stresses the part which the graduates of the Colonial university institutions must play in supplying the intelligent leadership which the Colonies need as they advance towards self-government and its importance if the institutions are to maintain high standards and academic autonomy. He notes, too, the financial problem set by the high cost of the colleges, capital and recurrent, and the low national income of the territories concerned, and questions the soundness of such decisions as that to build a hospital and medical school at Ibadan to satisfy the training requirements of the University of London. Sir James believes that the suggestion he advanced as a member of the Asquith Commission, that each Colonial university college should establish a relation with a specific university in Great Britain and work for the degrees of that university until it reaches university status and grants its own degrees, would have facilitated the maintenance of high standards and greater flexibility in the arrangements needed in these early years; in particular, two-way traffic and a wider distribution of Colonial students in British universities would have been possible.

## Tree Root Development on Upland Heaths

THE planting of heathlands with trees has always proved a tempting subject to the forester on the Continent of Europe as well as in Great Britain. Some research work at the instance of the Forestry Commission, especially in connexion with the rooting of coniferous trees on upland heaths, was carried out between November 1951 and April 1953, at selected forest areas in north-eastern England and Scotland, and has now been described by C. W. Yeatman in Forestry Commission Bulletin No. 21, "Tree Root Development on Upland Heaths" (pp. 72+24 plates and diagrams. London: H.M.S.O., 1955; 1*s*. 6*d*. net). There are considerable areas of this type of land available in Britain. The object of the investigation was to determine: the relationships existing between the development of the root systems, the soils, and the types and intensities of cultivation prior to planting; the effects of the application of fertilizers on the vigour of the root systems; differences occurring in the root systems of the species studied; and the comparative ability of the root systems of these species to exploit the soil both in their natural state and when cultivated. An upland heath has been defined as "A Callunetum on shallow peat in which the roots of the vascular plants penetrate into the sub-peat layer". The peat is commonly two to four inches thick. Notes are given on the distribution of these heaths and the methods used, the findings, and the conclusions of an investigation into the root development of the principal conifers used extensively by the Forestry Commission in the north of England, such as Japanese larch, Scots pine, Sitka spruce, lodgepole pine and Corsican pine.

### Systematics Association: Meeting in Edinburgh

A MEETING of the Systematics Association was held at the Royal Botanic Garden, Edinburgh, during September 16–17. The three sessions were devoted respectively to the criteria of species, genera and families. Each session had a single main paper followed by general discussion, the principal speakers being Prof. I. Manton (species), Prof. T. G. Tutin (genera) and Mr. E. J. H. Corner (families). The meeting took its lead from the very beautiful electron micrographs of minute structure in the flagellate *Chrysochromulina* shown by Prof. Manton, and the prime necessity for accurate and detailed factual knowledge was emphasized at all three discussions. Two other themes also recurred: first, the difficulty of incorporating new types of data into the classification unless such data cover the whole geographical and taxonomic range of the unit under study; secondly, the need for continued availability of the old categories in an aggregate sense, even when research has shown their subdivision to be necessary in critical work. The meeting terminated with a visit to the new establishment of the Scottish Society for Research in Plant Breeding.

Among those attending the meeting were students from a vacation course in practical taxonomy which had just been given in the University Department of Botany at Edinburgh, and Dr. P. H. Davis outlined the scope of this course during an informal soirée on the Friday evening. Following lectures on some important aspects of herbarium work, the students had been set to revise small groups of Mediterranean species. The course made full use of the excellent herbarium and library facilities at Edinburgh, and was intended to fill a gap which must often arise in botanical teaching elsewhere.

### Bibliographical Survey of Flexure Devices

THE British Scientific Instrument Research Association has started to publish a series of bibliographical surveys on instrument parts, and the first of this series is entitled "Flexure Devices", by P. J. Geary (pp. 44; from the Association at Chislehurst, Kent; 1955; 10s. 6d.). It is a booklet comprising an illustrated technical introduction, digests of twenty-eight selected texts of major importance, an annotated list of one hundred and eleven references to texts of secondary importance, supplementary references and a name index. The period covered by the survey is from 1900 to the present. Periodical, book and report literature has been searched methodically, but not patent literature, although digests of some patent specifications have been included. No claim is made to complete coverage. Flexure devices take many forms, and for the purpose of the survey they have been grouped under the six headings: flexure pivots, parallel movements, twin strip mechanisms, buckling strip devices, rolling suspensions and the sine spring. These are described in some detail in the technical introduction, and their advantages and limitations are mentioned. Reference is made to the general use of flexible strips in gauging instruments following their introduction in about 1916 by the Metrology Department (now Division) of the National Physical Laboratory, Teddington, and to the forthcoming useful review, "The Application of Spring Strips to Instrument Design," to be published in the series of "Notes on Applied Science" of the National Physical Laboratory. The sine spring, a resilient member of adjustable stiffness, has been developed and applied by the Ministry of Supply.

### National Foundation for Scientific Research, Brussels: Annual Report

THE twenty-seventh annual report of the National Foundation for Scientific Research, Brussels (pp. 227; from the Foundation), covers the year 1953–54 and records a fourth grant, of 1,671,000 francs, to the Commission for Clinical Research. Of this, 350,000 francs went to the University of Ghent, 520,000 francs to the University of Liège, 345,000 francs to the University of Brussels, and 456,000 francs to the Catholic University of Louvain, chiefly for work on cortisone and the adrenocorticotropic hormone; lists of publications are appended to brief reports from each of these centres. Special grants made during the year include 200,000 francs for research on a scientific method of determining the mechanical characteristics of hydraulic cement; 250,000 francs for investigations on the physiology and pharmacology of the pulmonary circulation; and 750,000 francs for work on calculating machines in the university laboratories. Brief notes on the work on the utilization of radioisotopes at the Universities of Brussels, Ghent, Liège and Louvain, at the State Agronomic Institute at Gembloux, as well as in industry, are included. A further 2,000,000 francs was voted to the Interuniversity Microfilm Commission, and 100,000 francs for low-temperature research at the University of Louvain. Lists of recipients of grants for 1953–54 and of publications by recipients of grants during 1952–54 are appended.

### Queen Victoria Museum and Art Gallery, Launceston, Tasmania: Annual Report

THE annual report for 1953–54 of the Queen Victoria Museum and Art Gallery, Launceston, Tasmania (pp. 7; from the Museum; 1955), indicates progress in many directions. The vertebrate gallery has been reorganized, new displays have been completed in the new anthropological gallery, a new series of Tasmanian fossils has been placed on exhibition, the water-colour gallery has been re-hung, and photographic copies of certain paintings made available for art historians. The matter of public relations has been one for serious attention, and there is ample evidence in the report that the services provided by the Institution are appreciated by the community.

### Classified List of Egyptian Scientific Papers

IN 1952 the National Research Council of Egypt started to compile and issue annual lists of research papers published in Egypt and by Egyptians abroad. The third volume has recently appeared (pp. 127; from the Council, Cairo) covering papers published in

1953, and includes more university theses than the first two volumes. Entries are arranged by subject according to the Universal Decimal Classification and alphabetically by the names of authors; in this latest volume the rules used in the "World List of Scientific Periodicals" have been adopted for abbreviation of titles of periodicals. There are an author index and a supplementary list of Egyptian periodicals.

## Science and Management: Conference in Harrogate

The British Institute of Management will hold its national conference this year at Harrogate during November 2–4, the general theme being "The Impact of Science on Management in the Future". Among the subjects to be discussed are: training science and engineering graduates for industry; electronic processing of data; development of tools of production; operational research; the research associations; automation; human implications of technical innovation; use of radioactive isotopes; and training scientists for management. Stress will be laid throughout the Conference on the need to translate new scientific discoveries into immediate and practical day-to-day effect. Twenty-four sectional meetings will be held during the two full days of the conference; these will be arranged so that five or six will be held simultaneously, and, in effect, delegates will be able to attend five meetings altogether, at each of which there will be a choice of about half a dozen topics. On the evening of November 3 there will be a choice of sixteen discussion groups, each devoted to a topic currently attracting widespread attention in management circles. Altogether about a thousand persons will be attending the conference. The fee is £9. Further information can be obtained from the Institute at Management House, 8 Hill Street, London, W.1.

## Fresh-water Biology in Scotland

A two-day meeting is being arranged for April 9–10, 1956, by the Institute of Biology (Scottish Branch), to be held in the Zoology Department of the University of Glasgow. There will be three half-days for papers and a half-day excursion to the University's Field Station at Rossdhu, Loch Lomond. The subjects will be: chemistry of fresh waters; plants as indicators of fish productivity; bottom fauna and bottom deposits; erosion products as affecting the river regime; fish parasites; molluscs; amphibia; trout; char; powan; pike; coastal migration of salmon; endocrines of salmonids; the work of the Salmon Inspectorate, that of the North of Scotland Hydro-Electric Board and that of the Brown Trout Research Laboratory, Faskally. Further information will be available in due course from Dr. R. M. Gorrie, "Balnagowan", Murrayfield Drive, Edinburgh, who is secretary of the Scottish Branch of the Institute of Biology.

## Announcements

We regret to record the death on September 29 of Prof. H. M. Turnbull, F.R.S., emeritus professor of morbid anatomy in the University of London, aged eighty.

Prof. P. M. S. Blackett, professor of physics, Imperial College of Science and Technology, London, and Mr. H. Douglass, general secretary of the Iron and Steel Trades Confederation, have been appointed members of the Advisory Council for Scientific and Industrial Research. Mr. J. Crawford, Prof. T. R. C. Fox and Sir George Thomson have retired from the Council on completion of their terms of office.

Mr. Stephen Cheveley, chairman of the Central Agricultural Control, Imperial Chemical Industries, Ltd., has been appointed by the Minister of Agriculture, Fisheries and Food and the Secretary of State for Scotland to be chairman of the Governing Body of the Foot-and-Mouth Disease Research Institute, Pirbright, Surrey, in succession to Prof. Wilson Smith, who is retiring.

A conference on "Raw Cotton—its Properties and Distribution" has been arranged by the Textile Institute and will be held in the Walker Art Gallery, Liverpool, on November 23. The speakers and their subjects are: Prof. S. C. Harland (University of Manchester) on genetics; E. Lord (British Cotton Industry Research Association) on cotton quality; Allan Draper (William Birtwistle Allied Mills, Ltd.) on spinners' requirements; and W. B. Hutchinson (Major Cleaver and Co.) on marketing. Further information can be obtained from the General Secretary, Textile Institute, 10 Blackfriars Street, Manchester 3.

A one-day symposium on chromatography will be held at Hatfield Technical College, Roe Green, Hatfield, Herts, on November 4. Four papers will be read, as follows: principles of chromatography (Dr. A. J. P. Martin), inorganic chromatography (Dr. F. H. Pollard), paper electrophoresis (Dr. A. B. Foster) and vapour-phase chromatography (H. N. Wilson). Tickets for the symposium are available on application to the College.

The British Institute of Recorded Sound, in conjunction with the Department of Extra-Mural Studies of the University of London, has arranged for six lectures to be given by Mr. Eric Simms on "The Language of Birds and other Animals". The first lecture was given on October 4, and the others will be given on alternate Tuesdays (7 p.m.) at fortnightly intervals from that date. The fee is 10*s.* the course or 2*s.* 6*d.* each lecture. On January 25 at 7.30 p.m., Dr. W. H. George will give a lecture (fee 2*s.* 6*d.*) on "Pianists' Touch—its Scientific Study". All the lectures will be at the Institute premises, 38 Russell Square, London, W.C.1, whence further information can be obtained.

The Department of Agriculture for Scotland has awarded the following postgraduate scholarships in husbandry, tenable for periods up to three years: A. D. Drysdale (University of Cambridge), Miss C. J. Falconer (University of Reading), David M. S. Livingston (University of Aberdeen and Low Temperature Research Station, Cambridge), R. A. N. Napier (University of Edinburgh) and Charles Smith (Iowa State College). In addition, the following current awards are being continued for a further period: I. C. Beattie, J. Frame and W. C. Smith (Massey Agricultural College, New Zealand), I. A. Munro (University of Reading) and T. M. Sutherland (Iowa State College).

The Association of British Chemical Manufacturers (Cecil Chambers, 86 Strand, London, W.C.2) has recently published "British Chemicals and their Manufacturers, 1955" (pp. 192), which lists about twelve thousand products with the names and addresses of the manufacturers. The book is available free to persons or firms interested in the purchase of chemicals on application to the Association.

# EDUCATION OF THE PHYSICIST

At the recent Bristol meeting of the British Association a recurrent theme in addresses to several sections was the specialist, and what should be done about him. Mr. J. F. Wolfenden, president of Section L (Education), spoke of the 'educated man' in 1955 as the man who could walk in the two great fields of thought, that of human aspirations and endeavour to which he would come through the humanities, and that of abstract thought and control over Nature to which man comes through science. Following him and speaking on the educated man in 1984, Dr. J. Bronowski threatened the world with Orwellian consequences if the schools and universities did not follow Mr. Wolfenden's advice; and Mr. Ritchie Calder, speaking as president of Section X (the Assembly of Corresponding Societies), accused scientists of knowing little in science itself outside each man's own speciality, and of being unable to achieve or communicate any broad picture of the state or meaning of science.

Mainly on this theme, a session on September 5 was organized jointly by Section A (Physics and Mathematics) and Section L (Education), devoted to the "Education of the Physicist", under the chairmanship of Mr. Wolfenden. The aims of the organizers were these: schools in Britain are frequently accused of over-specialization; Is this accusation just? Would anyone defend the present state of affairs? If the education of scientists is too specialized, where must we look for the remedy—to the schools or the universities? And would any remedies that might be suggested increase or decrease the number of boys who choose science? Finally, how, if at all, can we produce Mr. Wolfenden's educated man, the man who is equally at home in the humanities and in science?

The first speaker was Sir Philip Morris, vice-chancellor of the University of Bristol, who said that the central problem in education is the impact of the great increase in knowledge, particularly scientific knowledge, and its vastly increased importance. He feels that our primary education is notably successful, but that the secondary stage is the heart of our educational problem to-day. The idea of secondary education for all has caught men's imagination, as something we want and ought to have, but ideas as to what this education ought to be are shadowy, lacking coherent form and definite substance.

Interest in physics and the desire to make a career in the subject, or indeed in any other branch of science, normally show themselves during the secondary stage of a school education. The choice that a boy will make is partly a matter of natural aptitude, but partly a matter of the opportunities presented to him at school and the influences brought to bear on him. Sir Philip strongly emphasized how great is the influence of the secondary school, whether deliberate or not, in shaping the lives of the children who go there and in guiding them towards careers. He therefore thinks that a balance between the linguistic, the mathematical and the scientific is of the greatest importance during the first five years of the secondary school course, so that a child will have every opportunity to follow where his true abilities and ambition lie.

Sir Philip thinks that we have deviated more from a properly balanced education than we ought in these first five years. The problems that physicists in particular ought to ask themselves are: How vital is mathematical knowledge to the school child's appreciation of science? And should the sciences at this stage be taught as separate subjects? It is of the utmost importance that every secondary school pupil should learn about the scientist's outlook on the physical universe; Sir Philip placed this aim above, though not necessarily in opposition to, a preliminary grounding in particular scientific subjects.

In the last two or three years before the university, particular subjects chosen from those found in them must be followed seriously and deeply, but even so the course must have some balance. Much has been written on the educative value of a purely scientific education, and certainly really imaginative teachers can use science to provide for their pupils a full range of spiritual, emotional, social and political experience. But Sir Philip doubts the wisdom of making the attempt, and feels it better that science teachers should do their best to persuade their pupils of the importance of subjects outside their speciality and should leave it to others to teach these subjects.

Prof. N. F. Mott, Cavendish professor of physics in the University of Cambridge, spoke of his experience in interviewing candidates for admission to the University of Bristol when he was head of the Physics Department there, and the number of students who had said that, apart from their specialist studies, their curriculum included as little as one period of scripture, one of English, one of civics and one of gymnastics. Whether or not this was a fair description of the curriculum in many schools, it seems to him to indicate that in the boys' minds the subjects outside their specialization are treated with little respect. He believes that at least one arts subject, such as a modern language, should be continued seriously until the end of their time in the sixth form; and he believes that the sixth form rather than the university is the place where the basis of a general education should be laid. To widen the curriculum there would have two advantages. It would narrow the widely deplored gap between scientists and arts men, and it would defer the moment in a child's life when he has to choose between science and other subjects.

Prof. Mott then went on to discuss ways in which the universities could help the schools to widen the sixth form education with these ends in view. One way is to provide a means of entry into science faculties for those who have not specialized or have specialized late. Such opportunities already exist in the form of the Intermediate course, but Prof. Mott sees the possibility of an ambitious university, in co-operation with the Ministry of Education, founding a strong Intermediate course as the basis of a four-year course of study. He said he would like to see an increased emphasis on the 'General Paper' in scholarship examinations, and a renewed assurance given to the schools that this paper would be given a big role in awarding scholarships at Oxford and Cambridge. Another possibility is that a group of colleges would give an assurance that they would offer each year a certain number of mixed scholarships in which a candidate would take both arts and science subjects. Such scholarships do exist at Cambridge, but few candidates of high quality enter for them; nor, he thought, would the schools attempt this kind of education, unless they knew that scholarships would be reserved for candidates of this kind.

Another possibility might be that a group of colleges could set a qualifying examination, say one year before the entrance scholarship examination, in an arts subject. It would not be compulsory, but candidates who passed it would have a certain percentage of scholarships reserved for them. They would take the same papers in science as the specialists, but would not be in competition with them.

Prof. Mott felt that the right solution could best be obtained by a given university or college working in co-operation with a group of schools, rather than by experiments on a national scale.

Prof. F. A. Vick, head of the Department of Physics of the University College of North Staffordshire, agreed with Sir Philip Morris that courses in physics can be designed which contain everything that a complete education should have, and he went further than Sir Philip in believing that they should be so designed. He believes that they should teach a good fundamental knowledge of the subject and at the same time develop insight and imagination—as important in the physical sciences as in any other creative activity of the human mind—intellectual courage and honesty, understanding of scientific proof, ability to assess a situation, logical thought, clarity and precision of expression, experimental skill, ability to handle abstract ideas, judgment, recognition of the limitations of science, and humility in face of the wonders and mysteries of Nature.

An interesting suggestion brought out in Prof. Vick's paper was that he would advocate founding in some university a school which would stand alongside the Oxford 'Greats' and 'Modern Greats', and which would contain physics as a major component. Philosophy, physics and economics might be combined in such a course—P. P*. E. he called it. As a firm believer in the educational value of physics, he thinks that such a course would admirably equip the politicians, Civil servants and industrialists of the modern world. Prof. Vick's experience in teaching physics to arts students in courses lasting one or two sessions at the University College of North Staffordshire has convinced him that some of them become very interested in the subject, and are prepared to work hard in it, even if they would not wish to become professional physicists, and that they would be capable of doing well in a P. P*. E. combination. Even with the comparatively short courses at subsidiary level, the potential barrier which so often exists between an arts man and any science is penetrated or broken down. The whole outlook of the student is broadened.

Dr. A. W. Barton, headmaster of the City of London School, maintained in agreement with the other speakers that the school is just as important as the university; in particular, it has to choose the future scientists. He told how this is done at the City of London School. In the last resort, the choice is made by the boy and his parents; but Dr. Barton was emphatic that, in view of the needs of the community, the school would be right to lay strongly before a boy the advantages of a scientific career.

Dr. Barton does not think that the average physicist specializes too much at school. In the first four years he will spend two-thirds of his time on the humanities, and in the last three years one-third or one-quarter; and he does not think that Prof. Mott's "one period each of scripture, English, gym. and civics" is typical. Moreover, he believes that the sixth-form education is more liberal than it was forty years ago. Neither does he think that the competitive nature of the Oxford and Cambridge entrance scholarship leads to excessive specialization. The questions now set test no more ground than they did thirty-nine years ago. He thinks that the potential scholar is quite capable of answering these papers without being unduly pressed and without spending more than a reasonable time on science. It may well be that some pupils are over-specializing in the attempt to reach the standard of these papers; but that is not the fault of the papers, but of the schools in trying to prepare unsuitable pupils for them, and will soon disappear now as local authorities give reasonable assistance to potential physicists to go to the university even if they are well below the standard of an open scholarship.

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# BRITISH SEISMOLOGY DURING 1954–55

THE sixtieth annual report of the Committee for Seismological Investigations appointed by the British Association, covering the work done by British seismologists during the year 1954–55, was presented to Section A (Physics and Mathematics) of the Association at its recent Bristol meeting. As part of the work carried out in the Department of Geodesy and Geophysics at Cambridge, Dr. M. N. Hill has continued his seismic refraction-shooting experiments in the English Channel and the Western Approaches. From the results obtained at a line of stations extending down the middle of the English Channel from the Greenwich meridian to the longitude of Weymouth, it was found that the depth to the palæozoic floor varied between 2,400 and 3,500 ft. These figures are smaller than had been expected by Dr. Hill. Dr. R. Stoneley has investigated the problem of the propagation of surface waves in a medium with cubic symmetry, the free surface of which is a principal plane. The propagation of waves of Rayleigh type is not possible for all values of the density and the three elastic constants; but when it is possible, the wave velocity depends on the direction of propagation. For the symmetrical cases of transmission along a principal axis, or along a bisector of two perpendicular principal axes in the free surface, Rayleigh wave-motion can occur, in which the particles describe ellipses in a retrograde direction. In these cases only can transverse motion (as in Love waves) exist by itself. In the general case the plane of the particles is inclined to the plane of propagation; in fact, the separation in an isotropic solid into Rayleigh waves and transverse motion occurs as a mathematically degenerate case of this general type of motion.

At the University of Durham Observatory, the building of an underground chamber for the seismographs has begun, and it is estimated that, when completed, the diurnal temperature variation in it will not exceed 1 deg. F. The director, Mr. E. F. Baxter, hopes shortly to be in possession of a Wilson–Lamison vertical seismometer to complete a set of instruments, the Observatory being equipped at present with two horizontal Milne–Shaw seismographs. The two earth tremors felt at Hemsworth and South Elmsall in south Yorkshire on October 23, 1954 (see *Nature*, 175, 587; 1955), have also been investigated by Mr. Baxter. The first was recorded at Durham, at Kew and at Rathfarnham near Dublin, though not at Edinburgh. From an analysis of the seismograms, Mr. Baxter has determined the epicentre at lat. 53° 36′ N., long. 01° 19′ W., and time of origin 13h. 26m. 10s. G.M.T. The strength of the shock macroseismically was III on the Modified Mercalli scale.

At the National Institute of Oceanography, Mr. J. Darbyshire has calculated refraction diagrams for microseismic waves approaching Bermuda on the assumption that they are surface waves between the ocean and the sea-bed of the type described by Stoneley. The diagrams show that the refraction of energy away from the island is very marked for waves approaching from the north-east and south-west. This effect explains some of the anomalies observed at Bermuda, in one of which a storm slightly to the west of north gave large microseisms, whereas one slightly to the east of north had little effect. The work shows that the study of recordings at islands must take account of refraction.

International co-operation is most important in seismology as in other sciences and, apart from private research and personal contacts, British seismologists have been recently active with the loan of instruments (a new driving clock has been ordered for the instrument at Suva, Fiji, with money from the Gray–Milne Fund), through the International Seismological Summary, and through attendance at the tenth General Assembly of the International Union of Geodesy and Geophysics in Rome during September 14–25, 1954. The International Seismological Summary is under the direction of Sir Harold Jeffreys, the calculations being done at Kew by Mr. J. S. Hughes and his staff. The work for June 1947 is in hand, the first five months of the year being ready for printing. The third quarter for 1946 will be distributed shortly. Dr. Stoneley reports that the programme of the General Assembly of the International Union of Geodesy and Geophysics was a very full one and was notable for the number of interesting and successful symposia and joint meetings of associations. For the first time since the Second World War, Soviet geophysicists were present, attending by invitation; in particular, the names of Prof. Vladimir Beloussov, of the Moscow Academy of Sciences, and Prof. Georgy Gorshkov, of the Moscow State University, may be mentioned. The Assembly was preceded by a reunion of the European Seismological Commission, under the presidency of Prof. W. Hiller. The proceedings of the Association of Seismology and the Physics of the Earth's Interior opened with a presidential address by Prof. B. Gutenberg on "The Effects of Low-Velocity Layers", and some of the joint meetings held were as follows: constitution of the Earth and dissipation of energy (with vulcanology); isostasy (with geodesy), and gravimetric and seismic interpretation: variation of latitude (with geodesy and vulcanology). In addition to special sessions on apparatus, on microseisms and on seismography, the grouping of papers under headings gave the meetings more of the character of symposia. The considerable development of seismology during recent years was evident.

ERNEST TILLOTSON

# ADVANCES IN MOLECULAR SPECTROSCOPY

## MEETING IN OXFORD

THE European Molecular Spectroscopy Group, which was constituted informally after the Second World War and held meetings in Constance (1947), Basle (1951) and Paris (1953), met again this year, in Oxford, during July 7–11. This meeting was a great success, and thanks are due to the industrial firms whose financial help made it possible. Among two hundred and eighty participants were representatives from fourteen European countries, Brazil, the United States, Canada, South Africa and Japan. More than eighty papers were presented, covering many topics in ultra-violet, infra-red and Raman spectroscopy, with an emphasis on spectral theory and the correlation of spectra with molecular constitution and reactivity rather than on technique or analytical applications.

The ease with which spectra can now be photographed or recorded automatically has stimulated more attention to different conditions of excitation and to the physico-chemical factors which determine detailed spectral characteristics. For example, very interesting results are emerging from the study of infra-red absorption spectra of gaseous mixtures at high pressure, or of mixtures of liquids. B. Vodar (Bellevue, Paris) and his colleagues, using mixtures of hydrogen chloride and hydrogen at high pressure, have found an infra-red absorption band corresponding to $(\nu_{HCl} + \nu_{H_2})$, the combination of the active hydrogen chloride fundamental with the inactive vibration of hydrogen. Also, the absorption band due to $\nu_{H}$, which becomes active at high pressures, is affected by hydrogen chloride or other added gases. Similarly, J. Fahrenfort (University of Amsterdam) has found that using compressed mixtures of carbon dioxide with nitrogen, oxygen or hydrogen, absorption bands are observed due to simultaneous transitions in a collision pair, such as $(\nu_{CO_2} + \nu_{N_2})$ or $(\nu_{CO_2} + \nu_{H_2})$; he has examined this effect in terms of the mutual molecular polarization and has found satisfactory agreement between the predicted and observed band intensities. All these measurements bear on the question of the formation of transient molecular complexes or aggregates, quite apart from the general information they may provide about intermolecular forces.

Analogous effects have been found for liquid mixtures by J. Ketelaar (University of Amsterdam). In thick layers, a carbon disulphide–bromine mixture shows bands at 1,807 cm.$^{-1}$ and 1,204 cm.$^{-1}$, lying respectively 306 cm.$^{-1}$ on either side of the strong absorption band of carbon disulphide at 1,510 cm.$^{-1}$. This displacement interval corresponds to the vibration frequency of bromine. When polyatomic molecules are mixed with carbon disulphide, an array of displaced bands is found, analogous to a vibrational Raman spectrum spread around the main carbon disulphide band at 1,510 cm.$^{-1}$. Thus we may not only detect collision complexes but also determine the low frequencies of a heavy molecule in a more convenient spectral region. H. L. Welsh (University of Toronto) described further work on the 'forbidden' infra-red bands of carbon dioxide and hydrogen in the liquid and solid states. At low temperatures these bands assume a more complex pattern in consequence of intermolecular interactions and specific properties of the crystalline solids, and combination transitions of hydrogen–deuterium molecular complexes have also been observed.

The interpretation of vibrational band intensities, which are as significant as the frequencies, has progressed rapidly. These intensities are controlled by the polar characteristics of the vibrations concerned, and therefore lead to deductions about bond polar properties and the electronic structure of the whole molecule. Since, moreover, the creation during molecular vibration of centres of residual electrical charge may be a prelude to reactivity, the absorption band intensities may be correlated with the latter. True integrated absorption band intensities, as opposed to their 'apparent' values or the 'apparent' extinction coefficients, can now be determined with fair accuracy. Use of these data is limited, however, by uncertainties in the molecular force fields and by ambiguities which arise in part since the square root of the intensity has an indeterminate sign. One possible way out is to study a set of isotopic molecules where for a given vibration-type the derivative o electric moment with respect to a symmetry coordinate should be constant. B. L. Crawford (University of Minnesota) described such work on ethylene and the deutero-ethylenes, and on the methyl halides, D. F. Hornig (Brown University) on methyl cyanide and the cyanogen halides, and D. H. Whiffen (University of Birmingham) on benzene. It is noteworthy that in some of these structures, carbon–carbon bonds are found to have fairly large dipole moments.

S. Silverman (Johns Hopkins University) has determined the integrated band intensities of hydrogen halides and carbon monoxide from measurements on individual rotation lines, and has analysed the results in terms of a new more detailed theory which assumes a more general expression for the variation of dipole moment with bond-length and which also considers vibration–rotation interaction. Theoretical work on the band intensities of hydrogen halides was also discussed by S. Penner (California Institute of Technology, Pasadena).

The function expressing variation of a bond dipole with change in length, $M = M_0 + M_1\xi + M_2\xi^2 + \ldots$, has assumed greater interest since it is now realized that most vibrations involve considerable electrical anharmonicity, expressed by the quadratic and higher terms in $\xi$, and this determines the overtone intensities more than mechanical anharmonicity. H. W. Thompson and D. W. Russell (Physical Chemistry Laboratory, Oxford) described work on the bands $\nu_{NH}$ and $2\nu_{NH}$ of a selected series of complex organic molecules including aliphatic and aromatic secondary amines, amides and heterocyclic bases, from which the coefficients $M_1$, $M_2$ can be derived and correlated with variations of ionic character in the different kinds of NH bond.

Attempts have been made to correlate the variation of vibration frequency of a key group in a related series of molecules with changes in reactivity. L. J. Bellamy (Waltham Abbey) discussed further examples of substituted benzenes in which a relation exists between a particular vibration frequency and the Hammett σ-factor for the particular substituent. Such relations might be applied to estimate dissociation constants of acids and bases, redox potentials, etc., although there are some anomalies and the frequency variations are often small. Any inductive or mesomeric effects will be similarly reflected in the bond polar properties, and the consequential variation of band intensities may be more pronounced than the frequency shifts. Thus, H. W. Thompson showed that for the C≡N bond vibration in substituted benzonitriles there is a proportionality between log (intensity) and σ over a wide range, and similar correlations between the intensity and several reaction constants. A striking difference of intensity of $\nu_{OH}$ in the solvent carbon tetrachloride or chloroform was noticed in cases where hydrogen bonding of chloroform to the solute could occur favourably, which emphasizes the need for care where quantitative analysis is being carried out in apparently innocuous solvents. The intensities of NH-group vibration bands in platinum-amine complexes have also been correlated with electronic structure by L. A. Duncanson (Imperial Chemical Industries, Ltd., Welwyn); and G. Higgins (British Rubber Producers' Research Association, Welwyn) described how infra-red studies of the association equilibria between organic hydroperoxides, phenols or alcohols with dialkyl sulphoxides may be used to estimate the dissociation constants of weak acids.

Higher resolving-power in the infra-red, obtained with better detectors and gratings, is being used to obtain further details of molecular dynamics. Fermi resonance between vibrational levels often leads to anomalous values in the coefficients $\alpha_i$ relating the rotational constants in different vibrational states, and also in the centrifugal stretching-constants $D_i$. More accurate values can also be obtained for the Coriolis coupling factors $\zeta_i$ and $l$-doubling coefficients in degenerate vibrational levels. Such work on carbon dioxide, nitrous oxide and allene was described by H. H. Nielsen (Ohio State University), on some hydrides of the fourth-group elements by M. Kent Wilson (King's College, London), and on acetylene, methyl acetylene, hydrogen cyanide and their deuterium analogues by H. W. Thompson. A further revision of the bond-lengths in acetylene seems necessary. W. F. Edgell (Purdue University) explained a new method whereby the measurement of vibrational band contours promises to yield values for the molecular rotational constants.

Many papers were concerned with general infra-red developments and vibrational analysis. L. Genzel (University of Frankfurt) described a new grating spectrometer for use to 1,000μ, using a high-pressure mercury arc as source with suitable filters. R. C. Lord (Massachusetts Institute of Technology) and his colleagues have found from the spectra of *cyclo*butane and *cyclo*propane and of their deutero analogues that the former appears to contain a puckered ring, and in the latter $r_{cc} = 1524$ A. R. Mecke (University of Freiburg) has measured the spectra of homologous series of αω-dibromoparaffins and alkyl bromides in the liquid and solid phases. In the solids, rotational isomerism is excluded, and by considering the whole series a reasonable assignment of the carbon-chain vibrations can be made. S. F. D. Orr (Chester Beatty Research Institute, London) has found that in *trans* stilbenes, although the integrated intensity of the nonplanar =C—H deformation is unaffected by *ortho* substituents, the band-width and peak extinction coefficients are much affected, and an explanation in terms of vibrational damping is suggested. N. Sheppard (Laboratory of Colloid Science, Cambridge) has assigned the vibration frequencies of the guanidinium ion, $C(NH_2)^+_3$, in crystals and solid films, and data relevant to the study of ureas and amides. Mlle. M. L. Josien

(University of Bordeaux) and colleagues have measured $\nu_{CO}$ in ketones and in quinones of mono- and poly-nuclear aromatics, while N. Fuson (Fisk University) has studied substituted benzanthracenes of carcinogenic interest. The assignment of OH-group vibrations in enolized diketones and ketonic alcohols has been explored by D. Hadzi (University of Ljubljana) and by C. Duculot (University of Paris), and W. Lüttke (University of Freiburg) has studied the dimerization of nitroso compounds.

A packed session of the meeting, on the infra-red spectra of amides, peptides and polymers, served to emphasize the difficult stage which this work has reached, and the hazards of interpreting spectra with polarized radiation. G. B. B. M. Sutherland (University of Michigan) suggested that analysis in terms of group frequencies can only provide a partial interpretation. With crystalline polymers, in which a structural unit is visualized in the unit cell, appropriately influenced by its environment, more exact selection rules will apply than with liquid or amorphous polymers. He illustrated this argument by reference to polyethylene, ice and other substances. From results with crystals of naphthalene, iodoform and thiourea, R. M. Hexter (Cornell University) claimed to verify a point made several years ago, but not sufficiently appreciated, that transition moments of vibrations are often not parallel or perpendicular to bond directions; and he suggested that if dichroic ratios are to be correctly determined the complete anisotropy must be measured. A. Elliott (Courtaulds, Ltd.) has found that with crystals of acetanilide the transition moment of the carbonyl group is inclined to the bond direction.

E. K. Blout (Polaroid Corporation) observed that, whereas lower members of a series of polybenzyl glutamates have $\nu_{CO} = 1,628$ cm.$^{-1}$, the higher members have $\nu_{CO} = 1,655$ cm.$^{-1}$, in line with β- and α-configurations of polypeptides; and he suggested that some previous discrepancies between different laboratories might arise from degradation of polymers during the casting of films from solvents. H. A. Willis and R. G. J. Miller (Plastics Division, Imperial Chemical Industries, Ltd.) proposed a method for determining the crystalline–amorphous content of polymers such as polyethylene or polyethylene terephthalate, based only upon the broad bands of the amorphous form which are associated with the multiplicity of rotational isomers; J. Mann and J. Marrinan (British Rayon Research Association) showed how the hydroxyl group bands in different crystalline forms of cellulose can be used to characterize the latter; the old problem of the 'amide group' bands in the gaseous, liquid and crystalline state was reconsidered by S. Mizushima (University of Tokyo) and by M. Davies (Aberystwyth); and D. S. Barmby (Wool Industries Research Association, Leeds) outlined the effect on key bands of nylon when it is dissolved in antimony trichloride—a possible start to the study of the swelling of polymers.

As regards theoretical aspects, C. A. Coulson (Mathematical Institute, Oxford) showed how data on the lengths of carbon–carbon bonds can now be systematized in terms of specific types of hybridization and hyperconjugation. J. W. Linnett (Inorganic Chemistry Laboratory, Oxford), in reviewing possible ways of assessing molecular force fields, suggested that more use might be made of isotopic effects other than with hydrogen–deuterium, and that the Coriolis factors $\zeta_i$ and centrifugal stretching constants $D^i$ mentioned previously may also be useful. New methods were outlined by P. W. Higgs (Mathematical Physics Department, Edinburgh) for calculating the vibration frequencies of complex molecules, and by H. Günthard (Federal Technical Institute, Zurich) for obtaining relations between the intensities of bands of isotopic molecules, while G. Amat (P.C.B., Paris) considered the effects of Fermi resonance upon molecular rotational and vibrational energy-levels in detail. P. Tuomikowski (University of Helsinki) described comparative studies of Fermi resonance for a given molecule in different states of aggregation.

Raman spectra of coloured substances, using red or near infra-red radiation as the exciting source, were described by H. Stammreich (University of São Paulo); discharge lamps of helium, rubidium or cæsium were used, and the substances studied included bromine, iodine chloride, iodoform and polyhalide ions. Raman spectroscopy of gases with high resolution, using multi-reflexion cells and high-current water-cooled mercury arcs, is advancing rapidly, and H. L. Welsh (University of Toronto) gave new data on vibration-rotation bands of a number of simple hydrocarbons. This method not only provides information about certain bands not obtainable in the infra-red, but also the confusing influence of 'hot' bands is sometimes minimized. Several speakers discussed Raman spectra of crystals and complex ions, and on the basis of intensities of Raman bands in homologous series of ketones, esters and nitro compounds G. Michel (University of Liège) suggested that rules can be set up for analysis and structural diagnosis. D. A. Long (Physical Chemistry Laboratory, Oxford) discussed the more fundamental relationships between Raman band intensities and bond polarizabilities, with special reference to tetrahalides and related structures. Progress here runs parallel to that already mentioned in which infra-red band intensities are being correlated with bond polar properties.

W. C. Price (King's College, London), B. Vodar (Bellevue, Paris) and A. D. Walsh (University of Leeds) discussed technical advances in the vacuum ultra-violet and the correlation of absorption spectra with molecular ionization potentials. Improved emission sources and continuous photoelectric recording should lead to further progress in this field. H. Schüler (Hechingen) has obtained evidence for the ultra-violet emission spectra of benzyl and benzal radicals produced in the positive column of a glow discharge in vapours of certain benzene derivatives—an experimental method which may provide many data on the emission spectra of polyatomic molecules. The absorption spectra of such radicals have also been measured by G. Porter (British Rayon Research Association) after 'trapping' radicals formed by flash photolysis in a rigid medium where they persist for long periods in metastable equilibrium. This trick of retaining simple polyatomic radicals in solid matrices was also described by G. Pimentel (University of California). The use of crystals of aromatic compounds at very low temperatures has also enabled P. Pesteil (Sorbonne, Paris) to obtain sharper fluorescence spectra ($T \rightarrow S$) and to determine many molecular vibrational levels. Other ultra-violet studies included the exciton spectra in inorganic crystals at low temperature (S. Nikitine, University of Strasbourg); the effect of substituents on the spectra of diphenyls and benzophenones (G. H. Beaven, National Institute for Medical Research, Mill Hill, and R. F. Rekker, Free University of Amsterdam); the spectra of benziminazoles and thiophenes; and many new spectra of diatomic oxides, halides and diatomic ions which extend general theories of molecular structures further. H. C. Longuet-Higgins (Chemistry Laboratory, Cambridge) analysed theoretically the electron states of a composite system in relation to those of its constituent parts and showed how some general ideas about electron transfer configurations can be used in this connexion. R. S. Mulliken (University of Chicago) and C. J. Timmons (University of Nottingham) discussed charge transfer and charge resonance spectra and the correlation of spectra with intermolecular complex formation.

H. W. THOMPSON

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# PROGRESS IN RADIOBIOLOGY

## CONFERENCE AT CAMBRIDGE

ON August 15, radiobiologists met in Cambridge for the third annual conference to discuss progress in their field. The three-day meeting, under the chairmanship of Sir Ernest Rock-Carling, was organized by Prof. J. S. Mitchell and his staff. Some 250 scientists, from sixteen countries including the U.S.S.R., enjoyed the hospitality of our Cambridge hosts. Eighty papers were discussed, the variety of the contributions reflecting the large number of disciplines on which an understanding of the biological effects of radiation must rest.

Biological lesions due to ionizing radiations must originate in the process of absorption of primary energy. Our current picture of the particle track, and relevant knowledge of the nature of the chemical intermediates, were presented by Prof. F. S. Dainton in an introductory lecture. A number of metabolic steps occur between the initial chemical disturbance and the appearance of damage in the organism, and some papers dealt with such effects. In the bacterium *Achromobacter fischeri*, the enzymatically controlled luminescence decreases during exposure to X-rays and recovers rapidly afterwards. Both decrease and increase follow an exponential time relationship (O. Hug and I. Wolf). Bacterial enzymes show a lower sensitivity to X-rays at low temperatures when exposed in the dry state or in solution, or when in the intact cell, suggesting some common physicochemical mechanism of inactivation (H. Pauly and B. Rajewsky). It appears, however, that in the etiology of the opacity of rabbit lens caused by X-rays, biochemical changes in the lens are secondary to cellular damage in the dividing cells of the lens epithelium (A. Pirie).

The genetic effects of radiation took a prominent place in the discussions. Nucleic acids appear to be the main carriers of hereditary factors, and some insight into the action of radiations on genetic material may be expected from the study of radiation effects on them and their metabolism. Some questions discussed were the effect of ultra-violet light on ribonucleic acid metabolism in starfish oocytes (M. Errera and A. Ficq), the inhibition of deoxyribonucleic acid (DNA) synthesis by X-rays in the early stages of regeneration of rat liver (L. K. Mee), and the interesting results obtained in the irradiation of dry preparations of herring sperm deoxyribonucleic acid (P. A. Alexander and K. A. Stacey). The sensitivity of female germ cells of mice to the induction by X-rays of dominant lethal mutations is some seventy times greater at first meiotic metaphase than at a stage seven hours earlier (L. B. Russell and W. L. Russell). In *Habrobracon* eggs irradiated with ultra-violet light, damage to the nucleus is qualitatively and quantitatively different from cytoplasmic damage (R. C. von Borstel and H. Moser). A surprising result was obtained when a breeding population of *Drosophila* was exposed to 5·1 r. per hr. for about five years. Its genetic fitness was only 1–5 per cent lower than that of an unirradiated population, despite an accumulated dose of 250,000 r. (B. Wallace). We are not justified, however, in extrapolating from insects to mammals on the basis of these data (W. L. Russell). Bacteria and bacteriophage have been used as a simplified model for the study of genetic changes in populations (H. Marcovitch).

Since certain chemicals and X-rays cause similar biological damage, it is of interest to study the mechanisms by which these lesions arise. A whole-body dose of 100 r. of X-rays, or 1 mgm. per kgm. of nitrogen mustard, produce the same damage in rat lymph nodes; but the treatments have dissimilar actions since they are not interchangeable (C. Biagini). N,N-dichlorethyl-*p*-amino-phenyl-butyric acid causes mainly lymphoid, whereas 'Myleran' causes mainly myeloid effects in rat bone marrow. The effect of X-rays can be reproduced almost exactly by applying both chemicals at once, suggesting two separate physiological pathways for the developing X-ray damage (L. A. Elson, D. A. G. Galton, L. F. Lamerton and M. Till).

Factors influencing the radiosensitivity of biological systems were discussed in almost every session. It has been known for some time that radiation effects are usually greater in the presence than in the absence of free oxygen. Tails of young mice were used to demonstrate this with X- and neutron-irradiation (P. Howard-Flanders; E. A. Wright). The rapid autoxidation of cysteine in aqueous solutions suggests that a number of protective effects ascribed to this compound could be accounted for by anoxia (L. H. Gray). Cysteine and cysteamine have a stimulating effect on the oxygen consumption of liver slices. Their protective effect may therefore be due to a reduction in the amount of free oxygen in some organs (D. W. van Bekkum). Chemical protection and anoxia do not, however, always seem to act along identical pathways (R. W. Brauer, J. S. Krebs and R. Pessotti; J. Maisin, P. Maldagne, A. Dunjic and H. Maisin). Further, cysteine and cysteamine react with the sulphhydryl group of proteins and might thus protect the protein (L. Eldjarn and A. Pihl; R. Koch).

The effects of oxygen on radiosensitivity may be explained in terms of the relative efficiencies of oxidizing and reducing radicals in reacting with organic molecules, although the state of oxidation of the acceptor substances is of importance (A. J. Swallow; M. Ebert and A. Howard; H. Laser).

The radiosensitivity of barley seeds and of starch depends on humidity, and is at a minimum at 20 per cent. It was suggested that the cause is physicochemical rather than physiological (L. Ehrenberg). The production of chromosome aberrations in *Vicia faba* roots by 8-ethoxycaffeine or X-rays is sensitive to oxygen, but adenosine triphosphate appears to be involved only in the case of the caffeine (B. A. Kihlman). Other work on *Vicia* indicates that inhibition of oxidative phosphorylation interferes with the rejoining of broken chromosomes (S. Wolff).

It is well established that shielding of hæmopoietic tissue, or implantation of such tissue after irradiation, greatly improves the recovery of animals from acute radiation injury. It seems likely that the implanted cells are fully effective only if not destroyed by tissue antibodies (D. M. H. Barnes and J. F. Loutit). Spleen irradiated *in vitro* or taken from an irradiated donor can resume hæmopoiesis in the host even after a dose of 10,000 r. (E. H. Betz, G. Booz and J. Firket), and the spleen of an irradiated animal recovers more quickly if part of its bone marrow is shielded (E. H. Belcher, E. B. Harris and L. F. Lamerton).

The carcinogenic effect of a given dose of whole-body X-irradiation is approximately the same whether given in daily, weekly or fortnightly fractions, but is less effective when delivered in one exposure, as judged by the appearance of leukæmia in mice (R. H. Mole). Beta-radiation applied to the skin of rats produces more tumours when given in two exposures than in one (J. W. Boag and A. Glücksmann). Glass beads containing strontium-90 produce tumours at the site of implantation under the skin of rats, and the incidence of tumours is proportional to the logarithm of the radioactivity (G. Schubert, H. A. Künkel and G. Uhlmann). Rats of a tumour-free strain, protected by cysteamine or part-shielding against the acute effects of X-irradiation, develop a variety of tumours if they survive more than six months (Maisin *et al.*). Therapeutic irradiation for ankylosing spondylitis appears to be followed by a five- to ten-fold increase in the rate of deaths from leukæmia (W. M. Court-Brown).

For those who attended the previous conferences (Aarhus, 1953, Liège, 1954), several points of increased emphasis became apparent at this meeting. They included more widely based inquiries into the mechanism of action of protective agents, the long-term carcinogenic effects of radiation, and the search for biochemical links in the developing radiation-induced lesion.

M. Ebert
A. Howard

# NEW NATURE RESERVES IN GREAT BRITAIN

The Nature Conservancy has announced the establishment of five new nature reserves, three in England and two in Scotland, as follows: Roudsea Wood, Lancashire (ten miles west of Grange-over-Sands); Wybunbury Moss, Cheshire (three and a half miles south of Crewe); North Fen, Lancashire (two miles west of Windermere); Hermaness, Unst, Shetland; and Noss, Shetland. The Conservancy has also announced the addition of areas to the following two existing reserves: Castor Hanglands, Northants (four and a half miles north-west of Peterborough); and Kingley Vale, Sussex (four miles north-west of Chichester).

Roudsea Wood is one of the most varied woodlands in the British Isles, with a rich flora and fauna and many different types of vegetation. It lies in the south of the Lake District and is the first nature reserve to be declared within an English national park. The reserve, which has been formed by agreement with the owner, Mr. R. E. O. Cavendish, covers an area of 287 acres and is about ten miles west of the Conservancy's Research Station at Merlewood, Grange-over-Sands, Lancashire. The main part of the wood consists of two parallel ridges, one of limestone and one of slate. The limestone ridge is crowned by a yew wood and has interesting mixtures of oak and ash on its flanks with a luxuriant ground flora, including lilies-of-the-valley. The slate ridge, on the other hand, is a typical Lake District slate oak-wood which has, in part, been coppiced for charcoal production. Between ridges there is a small tarn, now nearly filled, and around it an abundance of fen plants and fen insects. Among these is a sedge (*Carex flava*) for which this is the only British locality. There are a wealth of sloe, alder, birch and other shrubs, and a correspondingly great variety of insect and bird life.

On its seaward side, Roudsea Wood slopes down into the Morecambe Bay salt-marshes, this being one of the few places where the transition from salt-marsh to woodland can be studied. On the landward side lie the Holker mosses, and the transition from the vegetation of peat to that of limestone and slate is also of very great biological interest. In addition to the usual plants and insects, there are roe-deer, occasional fallow and red deer, and a great variety of wild-life of every kind. One of the main objects of this reserve is to serve as an undisturbed outdoor laboratory for the scientific workers at Merlewood, who have already begun their investigations, and applications for permits to visit the reserve for research or collecting purposes should be made to the Conservancy's regional officer at Merlewood.

Wybunbury Moss in South Cheshire is an unusually large example of a 'Schwingmoor', a type of bog not before described in Britain. It has been formed in a steep-sided kettle-hole in sandy, glacial material, the sides of which are cultivated and used for grazing. Only part of the land has been declared a reserve, and it is hoped to extend the area in the future. At the centre of the bog there is only a thin crust of sphagnum peat 6–10 ft. deep floating on water, but at the margin deposits of both sphagnum and fen peat have accumulated to form a solid organic layer over the glacial sand. The surface vegetation shows a surprising variety for such a small area. The margins, which must receive a mineral supply from the cultivated sides of the kettle-hole, carry a fen community with sedges such as *Carex paniculata*, but this fen is a secondary development because it is underlain everywhere by sphagnum peat. As a marked contrast, the central area shows a typical bog flora carpeted with sphagnum species in which cross-leaved heath (*Erica tetralix*), cranberry (*Oxycoccus palustris*) and marsh andromeda (*Andromeda polifolia*) are common. The ground is gradually becoming drier as part of the natural development, and, as this occurs, trees, mainly birch and scots pine, are spreading. The reserve will be used solely for scientific research, and permission to visit it can only be obtained through the Conservancy's officer at Merlewood.

The main interest of North Fen is that it shows the vegetational succession characteristic of the climatic conditions found in north-western England—open water, rich in mineral salts, to fen-carr and bog. It is mainly woodland and is only just beginning to show signs of sphagnum bog development, in contrast to the nearby Blelham Bog reserve, where there is very little left of the original woodland. The reserve lies on the north side of Esthwaite Water in the Lake District National Park and is being established under a lease from the National Trust. The vegetational succession in North Fen is reedswamp (*Phragmites communis* dominant, with *Scirpus lacustris* on the offshore margin), mixed fen (predominantly a sedge association with *Carex elata* and *Carex rostrata* conspicuous), open carr followed by closed carr (dominated by *Salix atrocinerea*). Some modification of this succession occurs, particularly on the western and eastern flanks of the fen as the result of a difference in the rate of inorganic silting. It appears that, in north-west England, fen communities are only developed where substantial inorganic sedimentation occurs. Such communities are of a purely transitional nature, eventually giving way to bog as the organic/inorganic ratio of the substrate increases. Access to the reserve will not be restricted, but to collect specimens permission is needed from the Conservancy's officer at Merlewood.

Muckle Flugga and the Outstack, the northernmost of all the British Isles, are included in the new nature reserve of Hermaness, which is closer to the north pole than the southern tip of Greenland. Hermaness itself is a peninsula on the north-west of the Island of Unst, Shetland, and carries rough moorland with blanket bog on gneiss; there are many lochans and several miles of high sea-cliffs. The size of the reserve is 1,071 acres, all but 31 being on the mainland. The scientific interest of the reserve is mainly ornithological, in particular as an important breeding-station of the great skua, a bird with a very restricted distribution in the northern hemisphere but also breeding in the Antarctic. An ancestor of the present proprietor, Lieut.-Colonel Laurence Edmonston, was responsible for protecting the great skuas on Hermaness: in 1850 there were only two pairs; by 1890 there were not more than nine pairs; later the increase there and elsewhere was rapid; and to-day there are about five hundred pairs nesting on the reserve. In addition, the species has spread to other parts of Shetland and to the Orkney Isles. Besides great skuas, numbers of arctic skuas, red-throated divers, eider duck and arctic terns breed on the peninsula. The sea-cliffs contain an expanding gannetry and also colonies of guillemots, razorbills, kittiwakes, puffins, storm petrels and other birds. There is a watcher's hut on the slopes of Hermaness Hill. The Royal Society for the Protection of Birds will continue to provide a warden, as before.

With its great cliffs, Noss is one of the most spectacular islands in Europe. Divided from the mainland of Shetland by the larger island of Bressay, Noss Head rises to 592 ft., and the uninhabited island extends to 774 acres, mainly of rough moorland. On the cliffs there are many nesting gannets, guillemots, shags, kittiwakes, puffins, greater black-headed gulls and herring gulls. On the moorland there are colonies of great and arctic skuas, and the eider duck also breeds there. Geologically, Noss exhibits striking erosion in sandstone and phyllites of the Old Red Sandstone age. The Royal Society for the Protection of Birds will continue to provide a warden, as before.

The Castor Hanglands nature reserve was declared by the Nature Conservancy in June last year, and the present declaration completes the reserve by bringing in an area of 113 acres, under a lease from the Forestry Commission—the western portion of Castor Hanglands Wood which adjoins Ailsworth Heath. The woodland fringe now added completes a series of habitat types characteristic of this part of the Midlands, few examples of which still remain. The grass heath, which is not represented on the other Nene reserves, merges into the fringing shrub margin of the oak–ash woodland. The whole area has long been known for its rich insect life and particularly for butterflies, such as the black hairstreak and the chequered skipper. There are two small pools which support a variety of aquatic vegetation. Access to this area and the Blacklands part of the reserve is by permit only, obtainable from the Conservancy's regional officer for East Anglia at 6 Upper King Street, Norwich.

The latest addition of a further 17½ acres to Kingley Vale completes this reserve of approximately two hundred acres which was first declared in 1952. The reserve includes a famous natural yew wood, chalk grassland on the downland slopes, and an area of heath overgrown by scrub on the plateau of Bow Hill. The additional area is a well-developed heath on the clay soil of the plateau and provides a marked contrast to the grassland of the chalk slopes. The predominant plants are heather and other species typical of acid soils, but there are also some chalk grassland species which have deep roots penetrating to the underlying chalky soil. Thus the area is of particular value for studying the distribution of species which are restricted to either calcareous or to acid soils. As with the rest of the reserve, there are no restrictions of access, but permission is required to collect specimens, application for which should be made to the Conservancy's regional officer for the south at Furzebrook Research Station, Wareham, Dorset.

# THE MEDICAL RESEARCH COUNCIL

## REPORT FOR 1953–54

THE report for 1953–54 of the Medical Research Council (pp. v+274. Cmd. 9506. H.M.S.O. 7*s.* 6*d.* net) follows the plan used during recent years. The work of the Council's many establishments is given only in summary, together with a list of the scientific papers published by the Council's many workers, from which the reader may learn the extraordinarily wide range of the Council's activities; but the main part of the report discusses each year, from a broader point of view, some aspect of the general trends of medical research.

This year the report considers, in a fascinating article entitled "Modern Trends in Chemotherapy", the remarkable researches which are gradually transforming our methods of treatment of many serious diseases. Not the least interesting part of this article is its introductory account of the evolution of modern methods of research in this field and the development of the co-operation between biologists and biochemists which has enabled us either to attack directly biochemical processes upon which the lives and activities of pathogenic organisms depend or, in some instances, to reinforce the defensive mechanisms of the host, so that the host is enabled to deal more effectively with the pathogenic organism that invades its body. This phase of chemotherapeutic research began with the discovery by Dr. D. D. Woods that sulphanilamide derivatives exercise their antibacterial effects by interfering with a metabolite essential to the pathogenic organisms concerned, namely, *p*-aminobenzoic acid, the chemical constitution of which closely resembles that of sulphanilamide. Sir Paul Fildes then supplied the hypothesis that an effective chemotherapeutic agent will be a substance that interferes with some essential metabolic reaction of the pathogenic organism, and that such a substance should be sought among compounds biochemically similar to those normally utilized by the pathogen. This Woods–Fildes theory is a special application of the results of earlier work by Prof. J. H. Quastel and

Dr. Marjorie Stephenson, which showed that enzymic reactions are inhibited by compounds chemically similar to those in which the enzymes normally produce a change. This is a good example of the way in which academic research may lead to ideas of practical importance and of the valuable results that may result from the policy consistently followed by the Medical Research Council of fostering fundamental researches of a kind that may form the bases of advances in practical methods of actually treating disease.

For details of the remarkable biochemical work now being done by the Council's workers, the article just mentioned must be consulted. It deals with work on factors which influence radiosensitivity, the action of biologically active substances on tissue cultures, blindness in premature infants, pernicious anæmia, cortisone in the treatment of ulcerative colitis, trends in research in human malnutrition, the neurotic in industry, pneumoconiosis, analgesia in midwifery and research on the mechanism of virus infection. The reader in search of dramatic developments will certainly find them here. Dramatic undoubtedly are the results achieved by the staff of the Strangeways Laboratory at Cambridge. Directed by Dr. Honor B. Fell, this Laboratory has been quietly developing for many years the tissue-culture technique as a tool which has widespread applications. The brief account given in this report of some of the results achieved shows what can be accomplished by this technique. Work on the effects of vitamin A on chick ectoderm growing in tissue cultures has, for example, not only confirmed that absence or deficiency of vitamin A results in keratinization, but also it has produced the remarkable result that high concentrations of vitamin A can convert growing ectoderm into ciliated epithelium secreting mucus that is indistinguishable from the normal epithelium of the respiratory tract of the chick. It seems, therefore, that one of the functions of vitamin A is to control the structure and function of certain epithelial cells, and the intact animal seems able to pick out of the circulating fluids the level of vitamin A needed for its normal development. Not less interesting is the tissue-culture work done on the effects of substances produced by the thyroid gland and by insulin.

Dramatic also is the work outlined in this report on the cause of blindness that developed in the United States and in Britain in premature infants. This proved to be a result of the action of oxygen treatment normally given to these infants. A result of this treatment apparently may be that, when a premature infant is exposed to high concentrations of oxygen for the periods of time formerly considered to be necessary, the blood vessels supplying the retina of the eye become constricted and eventually the blood supply to the retina becomes obliterated. When the infant is afterwards returned to normal air with less oxygen in it, the retina demands, so to speak, more oxygen, and an overgrowth of blood vessels occurs which is so exuberant that it results in filling the back of the eye with fibrous tissue in which the retina is involved, so that all power of sight is irretrievably lost. The remedy that has now been successfully applied is a drastic reduction of the oxygen treatment.

These two examples of the work recorded in this report will suffice to indicate the quality of the beneficent work that is being done by the Council. As the report itself implies, the discoveries which attract public attention and bring great relief of suffering to mankind are inevitably based on long months of patient and unspectacular labour performed by many workers who each contribute something essential to the final triumphs. All these workers, whatever their status, deserve our gratitude, as do, indeed, all those others who work outside the Council's authority but contribute no less in their several ways to the general and continuous progress of medical research.

G. LAPAGE

# UNIVERSITIES COUNCIL FOR ADULT EDUCATION

"ACHIEVEMENT under difficulty" is the dominant note in the report of the Universities Council for Adult Education for the year 1953–54 (Universities Council for Adult Education. Report on the year 1953–1954. Pp. 28. (Bristol: W. E. Salt, Hon. Secretary and Treasurer, 1955)). The timely financial assistance given by the Ministry of Education enabled extra-mural departments to carry on with their existing work and even to venture on a certain amount of exploratory work. While the total number of three-year tutorial classes fell, for the first time since the War, from the previous session's total of 1,001 to 974, the number of one-year sessional classes, which had fallen slightly in the previous session, rose by twenty-three to the record figure of 1,283. Six universities report increases in the number of three-year classes and no fewer than ten an increase in two types of longer courses. Moreover, London and Manchester achieved record numbers of three-year classes: the London total has been climbing steadily for some years and is now more than twice as large as before the War. The total number of students has increased with the number of classes.

A remarkable feature about the subjects of study is the rise of history to the leading place, with 684 classes out of the total of 3,994 as against 597 in the previous session and 584 in 1951–52. Most subjects show a substantial increase over the figures for the previous session, but only history, the sciences and the arts have yet recovered the ground lost since 1951–52. In the case of psychology, there has been a continued decline from 294 classes in 1950–51 to 184 in the present session. The number of courses in the physical and biological sciences increased by 56 during the year to a total of 434. Taken together, they stand fifth in the order of subjects, while the physical sciences alone stand higher than psychology, religion and government, and very little below philosophy.

A number of interesting courses and experiments was undertaken. Sheffield had large audiences for courses in "Twentieth Century Physics", "Electrons in Action", and various aspects of engineering; Bristol even larger audiences for "Seeing Atoms" and "The Living Brain"; while London was highest with the thousand who attended a course on "Atomic Energy". London held a rewarding residential course on "Embryology" for graduates in biology, and a similar 'refresher' course conducted by Birmingham, as one of an established series, had far-reaching results. The main problem in science was the provision of courses for non-scientists.

Interesting experiments have also been carried out in the supply of special courses for trade unionists.

# AMINO-ACID SEQUENCE OF ALPHA-CORTICOTROPIN

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THE isolation and partial structure of α-corticotropin, a polypeptide from sheep pituitary glands possessing adrenocorticotropic (ACTH) activity, have been reported from this laboratory[1-3]. In this preliminary communication, we wish to propose a complete amino-acid sequence, deduced from the structure of peptide fragments isolated from enzymatic and partial acid hydrolysates of the hormone.

## Action of Pepsin

Earlier investigations demonstrated that limited digestion with crystalline pepsin effects the cleavage of peptides and amino-acids chiefly from the C-terminal portion of the molecule. The core material remaining after peptic digestion, which may be separated from smaller peptide fragments by precipitation in 25 per cent trichloroacetic acid solution, was shown to possess ACTH activity.

150 mgm. of α-corticotropin trichloroacetate[1,2] and 2·4 mgm. of crystalline pepsin were dissolved in 45 ml. of 0·01 *M* hydrochloric acid and kept at 37° C. for four hours. After the whole digest had been heated to 100° C. for two minutes, it was mixed with an equal volume of 50 per cent aqueous trichloroacetic acid. After the solution had stood for one hour at 0° C., the precipitate was removed by centrifugation. The supernatant fluid was freed of excess trichloroacetic acid by repeated extractions with peroxide-free ether, and was then taken to dryness by lyophilization. The dried residue, weighing 22·5 mgm., was dissolved in 0·1 ml. of water. A small aliquot containing about 0·2 mgm. of the residue was applied to paper as a spot, and the remaining solution was applied as a band (0·5 × 5 cm.) close to the spot. The chromatogram was developed by the descending procedure in the *n*-BuOH/HOAc/$H_2O$ (4 : 1 : 5) system of Partridge[4]. After being dried, the 'spot' chromatogram, which was to serve as the guide strip, was cut out and sprayed with ninhydrin solution. The zones in the 'band' chromatogram corresponding to the spots on the guide strip (Fig. 1) were cut out and the material was eluted with 0·3 ml. of 5 per cent sodium bicarbonate. Each eluate was allowed to react with Sanger's reagent, fluorodinitrobenzene, in the manner described by Porter[5]; the reaction mixtures were acidified and fractionated by extraction first with ether and then with ethyl acetate. Both fractions were submitted to chromatography on paper with *tert*-AmOH/*iso*-AmOH/3 per cent $NH_3$ (2 : 1 : 3) as the developing solvent; each of the spots in these chromatograms was cut out and the material was eluted with 2 per cent ammonia. The hydrolysate of each eluate was analysed for N-terminal amino-acids by the chromatographic procedure of Levy[6], and for the remaining amino-acids by one-dimensional chromatography on paper in the solvent system *n*-BuOH/HOAc/$H_2O$ (4 : 1 : 5). The C-terminal amino-acids in some of these peptide fractions were investigated by the carboxypeptidase procedure[1]. The following peptides[7] were identified: asp.glu; asp(glu,ala); asp(glu,ala)ser; glu(ala,ser); ser.glu; ser(glu,ala); ser(glu,ala,phe); glu.ala.phe; phe(pro, leu,glu), and pro(leu,glu,phe). Earlier investigations[1,9,10] showed that the single leucine residue is located in the C-terminal portion of the molecule, and that two of the three serine residues and one of the three phenylalanine residues occur in the sequence ser.tyr.ser.met.glu.his.phe . . . at the N-terminus. Thus, the following sequence can be deduced for the carboxyl end of α-corticotropin: . . . asp.glu.ala.ser. glu.ala.phe.pro.leu.glu.phe.

## Action of Trypsin

50 mgm. of α-corticotropin trichloroacetate and 0·75 mgm. of crystalline trypsin were dissolved in 5 ml. of water and the *p*H of the solution was adjusted to 9·3–9·4 by the dropwise addition of 2 per cent ammonia. The whole solution was then diluted to 10 ml. with water and kept at 38° for 6 hr. After incubation, the digest was immediately lyophilized. The lyophilized product was submitted to chromatography on paper in the first dimension, in the solvent system *n*-BuOH/HOAc/$H_2O$/pyridine (30 : 6 : 24 : 20) of Waley and Watson[11], and then, in the second dimension, to zone electrophoresis on paper for 6 hr. at 11·5 volts per cm. in the buffer system γ-collidine/HOAc/$H_2O$ at *p*H 7·0, described by Lockhart and Abraham[12]. When the paper was sprayed with ninhydrin, the typical pattern shown in Fig. 2 was revealed. The material corresponding to each spot in the pattern was accumulated by submitting the digest first to paper chromatography and then to paper electrophoresis with the aforementioned solvent systems. The eluate from each zone obtained in the

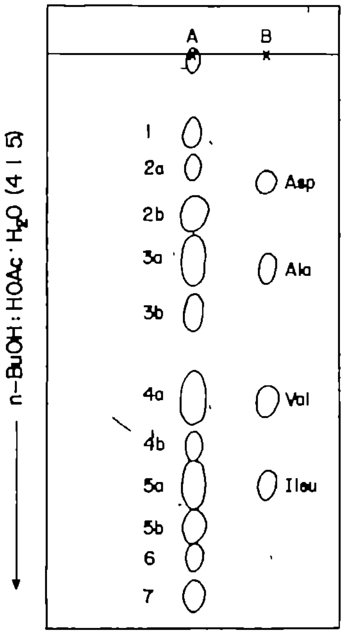

Fig. 1. Chromatogram of trichloroacetic acid-soluble peptides released by the action of pepsin on α-corticotropin

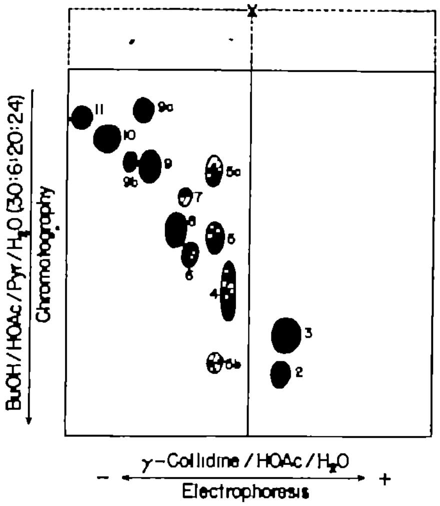

Fig. 2. Resolution of a tryptic digest of α-corticotropin by paper chromatography in the first dimension and by zone electrophoresis on paper in the second dimension

latter procedure was submitted to quantitative amino-acid analysis by the DNP-paper method[6], as well as to stepwise degradation, proceeding from the amino end of the peptide, by a modification[13] of the method of Edman[14]. Results disclose the occurrence of the following peptides in the tryptic digest of α-corticotropin: ser.tyr.ser(met,glu,his,phe)arg; try.gly.lys.pro.val.gly.lys; lys.arg; lys.arg.arg; arg.pro.val.lys; and val.tyr.pro.ala.gly.glu(asp$_2$,glu$_3$,ala$_2$,ser,phe$_2$,pro,leu).

## Action of Chymotrypsin

50 mgm. of α-corticotropin trichloroacetate was dissolved in 2 ml. of water and mixed with 2 ml. of 0·2 *M* ammonium acetate buffer, at *p*H 8·2, containing 0·5 mgm. of crystalline chymotrypsin. After the mixture had been kept at 38° C. for 4·5 hr., it was placed in a boiling water-bath for two minutes to terminate the enzymatic activity. The slight coagulum formed was removed by centrifugation and the clear supernatant liquid was lyophilized. The digest was then submitted to zone electrophoresis on paper in a γ-collidine/HOAc/H$_2$O buffer of *p*H 6·7[12] for 6 hr. at a potential gradient of 10·2 volts per cm. Fig. 3 presents a typical pattern after the paper strip had been sprayed with ninhydrin; the bands were further examined by means of stain reactions for tryptophan[15] and arginine[16]. It was found that band No. 7 gave the strongest colour reaction for these two amino-acids. The material in band No. 7 was then eluted with 3 per cent ammonia and submitted to chromatography on paper in the solvent system of Partridge[4]. The material from the main spot in the chromatogram was eluted and examined by a modification of the Edman procedure (Geschwind, I. I., unpublished work). The results gave evidence for the presence of the sequence . . . arg.try . . . in this peptide. (The sequence his.phe.arg.try . . . was found by applying the paper-strip modification[17] of the Edman procedure to a fraction obtained from countercurrent distribution of the core derived from extensive digestion of α-corticotropin with pepsin. This sequence confirms the arg.try linkage.)

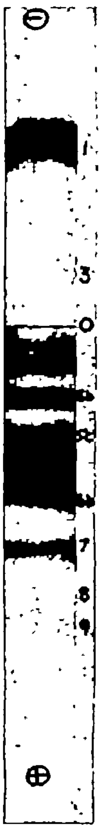

Fig. 3 Resolution of a chymotryptic digest of α-corticotropin by zone electrophoresis on paper

## Partial Acid Hydrolysis of DNP-α-Corticotropin

The DNP-derivative of α-corticotropin was prepared according to the procedure previously described[18]. 50 mgm. of DNP-α-corticotropin was suspended in 1 ml. of 6 *M* hydrochloric acid; the suspension was sealed in a test-tube and kept at 110° C. for 5 hr. The separation and identification of DNP-peptide fragments in the partial acid hydrolysate were effected by paper chromatographic procedures similar to those employed for separating the products of peptic digestion (*vide supra*). This procedure disclosed, *inter alia*, the peptides pro(val$_2$,lys,tyr) and ala(gly,glu,asp); the quantitative estimations were

Table 1. PEPTIDES OBTAINED FROM PEPTIC, TRYPTIC, CHYMOTRYPTIC, AND PARTIAL ACID DIGESTS OF α-CORTICOTROPIN: COMPLETE AMINO-ACID SEQUENCE OF THE PEPTIDE HORMONE

| Hydrolytic agent | Peptide No. | Amino-acid sequence |
|---|---|---|
| Trypsin | 5 | ser.tyr.ser(met,glu,his,phe)arg |
| Chymotrypsin | 7 | arg.try( ) |
| Trypsin | 8 | try.gly.lys.pro.val.gly.lys |
| Trypsin | 10 | lys.arg |
| Trypsin | 11 | lys.arg.arg |
| Trypsin | 9 | arg.pro.val.lys |
| Acid | B2–5 | pro(val,lys,val,tyr) |
| Trypsin | 2, 3 | val.tyr.pro.ala.gly.glu(asp,asp,glu,ala,ser,glu,ala,phe,pro,leu,glu,phe) |
| Acid | WOH–4 | ala(gly,glu,asp) |
| Pepsin | 2b–1 | asp.glu |
| Pepsin | 2a–1 | asp(glu,ala) |
| Pepsin | 1–1 | asp(glu,ala)ser |
| Pepsin | 3b–1 | glu(ala,ser) |
| Pepsin | 4a–2 | ser.glu |
| Pepsin | 2b–2 | ser(glu,ala) |
| Pepsin | 4b–2 | ser(glu,ala,phe) |
| Pepsin | 4 | glu,ala.phe |
| Pepsin | 7–2 | phe(pro,leu,glu) |
| Pepsin | 7–3 | pro(leu,glu,phe) |
| Complete sequence: | | ser.tyr.ser.met.glu.his.phe.arg.try.gly.lys.pro.val.gly lys.lys.arg.arg.pro.val.lys.val.tyr.pro.ala gly.glu.asp.asp.<br>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29<br>glu.ala.ser.glu.ala.phe.pro.leu.glu.phe<br>30 31 32 33 34 35 36 37 38 39 |

nade visually on the basis of ninhydrin-sprayed hromatograms.

Table 1 summarizes the results obtained from eptic, tryptic, chymotryptic, and partial acid ydrolysates of α-corticotropin. From them, together vith previously reported sequences for the N- and -terminus[8], the complete amino-acid sequence of he hormone is established. Since no amino-acid equence inconsistent with this formulation was ncountered, it may be assumed that no appreciable ranspeptidation has occurred during enzymatic ligestion. Although no structure containing the equence . . . lys.lys . . . has been found, there is vidence to suggest that the linkage postulated in ositions 15–16 must exist. The specificity of trypsin vould demand that the . . . gly.lys . . . bond (positions 4–15) not be split. Consequently, the N-terminal ysine of peptides 10 and 11, which together with eptide 8 are found in high yield, cannot represent osition 14 and hence must occupy position 15. It hould be noted that the location of the amide groups n the molecule has not been established. Previous tudies[19] have shown that α-corticotropin contains wo amide residues.

Recently, Bell and his co-workers[20] reported the urification and structure of β-corticotropin from iog pituitary glands. Both the ovine and the porcine iormones contain 39 amino-acids, the only difference eing the occurrence of one less serine and one more eucine in β-corticotropin; this difference is accounted or by the . . . ala.ser . . . sequence (positions 31–32) n the sheep hormone in place of a . . . leu.ala . . . equence in the porcine β-corticotropin. The only ncertainty reported in the structure of the latter[20] vas in the sequence . . . ala(gly,glu,asp) . . . in ositions 25–28. White and Landmann[21] reported he sequence . . . gly.ala.glu.asp . . . in these positions n corticotropin-*A*, which is also of porcine origin. n the ovine hormone, the sequence for these positions, as shown in Table 1, is: . . . ala.gly.glu.asp. Some uncertainty about the sequence of positions 25–28 was introduced when peptides 2 and 3 in the tryptic digest were re-investigated by the Edman procedure. However, a single experiment with acid hydrolysis (*WOH-4*) favoured the proposed sequence. Further investigation is being carried out.

Complete details will be published elsewhere.

We wish to acknowledge with thanks the generous support of the National Institutes of Health, the United States Public Health Service (Grant No. *G* 2907), the Albert and Mary Lasker Foundation, and Eli Lilly and Company, which have aided greatly in the present investigation.

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# FORMATION OF TUBES BY A SIMPLE ROLLING ACTION: A NEW NORMAL-PRESSURE EFFECT

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IN the steel industry, it is known that, in the Mannesmann process[1], a red-hot rod of metal orms itself into a tube when rolled between rollers. Villiamson[2] has recently described a similar phenmenon which he observed in the rolling of a certain iatural Australian clay ('blue ball clay') and also vith warm 'Plasticine'. He studied in great detail the nicrostructure of the clay with regard to its chemical onstitution, water content, and particle size, shape nd crystallographic orientation, and concluded that he phenomenon was specific to the microstructure nd in particular to the difference in water content etween the inner and outer regions of the specimen.

Weissenberg[3] has analysed the experimental obserations and concludes from his theory of flow that he phenomenon should depend only on the macrocopic characteristics of the process and the material, nd should be much more general than has hitherto een imagined. It should be observable as an effect f normal pressure in materials with the most varied ypes of microstructure and be particularly sensitive to the amount of elastic recovery present. When this amount approximates to zero, the plastic deformation caused by the rolling process should generate near the axis of the specimen a concentration of tensional normal pressures which suck in the end-planes of the specimen and open up radial cracks. This could continue under favourable conditions until a tube is formed. Tests with elastic recoveries progressively increasing from zero to large amounts should produce plastic and elastic deformations, and the latter should reduce the strength of the tensional pressures to zero and beyond this to compressions. Thus, in extreme cases, a reversion of the phenomenon of tube formation should be observed, as the compressions would tend to push out the end-planes of the specimen. The early stages of the sucking-in or pushing-out should be insensitive to changes in the initial shape of the specimen, but the completion of a tube by continued rolling should be facilitated by the choice of initial dimensions with a length to width ratio smaller than unity.

We were interested in testing Weissenberg's conclusions, particularly because it seemed unlikely that a merely macroscopic theory could predict qualitatively all the various widely differing normal pressure effects such as these and the better-known 'Weissenberg effects'[4,5] which occur under torsional shears and are almost diametrically opposed to those described here. Two series of tests were carried out.

We started the first series by reproducing and confirming Williamson's observations. We rolled tubes from warm 'Plasticine' and from an aqueous paste of a clay very similar in constitution to his 'blue ball clay'. Both materials had a macroscopic consistency which was putty-like and plastic, with no apparent elastic recovery. We then prepared a series of materials of similar macroscopic consistency but with widely differing microscopic structures by stirring liquids into aggregates of solid particles to a solid concentration of about 75 per cent (though this was not very critical). The rolling of flat-ended cylindrical specimens with a length to diameter ratio of about 0·5 produced tubes in every material of this series irrespective of the nature of the liquid phase (water, paraffin oil, or silicone oil) or whether the solid particles were coarse or fine, crystalline or amorphous, in the shape of plates (graphite), needles (asbestos), or spheres (starch). The effect of varying the dimensions of the specimen was most pronounced in cold 'Plasticine', from which Williamson failed to produce a tube. In this material we produced tubes by rolling cylindrical rods with initial length/diameter ratios equal to or smaller than 0·5, and found that the rolling of spheres and cylinders with a ratio equal to or larger than 1 (such as were used by Williamson) exhibited in the early stages a drawing-in of the ends; but the end cavities did not meet however long the rolling continued.

The appearance of cracks during rolling allowed a rough assessment of the pressure distribution to be made. An accumulation near the axis of tensional normal pressures was indicated by the opening-up of radial cracks originating near the axis and decreasing in width from the centre outwards (see Fig. 1). The effects of varying the chemical and physical properties of the components were difficult to assess; but, in a qualitative way, it was possible to distinguish two types. One type formed tubes by the sucking-in of the ends of the cylinder until the concavities met; for example, smooth pastes containing, in 'Nujol' (liquid paraffin): powders of aluminium, aluminium stearate, cement, clay, cornflour, graphite, icing sugar, iron, jeweller's rouge, lycopodium, polystyrene, 'Pyrex' glass, starch, and talc; in water: clay, icing sugar, lithopone; in silicone oil: graphite, icing sugar. The other type formed tubes by the opening-up of radial cracks with little or no drawing-in of the ends; for example, fibrous pastes of 'Nujol' and asbestos or of water and filter-paper pulp.

In a second series of tests, we investigated materials with a macroscopic consistency which was again putty-like but showed noticeable amounts of elastic recovery (as evidenced by bouncing or recovery from stretching) in contrast to the first group. Some extreme cases of such materials are a polyisobutylene with a molecular weight of about 20,000, silicone bouncing putty, and Reeves's 'putty' rubber, all of which on rolling produced elongated rods with convex ends and thus exhibited the opposite of the tube-forming phenomenon. Tests of the remaining materials in this series (Remington 'Everclean' rubber, and pastes of 'Plasticine' + rubber solution + talc, and vinyl chloride-acetate copolymer + dioctyl phthalate + china clay) showed poor reproducibility. The same material exhibited in successive experiments both drawing-in of the ends and the converse effect even with no deliberate variation of the experimental conditions. An assessment of these results has to be postponed until quantitative data are available under carefully controlled conditions of temperature, speed and pressure of rolling, etc.

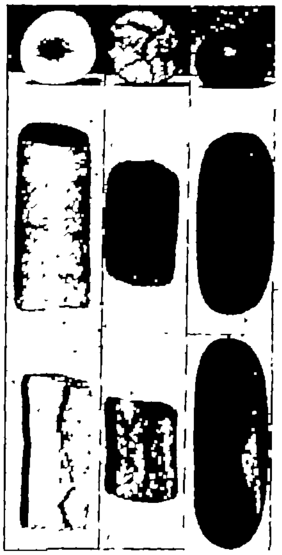

Fig. 1. Tube formation and its opposite in different types of materials. The rolled specimens are viewed in elevation (top), plan (middle), and axial section (bottom). From left to right: cornflour in 'Nujol', asbestos in 'Nujol', polyisobutylene with a molecular weight of about 20,000

Fig. 1 illustrates the normal-pressure phenomena observed in rolling. Tube formation of the two types is shown in two materials of the first series of tests and the opposite phenomenon in an extreme material of the second series.

These two series of tests do not provide sufficient information to decide for or against Weissenberg's theory. However, such indications as have been obtained are consistent with his predictions of an accumulation of normal pressures near the axis of the specimen, and of a change of the pressures from tension to compression with an increase in the amount of elastic recovery. In any event, the application by Weissenberg of the macroscopic point of view has revealed the great generality of a new set of normal-pressure phenomena occurring in the shearing movement of the rolling process.

We thank Mr. A. J. Gaskin, of the Commonwealth Scientific and Industrial Research Organization, Melbourne, in whose department Williamson's experiments were performed, for bringing the phenomenon to our notice and for his continued interest and co-operation. We thank also Mr. J. E. Roberts and Mr. W. F. O. Pollett for help and advice in the experimental investigation, and Dr. J. H. Schulman for useful discussion about the materials under test. A number of firms and individuals have generously provided samples of powders of known size and shape.

[May 10

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## A Measurement of the Earth's Magnetic Field by Nuclear Induction

EXPERIMENTS have been carried out recently to measure the total magnetic field in the vicinity of Christchurch, Hants, using the free precession technique briefly reported by Packard and Varian[1].

In these experiments, the protons in a sample of water are initially polarized magnetically at right angles to the earth's field, and then the polarizing field switched off non-adiabatically. The residual magnetic vector is free to precess about the earth's magnetic field $F$, and in so doing induces a signal voltage in a pick-up coil. The frequency $f$ of the precession is simply related to the field by the equation

$$2\pi f = \gamma_p F,$$

where $\gamma_p$ is the gyromagnetic ratio for the proton.

The frequency $f$ at this particular site at Christchurch at 12.30 p.m. on June 30, 1955, was 1,997·22 c./s., which corresponds to a value for $F$ of 0·46906 ± 0·00001 gauss.

The frequency was measured in a simple manner by beating the input signal with the second harmonic of a 1,000 c./s. valve-maintained tuning fork checked against Rugby and B.B.C. to about 1 part in $10^6$. The beat pattern was photographed from the cathode-ray oscilloscope display and, by comparison with a crystal-derived 50-c./s. trace, estimated to 1 part in 300. The beat frequency was 2·784 ± 0·005 c./s., hence the error in precession frequency is only 1 part in $4 \times 10^5$. Since the latest available value[2] of $\gamma_p$ is 26,753 ± 0·6 sec.$^{-1}$ gauss$^{-1}$, the computed value for the total magnetic field is therefore limited by this. The value of $F$ obtained is the time average over the period of an observation, about 5 sec.

For relative measurements, where the value of $\gamma_p$ is not required, differences of the order of 1 microgauss should be just detectable.

The experiment recommends itself for its extreme simplicity. The apparatus consists of a rugged and portable nuclear magnetometer head, requiring no careful orientation in setting up, and standard frequency-measuring equipment. Placing the head on a selected site and taking a reading requires only a few seconds.

The experiment does, incidentally, provide a striking means of demonstrating the nuclear relaxation times $T_1$ and $T_2$.

Full details of the method and results will be reported elsewhere.

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Signals Research and Development Establishment
(Ministry of Supply),
Christchurch, Hants.
Aug. 4.

Packard, M., and Varian, R., *Phys. Rev.*, 93, 941 (1954).
Ramsey, N. F., "Nuclear Moments" (John Wiley, 1953).

## Colour of Tellurite Glasses

THE glass-forming properties of tellurium dioxide, and the interesting properties of some tellurite glasses have been described by Stanworth[1]. Certain of these glasses have possible applications as optical components owing to their high refractive indices. However, all the tellurite glasses were prepared using commercially available tellurium dioxide and were coloured, usually slightly, yellow-green. This is in contrast to the statement of Berzelius[2] that clear, colourless glasses could be made by fusing the tetra-tellurites of barium and the alkali metals.

It was considered probable that the colour of the glass originated from impurities present in the tellurium dioxide. Spectrographic examination showed that the amount of impurity in the glasses was very small, that calcium and strontium were the main impurities and that slight traces of aluminium, magnesium, sodium, iron and gold could be detected. Of these it was judged that iron was by far the most probable source of the coloration. Chemical analysis of some tellurite glasses for iron gave values between 0·004 and 0·007 per cent for the total iron expressed as $Fe_2O_3$, in the glasses exhibiting least colour.

A number of attempts were then made to prepare a sample of pure $TeO_2$, particular reference being paid to the iron content. According to Köthner[3], tellurium metal may be separated from all impurities, except antimony, by repeated distillation under reduced pressure. This method was applied by distilling tellurium (50 gm.) in a bent quartz tube connected to a water-jet pump. Half the tube was heated in a small electric furnace, and the middle fraction of the distillate was collected at about 650° under 20 mm. mercury pressure. This procedure was repeated four times. The product was converted to the oxide $TeO_2$, via the basic nitrate, by the method described by Marshall[4], thus effecting a further purification.

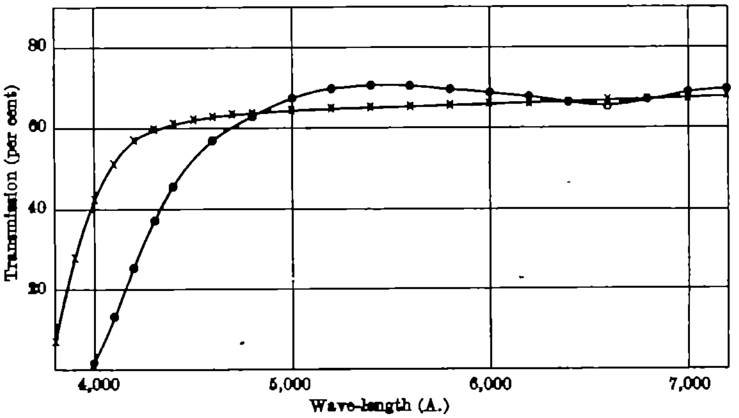

Fig. 1. Spectral transmission of barium tellurite glass of molecular composition BaO.8TeO$_2$. ○, Melted in gold, using commercial tellurium oxide; ×, melted in gold, using purified tellurium oxide

Glasses of molecular composition BaO.8TeO$_2$ were melted from 'Analar' barium carbonate and various samples of $TeO_2$, and it was immediately evident that the $TeO_2$ purified as above gave glasses with much reduced colour. All the glasses were melted for 10 min., in a gold crucible at 900°, and were afterwards annealed from 310°. The glasses were ground and polished to a thickness of 3·5 mm. and the visual transmission curves obtained. The curves relating to two glasses, one melted from commercial $TeO_2$ and the other melted from purified $TeO_2$, are shown in Fig. 1. Chemical analysis of these glasses showed that they contained respectively ~ 0·004 per cent and ~ 0·001 per cent iron, expressed as $Fe_2O_3$. Examination of the curves shows that with increasing purity of the glass, the ultra-violet absorption edge shifts towards shorter wavelengths. This is consistent with a decrease in proportion of ferric iron in the glass. Thus, it is concluded that the yellow-green colour of tellurite glasses melted from commercial materials is due to traces of iron impurities, and that the coloration may be greatly diminished by using a purer form of $TeO_2$.

It should be pointed out that the refractive index of the glass of composition $BeO.8TeO_2$ is approximately 2·1. Thus, there occurs during the transmission measurements a loss by reflexion at both surfaces amounting to about 24 per cent. This explains, in part, why the overall transmission of the glasses is low.

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May 11.

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## A Method of determining Particle Size of Powders

Mills[1] recently described an apparatus for determining the mean diameter of the particles of a powder. This method, based on the measurement of the capillary pull of the interstitial pores, is not applicable in the case of very fine particles, since $h$, the capillary pull, cannot exceed the barometric height and $l$, the length of the column of the powder, must be kept as short as possible. The present communication describes in brief an alternative method (based on permeability principles) which is free from this limitation. The apparatus is illustrated in Fig. 1.

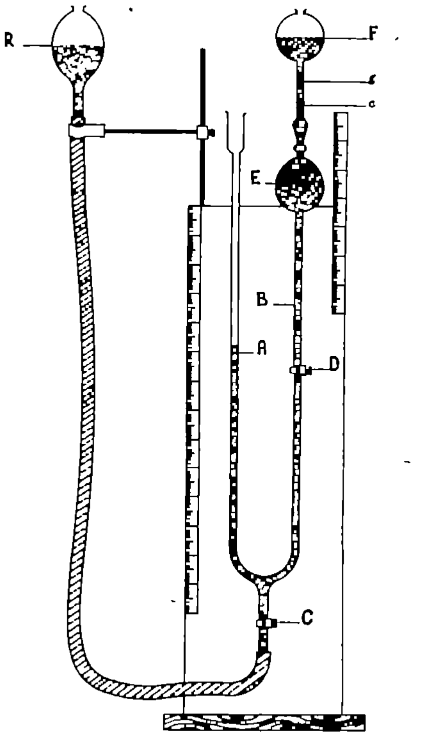

Fig. 1

By opening the stopcock $C$, mercury from the reservoir $R$ is introduced into the apparatus until the bulb $E$ (about 25 c.c. capacity) is almost half full. The rest of the bulb $E$ is filled with air-free water (or any other suitable wetting liquid). The powder under examination is closely packed over a plug of cotton or any other fibrous material of surface area much less than the powder at the constriction $c$, in the stem of the bulb $F$ (25 c.c. capacity). The bulb $F$, detached from the main apparatus at the ground-glass joint, is then connected to a vacuum system at the lower end and water (or whatever wetting liquid is used) is poured in from above. The air contained in the pores of the powder is thereby replaced by the wetting liquid. The bulb is then mounted on the apparatus as shown in Fig 1. This ensures an air-free joint. Sometimes tiny bubbles of air may appear at the bottom of the cotton plug on the removal of the bulb $F$ from the vacuum system. These can be removed by simple manipulation.

The stopcock $D$ is then closed and the mercury reservoir $R$ is lowered. When the difference in the mercury levels in the tubes $A$ and $B$ is about 50 cm. the stopcock $C$ is closed and $D$ is opened. Thus a certain amount of pressure deficiency is applied at the powder end and the liquid begins to flow through it. The level of mercury in the tube $A$ begins to rise. The time ($t$) taken by the mercury level to rise through a given length, say, 5 cm., is noted. Applying Poiseuille's equation with suitable modifications for flow of liquids through porous media[2], and taking into account the flow under gradually decreasing pressure head, as in the present case, the following expression can be deduced:

$$r = \frac{1 - \varepsilon}{\varepsilon} \sqrt{\frac{0\cdot006905\ L\eta R_1{}^2}{\varepsilon R^2 t} \log \frac{l_0}{l}}$$

where $r$ is the mean particle radius, $\eta$ is the coefficient of viscosity of the wetting liquid, $R_1$ is the radius of the tube $A$, $R$ is the radius of the tube $g$, $l_0$ is the initial and $l$ the final difference in the mercury levels in the two limbs, and $\varepsilon$ is the pore space per c.c. of the powder.

The method was tested on several powders, varying in mean diameters from 0·015 to 0·0005 mm. Water and benzene were used as experimental liquids. The results obtained with both these liquids were in fairly good agreement with one another. The mean diameters were also calculated by microscopic counts and by Mills's method wherever it was applicable. The values obtained by the various methods were found to be of the same order.

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April 2.

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## Growth Spirals in Electrodeposited Copper

It was first pointed out by Frank[1] that the termination of screw dislocations in a crystal face would produce steps, by the propagation of which crystal growth could take place. Such steps would obviate the need for two-dimensional nucleation and thus allow crystal growth to proceed at considerably lower supersaturations than those required to form two-dimensional nuclei. Frank predicted that the presence of an isolated dislocation on a close-packed crystal face would allow this to grow *ad infinitum* in the form of an ascending spiral. This prediction was afterwards substantiated experimentally by observations of crystals grown both from the vapour and from solution. The spirals of silicon carbide grown from the vapour by Verma[2], and those of cadmium iodide grown from solution by Forty[3] may be quoted as examples.

No observations of spirals grown by electrodeposition seem, however, to have been reported. A recent examination of the surface of electrodeposited copper has led to the identification of spirals, and these must be assumed to have originated in a manner similar to that discussed in the previous paragraph. The copper was deposited at an average current density of 10 m.amp./cm.$^2$ on a polycrystalline sheet of copper which had been cold-rolled and annealed so that a high proportion of the grains were oriented with their (100) planes parallel to the surface of the sheet and their [001] directions parallel to the rolling direction. The cathodes were electropolished prior to plating.

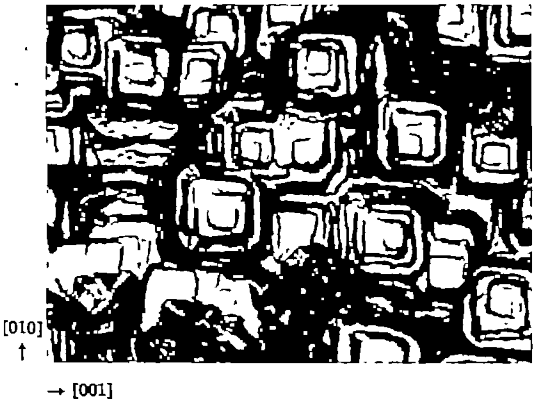

Fig. 1. Growth spirals in copper electrodeposited from an acid copper sulphate bath. (× 570)

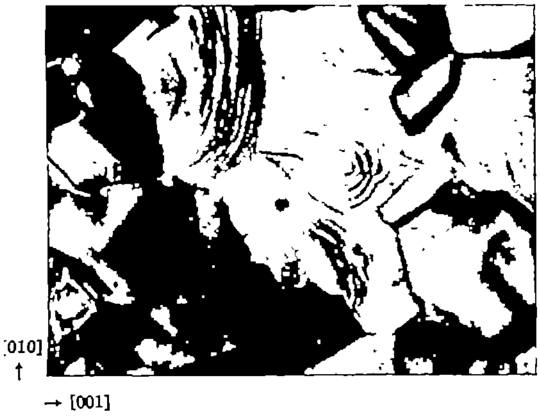

Fig. 2. A growth spiral in copper electrodeposited from a neutral copper sulphate bath. (× 940)

Two types of spiral have been observed: (*a*) those deposited from aqueous $N/2$ copper sulphate + $N/2$ sulphuric acid solution, in which the rate of growth appears to have varied with crystallographic direction (see Fig. 1); (*b*) those deposited from neutral aqueous $N/2$ copper sulphate, in which growth was insensitive to crystallographic direction (see Fig. 2).

The conditions under which these spirals grow are now the subject of investigation. Plans are in hand to produce a continuous photographic record of the development of these spirals and of other features of crystal growth encountered in electrodeposition. This will be done by placing a suitably designed electrolytic cell on the stage of a microscope fitted with a reflecting objective. Such an objective may easily be corrected for the refractive index of the plating solution.

Since writing this communication, my attention has been directed to a photograph of a spiral on the surface of electrodeposited silver–indium alloy, reproduced in a paper by Raub[4]. This spiral is visible to the naked eye, but no details are given of the way in which it has been produced.

H. J. Pick

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May 16.

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## Partition Chromatography of Synthetic Detergents

In the course of a study on the adsorption at liquid/solid and liquid/air interfaces, difficulties were encountered in identifying small quantities of adsorbed detergents and in separating mixtures of such substances containing alkyl groups differing in length.

A convenient method of separation has now been developed by means of paper partition chromatography. The compounds mainly dealt with were the normal sodium alkyl sulphates, the number of carbon atoms in the hydrocarbon chain ranging from twelve to eighteen. However, with minor modifications the method was successfully applied to alkyl aryl sulphonates, secondary alkyl sulphates, quaternary ammonium and pyridinium salts.

The methods of ascending and circular[1] chromatography were employed. Whatman No. 1 filter paper was impregnated with a long-chain fatty alcohol, usually cetyl alcohol, which acted as stationary phase; this was applied from a 1 per cent ethanolic solution. The mobile phase consisted of an aqueous ethyl alcohol solution saturated with cetyl alcohol. The concentration of this solution varied according to the alkyl sulphates to be separated. The chromatogram of the detergent mixture was developed for 10–24 hr., and the paper dried. It was then immersed in 0·5 per cent cupric acetate and sprayed with a 0·05 per cent solution of rhodamine 6*GB*. After drying, the detergent spots appeared crimson on a pink background in daylight, and dark purple on a yellow background under ultra-violet light. $R_F$ values were determined for various concentrations of ethyl alcohol and are shown in Table 1.

Table 1

| Concentration of ethanol | No. of carbon atoms in n-alkyl group | | | |
|---|---|---|---|---|
| | 12 | 14 | 16 | 18 |
| 50 | 0·88 | 0·50 | 0·11 | 0 |
| 62 | 1·0 | 0·70 | 0·39 | 0·07 |
| 75 | 1·0 | 0·90 | 0·50 | 0·15 |

By a similar procedure applied to 'Teepol', it was possible to obtain resolution into six well-defined components. It was, however, necessary to reduce the concentration of the mobile phase owing to the high solubility of secondary alkyl sulphates in ethyl alcohol. Resolution of commercial cetyl pyridinium chloride was also achieved by the above method, when four distinct compounds were obtained; the indicator used for cationic compounds was bromocresol green.

Other solvent systems are now being investigated, as well as a method for continuously changing the composition of the mobile phase, to achieve yet better separation and to enable quantitative determinations to be made.

A full account of this work will be published elsewhere. I wish to thank Mr. R. E. Wagg for helpful discussion and the Director of the British Launderers' Research Association for permission to publish this communication.

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[1] Schwerdtfeger, E., *Naturwiss.*, 40, 201 (1953).

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# Probable Nature of an Artefact in the Paper Chromatography of Thyroxine caused by Trichloracetic Acid

Interference of trichloracetic acid with the paper chromatography of adrenaline analogues and of histamine, using *n*-butanol/acetic acid/water (4 : 1 : 5), has already been reported[1,2]. A similar artefact is described below, affecting another compound, thyroxine, run in a different solvent system, *n*-butanol/dioxane/2 *N* ammonia (4 : 1 : 5). No effect of this nature is mentioned by Gross[3] in his review on the chromatography of thyroid hormones.

Shepherd and West[1] have been successful in removing trichloracetic acid from aqueous solutions before chromatography by treatment with the anion exchange resin 'Amberlite *IRA*-400'. Nevertheless, it was felt that an alternative method might prove useful in certain cases. Since trichloracetic acid is a strong acid, having a *pK* of 0·7 (Bell[4]), it seemed likely that electrolytic desalting would extract trichloracetate from aqueous solution, although neither Consden, Gordon and Martin[5] nor Dent[6] indicate whether the procedure is applicable to this ion. Consequently, an examination of this question was undertaken.

The thyroxine artefact was first encountered in experiments intended to discover whether the precipitation of plasma proteins by trichloracetic acid could cause the iodination of unsaturated plasma lipids by radioactive inorganic iodide; the possibility of this process occurring had been suggested by some observations on the behaviour of pure substances[7]. A plasma sample, which contained 0·1 mgm. heparin/ml., was obtained from a thyrotoxic patient who had received 10 mc. of radioiodine 48 hr. previously. A portion of this plasma (2 ml.) was treated with 20 ml. of 10 per cent (w/v) trichloracetic acid and the precipitated proteins washed three times with 10 per cent (w/v) trichloracetic acid. The precipitate was suspended in 5 ml. of water, brought to pH 4 with 1 *N* sodium hydroxide and extracted successively with 15 ml., 10 ml. and 5 ml. of water-saturated *n*-butanol and the extracts combined. Another 2-ml. portion of plasma was brought to pH 4 with 2 *N* hydrochloric acid and extracted directly. The *n*-butanol extracts were evaporated to dryness on a water-bath at 80° under reduced pressure and each residue taken up in 1 ml. of *n*-butanol. For chromatography, 50-µl. samples of these extracts were dried, 10 µl. at a time, on to a sheet of Whatman No. 1 paper, 100 µgm. of thyroxine being added as carrier to certain of the spots. The chromatogram was developed for 18 hr. in *n*-butanol/dioxane/ammonia using the descending method. The radioautograph of Fig. 1 was then prepared by placing the chromatogram in contact with 'Ilfex' double-coated X-ray film for 48 hr. Distortion of the thyroxine spot is seen to originate from those extracts which contain trichloracetic acid and spreads to adjacent runs which contain no trichloracetic acid.

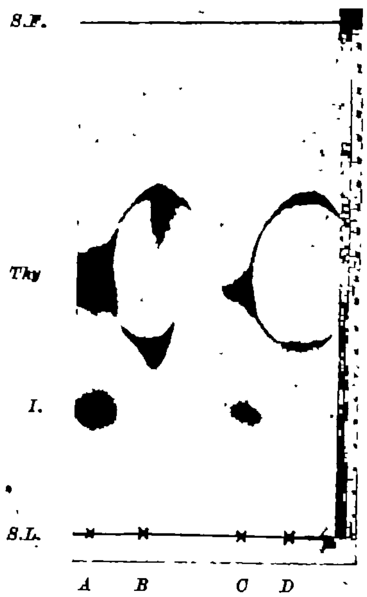

Fig. 1. Radioautograph showing trichloracetic acid interfering with the chromatography of endogenous radioactive thyroxine in extracts of plasma and plasma proteins. Scale in cm.; *S.F.*, solvent front; *S.L.*, starting line; *Thy.*, thyroxine; *I.*, iodide. (*A*) Original plasma; no trichloracetic acid; thyroxine carrier (100 µgm.). (*B*) Protein precipitate containing trichloracetic acid; thyroxine carrier (100 µgm.). (*C*) As (*A*) without carrier. (*D*) as (*B*) without carrier

The efficiency of the electrolytic desalting process was tested by noting how the chromatography of 50 µgm. thyroxine was affected by 50 µl. of a 2·5 per cent (w/v) trichloracetic acid solution before and after electrolysis of the latter for 1 hr. in a commercial model (supplied by the Shandon Scientific Co., London) of Dent's[6] desalter (initial current 0·9 amp.). The trichloracetic acid (in five portions) and thyroxine solutions were dried separately on to each spot and the chromatograms were developed for 21 hr. in *n*-butanol/dioxane/ammonia using the ascending method. Thyroxine was detected by spraying the paper with 0·2 per cent (w/v) ninhydrin in water-saturated *n*-butanol and heating it at 90° for 5 min.

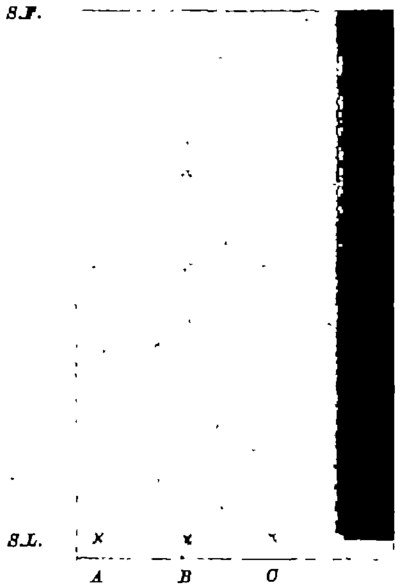

Fig. 2. Chromatogram showing the effect of trichloracetic acid on thyroxine chromatograms before and after electrolytic desalting. Scale in cm.; *S.F.*, solvent front; *S.L.*, starting line. (*A*) Thyroxine (50 μgm.) alone. (*B*) Thyroxine (50 μgm.) and 50 μl. of 2·5 per cent trichloracetic acid before electrolysis. (*C*) Thyroxine (50 μgm.) and 50 μl. of 2·5 per cent trichloracetic acid after electrolysis

Fig. 2 shows that electrolytic desalting causes the 'double spot' artefact to disappear. However, trichloracetic acid is probably not completely removed, since spot (*C*) shows an increase in the $R_F$ of thyroxine relative to spot (*A*). Incomplete desalting has been observed in the case of other ions and is treated theoretically by Consden, Gordon and Martin[5].

There are two possible reasons why trichloracetic acid might cause chromatographic artefacts. Either loose chemical combination might take place between it and one or more of the substances being chromatographed[1,2], or the acid could interfere with the chromatographic solvent system. The form and spread of the artefacts shown in Fig. 1 favour the latter explanation. In this connexion it should be noted that solvent systems containing *n*-butanol are highly sensitive to changes in the degree of saturation of the non-aqueous with the aqueous phase[8], and it seems likely that trichloracetic acid, which is strongly hygroscopic, could cause such changes to occur.

I wish to thank Dr. H. Miller for preparing the radioautograph, Prof. G. M. Wilson and Dr. D. R. Wood for their interest in this work, and the Board of Governors of the United Sheffield Hospitals for financial assistance.

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University of Sheffield,
and
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May 26.

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## Decomposition Flame of Methyl Nitrite

WHEN a stream of methyl nitrite vapour issuing from the mouth of an upright cylindrical glass tube about 5 cm. in diameter is ignited it burns in the air as a lambent diffusion flame, greyish-yellow in hue. At the inner surface of the diffusion flame an orange-red zone forms as a cone at the mouth of the tube. If the rate of flow is reduced, this orange-red inner flame peels away from the diffusion flame and slowly descends the tube as a flat disk surmounted by a fainter, conical afterglow of the same colour, easily visible in a darkened room. No oxygen is necessary for its propagation. After it has entered the tube it is not affected if the diffusion flame at the mouth is extinguished. It is the decomposition flame of pure methyl nitrite.

The decomposition flame is not propagated downwards in tubes with diameters much less than 2 cm. In wider tubes it may be stabilized at any point by adjusting the rate of flow. Its speed, measured in tubes of 3·9 and 6·2 cm. diameter, is about 3·0 and 2·5 cm. sec.$^{-1}$ respectively. In the presence of small amounts of oxygen or of ammonia, the flame burns more readily without any obvious alteration in its nature.

From the decomposition flame formaldehyde is liberated and condenses (as paraformaldehyde) on the walls of the tube downstream of the flame. Farther from the flame a brown, resinous tar is deposited. Nitric oxide is also present and forms, in the air above the flame, the familiar brown fumes of nitrogen dioxide. In a cylindrical tube of this type, the decomposition flame is too faint for convenient emission spectroscopy. An attempt was made to maintain the same flame under conditions in which the flame would be brighter and thus more suitable for spectroscopy by establishing the premixed oxygen – methyl nitrite flame on a sintered-disk burner and then cutting off the oxygen supply. On a 2·8-cm. diameter burner it was possible to reduce the oxygen/nitrite ratio to only 0·1 mole per mole and to maintain a flame very closely resembling the decomposition flame in a tubular burner. The odour of formaldehyde was again marked and a white smoke of paraformaldehyde visible. Absorption spectroscopy showed that nitric oxide passed through the flame without undergoing complete reduction. Relatively little oxidation occurred, and this flame, although maintained in part by oxygen, was primarily the decomposition flame of methyl nitrite.

A related phenomenon may be recognized on the nitrite side of the oxygen – methyl nitrite diffusion flame[1]. Far from the oxygen supply an orange-red zone of flame is formed. Absorption spectroscopy shows that nitric oxide is formed on the nitrite side of this zone, where the absorption by the nitrite begins to fade away, and that it is consumed in the zone itself, obviously by reaction with organic breakdown products of the nitrite, because CN and NH bands are observed in emission.

Although the thermal decomposition of the simple alkyl nitrites has recently been shown to be accompanied by chemiluminescence[2], this is a remarkable and unexpected flame. Its precarious existence is emphasized by the large quenching diameter; its burning velocity—about 3 cm. sec.$^{-1}$ at atmospheric pressure—makes it perhaps the slowest flame known. According to Steacie[3] and to Rice and Rodowskas[4], the normal thermal decomposition of the alkyl nitrites begins by O—N bond fission

$$RCH_2ONO \rightarrow RCH_2O + NO \quad E_{act} \sim 37 \text{ k.cal.} \quad (1)$$

and ends with the formation of aldehyde, alcohol and nitric oxide:

$$RCH_2ONO \rightarrow 0{\cdot}5\, RCH_2OH + 0{\cdot}5\, RCHO + NO \quad \Delta H \sim 0 \text{ k.cal.} \quad (2)$$

Neither this reaction (2), which is almost thermoneutral, nor any in which there is complete conversion to nitric oxide, can account for a decomposition flame. For the release of the necessary heat some of the nitric oxide must be reduced and nitrous oxide or nitrogen formed:

$$CH_3ONO \rightarrow 0{\cdot}5\, N_2O + 0{\cdot}5\, H_2O + CH_2O \;(\text{or } CO + H_2) \quad \Delta H = -30 \text{ k.cal.} \quad (3)$$

$$CH_3ONO \rightarrow 0{\cdot}25\, N_2 + 0{\cdot}5\, H_2O + CH_2O \;(\text{or } CO + H_2) + 0{\cdot}5\, NO \quad \Delta H = -29 \text{ k.cal.} \quad (4)$$

In practice, decomposition may be expected to lie between the last three extremes.

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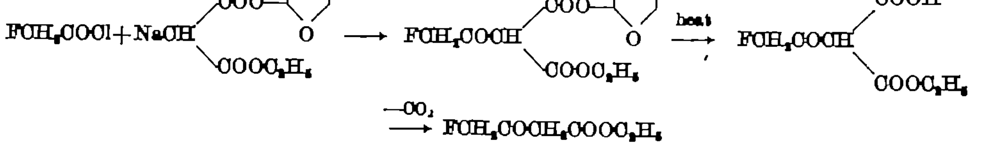
## Ethyl ω-Fluoroacetoacetate

ACETOACETIC acid is an important and widespread intermediary metabolite, being formed in the oxidative degradation of fatty acids and of certain amino-acids. For comparison with acetoacetic acid, we have prepared[1] the compound ethyl ω-fluoroacetoacetate, $FCH_2COCH_2COOC_2H_5$. From a consideration of its structural similarity to 4-fluorobutyric acid[2] and of its probable interference with the mechanism of fatty acid metabolism, we predicted that it would produce toxic symptoms.

The unequivocal synthesis, outlined below, was adapted from a previously described method[3]:



Ethyl ω-fluoroacetoacetate was obtained in 35 per cent overall yield as a colourless liquid with an odour almost indistinguishable from that of ethyl acetoacetate (b.p. 78–80° C./12 mm., and $n_D^{25}$ 1·4180; found: C, 48·64; H, 6·26; $C_6H_9O_3F$ requires C, 48·64; H, 6·08 per cent). It readily formed a 2,4-dinitrophenylhydrazone derivative (m.p. 91–91·5°; found: C, 43·71; H, 4·16; N, 17·19. $C_{12}H_{13}O_6N_4F$ requires: C, 43·90; H, 3·99; N, 17·07 per cent).

It proved to be toxic to mice (L.D. 50, c. 2·5 mgm./kgm.). Its pharmacological and biochemical properties are being examined, and may be reported at a later date.

We are grateful to Drs. M. K. McPhail, F. C. G. Hoskin and J. M. Parker for carrying out the toxicity assays. Acknowledgment is made to the Defence Research Board of Canada for funds (Contract *DRB X*-24) and for permission to publish this work (Report No. *SW*-5), and to the Research Council of Ontario for a scholarship for one of us (R. R. F.).

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## Characterization and Total Recovery of the Component Proteins of a Deoxyribonucleoprotein

RECENT developments suggest that the normal nuclei of all somatic cells of an organism contain the same quantity[1] and kind[2] of deoxyribonucleic acid, but that the different cell types within the organism may differ[3] in regard to the proteins associated with deoxyribonucleic acid: deoxyribonucleic acid appears to be specific for species and the associated proteins specific for cell type. The deoxyribonucleic acid of a species has been shown[4] to be multiple with regard to nucleobase ratios and may consist of as many chemical individuals as there are genes, while at the same time among different species the deoxyribonucleic acid-associated proteins of similar organs may be similar. Classical genetics postulates that each cell type is, through its chromosomes, *endowed* with all the potentialities of the species, but *expresses* only those potentialities which make up its own specific character. If the deoxyribonucleic acids are the physical correlate of the genetic potentialities, the implication arises that cellular differentiation may be mediated through attachment of cell-specific proteins (histones, etc.) to species-specific deoxyribonucleic acids. Indeed, the hypothesis that the former function as gene conditioners was advanced by Stedman[5] long before the emergence of chemical proof for the multiplicity of deoxyribonucleic acid, and has recently been reasserted[6] on the basis of experimental evidence for the cell-type specificity of certain preparations of deoxyribonucleic acid-associated proteins.

In view of these developments, the comprehensive chemical characterization of the proteins associated with deoxyribonucleic acid of different tissues (which began eighty years ago with the work of Miescher) has attained new importance. Along with others, we have in recent years been studying the protein moiety of calf thymus nucleoprotein. We have developed a working procedure which yields essentially all of the protein associated with the deoxyribonucleic acid of calf thymus nucleoprotein, in the form of three major fractions. Quantitative recovery is shown by the fact that the products contain all the sulphur and none of the phosphorus of the thymus nucleoprotein and account for its weight after subtraction of deoxyribonucleic acid corresponding to its phosphorus content.

Thymus nucleoprotein is obtained by extraction of homogenized fresh calf thymus tissue with water at 2° for 24 hr., centrifugation and precipitation in 0·14 *M* sodium chloride, followed by several re-precipitations. Four successive preparations, made from glands obtained at the slaughter house over a one-year interval, showed in terms of dry, salt- and lipid-free thymus nucleoprotein: phosphorus 4·20 ± 0·03 per cent and sulphur 0·31 ± 0·01 per cent (av. dev.). A modified Sevag procedure, applied to the fresh, moist thymus nucleoprotein precipitate, and consisting of a series of careful extractions and re-extractions at *p*H 11·0 with 1 *M* sodium chloride[7], yields essentially all of the phosphorus-free protein. Treatment of this latter protein with hydrochloric acid of *p*H 2·5, combined with high-speed centrifugation, separates it into soluble histone and residual protein. These products, properly washed and clarified, are neutralized and lyophilized. So far, no means have been found for re-dissolving the residual protein and examining its purity.

The histone fraction has been examined by fractional precipitation and by ultracentrifugal analysis. Successive adjustment of a histone solution to *p*H 10·3, 10·5 and 11·1 yielded three fractions of similar size which did not differ significantly from the whole histone in their nitrogen/sulphur and nitrogen/tryptophan ratios. Nevertheless, ultracentrifugal analysis of the whole histone revealed two major components. The faster of the two represents 63 per cent of the histone, yields a molecular weight estimate of 140,000 and contains methionine and cystine, as well as tryptophan. The slower component corresponds to 37 per cent of the histone, has a molecular weight of 11,000–16,000 and appears to contain one molecule of methionine, but no cystine or tryptophan. Table 1 gives a condensed summary of the preparative and analytical results.

Table 1

| Fraction | Weight (per cent) | N (per cent) | S (per cent) | Methionine (per cent) | Cystine (per cent) | Tryptophan (per cent) |
|---|---|---|---|---|---|---|
| Nucleoprotein | 100 | 18·5 | 0·31 | | | |
| Whole protein | 58 | 18·4 | 0·55 | 1·70 | 0 65 | 0·32 |
| Residual protein | 9 | 18·5 | 0·70 | 1·57 | 1·34 | 0·99 |
| Whole histone | 49 | 19·6 | 0·51 | 1·69 | 0 56 | 0·19 |
| 'Fast' histone | 31 | 19·4 | 0·70 | 2 41 | 0·67 | 0·23 |
| 'Slow' histone | 18 | 18·6 | 0·20 | 0 82 | 0·09 | 0 05 |

The use of dialysis as a means of separating the 'fast' from the 'slow' histone appears attractive, but is beset with difficulties and problems. Upon continuous dialysis of whole protein or whole histone, considerably more nitrogen than that corresponding to the 'slow' histone appears permeable. Because of these observations, which await explanation and resemble those of others[6], dialysis has not been employed in our fractionation. Several other authors[8,9] have recently reported a pair of histone fractions of low and high molecular weight, and it is noteworthy and puzzling that two of the procedures (Ahlström, Hamer) included extensive dialysis.

Our 'fast' and 'slow' histones showed sedimentation constants of $s^0_{20}$ = 8·40 *S* and 1·59 *S*, respectively (2·1 per cent in 0·18 *M* sodium chloride at *p*H 8·1). The constants reported by others for the slower fraction range from 0·9 to 2·0, and for the faster one from 8·7 to 30. Because of different experimental conditions the significance of the discrepancies is uncertain. In view of the aggregative tendencies of histones[6], the wide range of values reported for the 'fast' fraction, from 8·4 for our preparation to a maximum of 30, may reflect increasing degrees of aggregation.

We wish to thank Dr. Sam Sorof, who has provided the ultracentrifugal results, and Mr. Joseph J. Kolb, who has aided in the analytical work. A detailed account will appear elsewhere[10].

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## Is Fusaric Acid a Vivotoxin?

WHILE fusaric acid has been isolated and identified from culture filtrates of a number of *Fusaria*, its detection *in vivo* in diseased host plants has not yet been achieved in order to establish its vivotoxic complicity in wilt diseases[1]. Recent work of Zähner[2] on the detection and estimation of fusaric acid by chromatographic and bioassay techniques suggests the possibility of detection of fusaric acid *in vivo* in wilting host plants. We have been employing various chromatographic techniques, particularly the circular macro-[3] and micro-[4] techniques developed by one of us, for the detection and quantitative estimation of fusaric acid, and experienced considerable difficulty in obtaining sharp demarcation of the bands and reproducible $R_F$ values to facilitate quantitative estimation. Fusaric acid detected with brom cresol green indicator gives a diffused and ill-defined yellow band in a blue background, possibly due to the poor ionization of the acid. The difficulty was overcome by preliminary conversion of fusaric acid into its copper complex on the filter paper with copper sulphate and irrigating the complex with excess copper with *n*-butanol/acetic acid/water (4 : 1 : 5). The quantitative estimation of fusaric acid has been carried out with this technique based on the area method and will be published shortly; we have used the technique for the detection of fusaric acid *in vivo* in wilted cotton plants.

Cotton plants (Karunganni 2, *Gossypium arboreum*) susceptible to *Fusarium* wilt were grown in pots containing 500 gm. of sterilized garden soil mixed with 10 per cent soil-oat inoculum of *Fusarium vasinfectum* Atk. Visible symptoms of wilt were noted after ten days. The roots, shoots and leaves from wilted plants were collected, washed thoroughly with sterile distilled water and the sap squeezed out by maceration, and about 0·75 μl. of the clear sap spotted on circular filter paper (Whatman No. 1, 7·4 cm.) followed by copper sulphate (4 μgm./0·75 μl.). The paper was dried and irrigated with the solvent according to the technique reported earlier[3]. At the end of the period of irrigation the papers were dried and sprayed with 0·05 per cent rubeanic acid in acetone. The fusaric acid-copper complex and excess copper appeared as sharp green bands and were intensified by exposure to ammonia vapour as described elsewhere[4]. $R_F$ values were computed on the microscope. Table 1 gives the $R_F$ values of copper and the copper-fusaric acid complex in controls and in saps of roots, shoots and leaves of wilting cotton plants in the three typical solvent mixtures *n*-butanol/formic acid/water (5 : 3·5 : 5), *n*-butanol/acetic acid/water (4 : 1 : 5) and *n*-butanol/acetic acid/water (3·5 : 1·5 : 5), indicating the presence of fusaric acid *in vivo*. Chromatograms of saps of healthy cotton plants under similar conditions did not show the copper-fusaric acid complex bands. The results were confirmed with six more solvent mixtures to establish conclusively the presence of the toxin *in vivo*. The consistent presence of the complex bands in chromatograms of diseased sap in the positions corresponding to those of the copper-fusaric acid controls in every case would eliminate the possibility of interference by other metabolites which might also form complexes with copper.

Work on the quantitative aspects with resistant and susceptible varieties of cotton is under way and will be reported elsewhere.

Table 1

| Material spotted | $R_F$-values<br>*n*-Butanol/formic acid/water (5 : 3 5 : 5) | <br>*n*-Butanol/acetic acid/water (4 : 1 : 5) | <br>*n*-Butanol/acetic acid/water (3·5 : 1 5 : 5) |
|---|---|---|---|
| 1 Copper | 0 157 | 0 494 | 0·666 |
| 2 Copper-fusaric acid complex | 0 088 | 0·273 | 0·617 |
| 3 Diseased root sap | 0·086 | 0·266 | 0·610 |
| 4 Diseased shoot sap | 0 088 | 0 265 | 0·602 |
| 5 Diseased leaf sap | 0·083 | 0·269 | 0 617 |
| 6 Saps of healthy plants (root, shoot or leaf) | No bands in the positions of the copper complex | | |

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# Nerve Endings as Transducers of Thermal Stimuli in Lower Vertebrates

It is now generally accepted[1] that the changes in impulse frequency in a sensory nerve are the result of processes which alter the state of polarization of the nerve membrane in the sense organ. In thermoreceptors, and especially in those[2] in which the response to cooling is an increase in the frequency of discharge, the mechanism whereby the change of temperature can cause a change in membrane polarization remains unknown.

The existence of this change of polarization is suggested by the following experiment on the ampullæ of Lorenzini of *Raja*. By passing a weak direct current between the sensory nerve and the outside of the capsule surrounding the sense organs, it is possible to alter the membrane polarization of the nerve endings and thereby the frequency of the spontaneous discharge (cf. ref. 3); the relationship between the strength of the applied current and the change in the spontaneous frequency is linear. If a standardized sequence of temperature changes is applied while a constant current is passing (Fig. 1), the responses to the thermal stimuli are added quantitatively to the responses to the electrical stimuli. The thermal response (in terms of the change in the number of impulses per second) remains the same whatever the level of the spontaneous frequency at the start of the sequence. This suggests that the temperature change is acting on the mechanism of the repetitive discharge at the same point as the electrical polarization. A similar experiment on the lateralis organs of *Xenopus laevis* is shown in Fig. 2 (the response of the lateralis organs of *Xenopus* to temperature change is similar to that of the ampullæ of Lorenzini, although considerably less sensitive).

Tyrrell, Taylor and Williams[4] suggest that the spontaneous discharge from the ampullæ is due to the existence of non-isothermal conditions. From experiments with *in situ* and isolated preparations, it can be stated that the discharge continues even when the whole preparation is at the same temperature; the same is true of the spontaneous discharge from the lateralis organs of *Xenopus*. Moreover, in both these sense organs the response to temperature

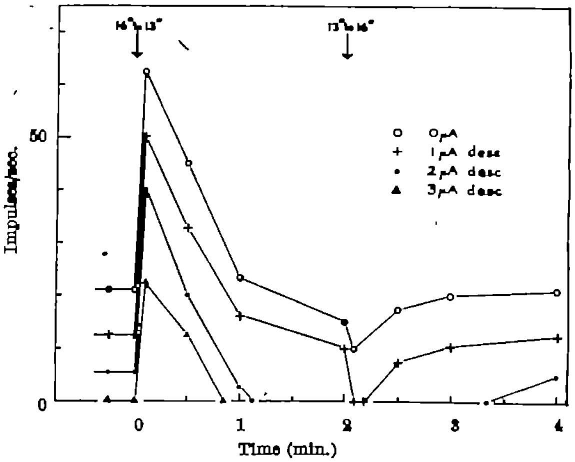

Fig. 1. Discharge frequencies in a single sensory unit from an ampulla of Lorenzini of *Raja clavata* showing the effect of a rise and fall of 3 deg. C. at four different current strengths (a descending current flows from sense organ to nerve, and an ascending from nerve to sense organ)

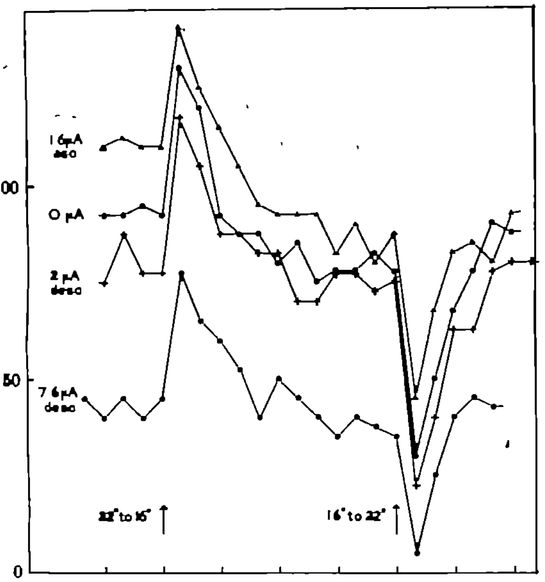

Fig. 2. Discharge frequencies in a multifibre preparation of lateralis organs of *Xenopus laevis* showing the effect of a rise and fall of 6 deg. C. at four different current strengths

hange is the same irrespective of the direction of he spatial temperature gradient. They therefore gree in this respect with the cold receptors of the at's tongue[5], and give no support to the spatial gradient theory of Lele, Weddell and Williams[6].

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## Long-term Transplants of Infantile Rat Pituitaries cultivated *in vitro* and grafted into the Anterior Eye Chamber of Young Cats

IN a previous communication in *Nature*[1], we have reported that successful grafts of the anterior rat pituitary have been obtained when glands cultivated *in vitro* were transplanted into the anterior eye chamber of very young cats. Following the same line of work, we have transplanted rat ovaries and testes, both normal and cultivated *in vitro*, under the kidney capsule of adult cats and observed a phenomenon which, so far as we know, has not been recorded in biological literature. A few days following the transplantation, at the site of grafting a 'tumour' was formed which when sectioned and stained was found to be composed almost exclusively of lymphocytes that had migrated into this region. Remnants of the grafted tissue, surrounded by lymphocytes, were also present, some in advanced stages of degeneration.

Further studies on the tumour tissue revealed a gradual process of organization suggesting lymphoid tissue normally scattered along the intestinal tract, with typical nodules composed of a central medulla and a peripheral cortex (Fig. 1). Some of these tumours of healthy tissue grew to the size of a pea. In some experiments as many as seven or eight nodules have been counted per section of the tumour tissue. The newly organized lympho-blastema persisted in the kidney long after the grafted tissue was destroyed (in the eye of the cat for four months and probably longer). If, however, cat ovaries or testes were transplanted under the kidney capsule of the rat, organized lymphoid tissue was not formed, although the number of transplants was not sufficient to warrant a definite conclusion. It appears that in the cat it is only living tissue that is capable of inducing the formation of organized lymphoid tissue at the site of transplantation, for spruce-wood splinters, knots of silk thread, boiled egg albumen and glass beads when placed under the kidney capsule, in repeated experiments, failed to produce this effect.

When the types of cells in the tissue found at the site of transplantation of some of the rat pituitaries in the eye of the cat were subjected to closer examination, it was found that they were comparable in every detail with the medullary portion of the lymphoid nodule developed at the site of transplantation of the rat gonad in the kidney of the cat. Hence we conclude that the graft-induced medullary portion of a lymph nodule in the eye of the cat was mistaken by us for the grafted pituitary tissue itself (Figs. 2 and 3 in our earlier communication).

We wish to make it clear, however, that we have definite evidence that some of the grafted explants of the rat pituitary survived for at least two months; the normal transplants did not survive (see Fig. 1 in the earlier communication). These persistent hetero-transplants, so far as we can tell, although intimately bound to the iris tissue of the host by fibrous connexions, were not vascularized, an observation which is in agreement with the findings of Merwin and Hill[2] on intraspecific grafts of normal tissue in mice. Further research has been undertaken in order to ascertain if non-vascularized hetero-transplants, similar to the homo-transplants reported by Merwin and Hill, survive for still longer periods.

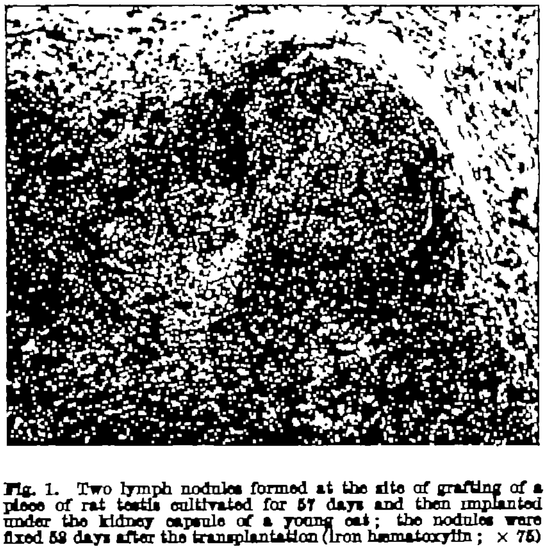

Fig. 1. Two lymph nodules formed at the site of grafting of a piece of rat testis cultivated for 57 days and then implanted under the kidney capsule of a young cat; the nodules were fixed 53 days after the transplantation (Iron hæmatoxylin; × 75)

In the face of evidence presented above, it is clear that our suggestion that embryo extract may have a protective action upon cultivated tissue following its transplantation into hosts belonging to a different species, will require further study, especially of the vascularized grafts. There is no doubt that the transplants previously cultivated *in vitro* behave differently from normal grafts; they establish circulation at a much later date than the latter, and, as a consequence, they survive longer.

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## Colicine *K*

Colicines are substances of unknown nature which are elaborated by certain strains of Enterobacteriaceae and which have the ability to kill other strains within this group. At the time of their discovery some thirty years ago[1], it was apparent that colicines bore a similarity to the bacteriophages, yet differed in that they could not be transmitted by serial passage. In recent years considerable attention has been paid these agents[2], largely because of this relationship and because of a renewed interest in the bacteriophages themselves. The brilliant investigations of Fredericq have revealed that there are many different colicines; some seventeen specific types have thus far been described[3]. Furthermore, these agents are now known to be elaborated by micro-organisms other than those of the enteric group. Because of this, the name 'bacteriocines' has been suggested to designate them[4].

The similarities between phages and colicines are striking. Thus, Fredericq[5] has demonstrated that colicine-susceptible micro-organisms yield resistant variants which are also resistant to certain phages, and vice versa. In addition, it has been shown that those chemical and physical agents which induce the release of phage from lysogenic bacilli can, in certain instances, also bring about liberation of colicine from colicinogenic micro-organisms[6]. Because of these seemingly intimate relationships, the implication has been made that colicines might be precursors of phages[7]. If this be true, one would expect these agents to bear some immunological relationship to one another. Yet it has not been possible to show, in the case of colicine *K*, that biological activity can be neutralized by an antiserum to the colidysentery phage *T6*, the virus to which this colicine is presumably related[8]. The affirmations which have appeared from time to time concerning the protein-like nature of colicines[1,9] are in reality not fully substantiated. These substances have never been isolated in purified form and hence their chemical status remains obscure.

Several years ago an attempt was initiated in this laboratory to isolate and characterize colicine *K*, to study its chemical and immunological properties and to relate these to phage *T6*. The following is an account of the present state of this investigation.

A strain of *E. coli* producing colicine *K* designated as *K235* was kindly supplied by Dr. Pierre Fredericq. When these micro-organisms were plated on proteose-peptone or nutrient agar, they yielded colonies which appeared to be morphologically uniform. On neopeptone agar, however, two distinct colonial forms were observed; one was transparent and slightly rough, the other smooth, mucoid and opaque. In liquid media the latter elaborated five times as much colicine as the former.

The opaque variant was grown in 15 l. of a medium consisting of 1 per cent 'Difco' casamino-acids, 1·5 per cent glucose, 0·5 per cent dialysed 'Difco' yeast extract, 18 gm. of $Na_2HPO_4$ and 7·5 gm. of $KH_2PO_4$. It was essential for the production of maximal amounts of colicine that the *p*H of the medium be maintained precisely at 7·0. This was achieved with the aid of an electronic device[10]. When bacterial growth had ceased ($2 \times 10^{10}$ B/ml.) the bacilli were killed with chloroform and separated by centrifugation. The supernate containing the colicine was rapidly concentrated *in vacuo*, and, after thorough dialysis, crude colicine *K* was obtained by freeze-drying the residue. This material (5·0 gm.) contained several components when examined in the Tiselius apparatus. Purification was accomplished by fractional precipitation with ethanol (75 per cent) at 0° followed by repeated precipitation with ammonium sulphate (75 per cent) at *p*H 4·5, and dialysis. An aqueous solution of this material, which still contained two electrophoretically different components, was then shaken with chloroform-octyl alcohol. The colicine fraction formed an emulsion with the organic solvent which was separated by centrifugation. The inert fraction remained in the supernate. The colicine (1·0 gm.) was recovered from the chloroform emulsion by precipitation with ten volumes of ethanol at 0° C.

Purified colicine *K* obtained in this manner is water-soluble, colourless and free of nucleic acid. It contains 6·5 per cent of nitrogen and 1·6 per cent of phosphorus. In the Tiselius apparatus it appears to show but one electrophoretic component when examined at various *p*H values. In the ultracentrifuge, however, solutions are heterodispersed. The material appears to be a macromolecular substance constituted from carbohydrate, protein and lipid. It is toxic both in mice and rabbits and has potent antibacterial properties as well. 0·02 ml. of a solution containing 1·0 γ/ml., when placed on the surface of nutrient agar contained in a Petri dish and seeded with $5 \times 10^7$ *E. coli* b. cells, inhibits completely the growth of the bacilli encompassed by the area of the droplet. Colicine *K* is thermostable; its activity is unimpaired by heating a neutral aqueous solution for 10 minutes at 100° C. Such solutions are also stable at room temperature between *p*H 3·0 and 9·5. Activity is rapidly destroyed, however, by treating a solution at *p*H 8·0 with crystalline trypsin, or chymotrypsin, and by contact with 1 per cent formalin. Colicine *K* is a potent antigen. It elicits antibodies in rabbits which specifically precipitate the colicine, neutralize its antibacterial activity, and agglutinate the organisms from which the colicine was derived. In neutralization tests colicine *K* antisera do not cross-react with phage *T6*, however, nor do *T6* antisera precipitate or neutralize the colicine. Although *T6* resistant variants of Phase II *Sh. Sonnei* exhibit resistance to colicine *K* and vice versa, this does not appear to be sufficient reason for believing that these two agents are otherwise related. The results of this study have revealed that phage *T6* and colicine *K* have neither chemical nor immunological properties in common.

The chemical, physical, immunological and toxic properties of the substance obtained from the culture medium in which *E. coli K235* is grown indicate that the material having colicine *K* activity is the somatic or *O* antigen of the bacillus. The fact that this complex has potent antibiotic properties seems at first sight extraordinary. Yet it should not be forgotten that *O* antigens of Gram-negative bacilli exert potent toxic effects upon certain mammalian species. It is not inconceivable, therefore, that they might exert a similar effect upon an occasional bacterial species.

It cannot yet be said with complete certainty, however, that colicine activity is an inherent property of the *O* antigen of *E. coli K235*. It is possible that colicine *K* is in reality a distinct molecular species bound to the lipocarbohydrate protein complex. If this is the case, the union is firm, and has until now defied attempts at dissociation. From the evidence at hand, however, we are at the moment inclined to favour the first point of view.

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## Anti-acetylcholine and Anti-histamine Actions of the Total Alkaloids of *Rauwolfia serpentina* Benth

Dasgupta, Ray, Roy and Werner[1], Mukherjee[2] and the present authors[3] have made certain observations on the anti-adrenaline effect of extracts of *Rauwolfia serpentina*, but their effects on the action of acetylcholine or of histamine have not yet been reported. Experiments have been carried out on isolated strips of guinea pig ileum in Dale's bath, containing oxygenated Ringer–Locke's solution at 35° C., and the modifications caused by varying concentrations ($10^{-6}$ to $10^{-4}$ gm./ml.) of extracts of *Rauwolfia serpentina* (total alkaloids extracted in 2 per cent hydrochloric acid) on the action of acetylcholine ($10^{-8}$ gm./ml.) or of histamine ($10^{-8}$ to $10^{-7}$ gm./ml.) were studied. The extracts produced, by themselves, a definite but slight and transient contraction of the intestine. Dasgupta *et al.*[1] did not, however, find any stimulating effect on intestine *in situ*, whereas Chopra, Gupta and Mukherjee[4] mention a stimulating property of the extract on such a preparation. (Dr. R. P. Banerjee, of the Indian Council for Medical Research, prepared extracts of *Rauwolfia serpentina* in three different concentrations of hydrochloric acid (namely, 2, 5 and 10 per cent) with the view of fractionating the different active principles. The results obtained with an extract in 2 per cent hydrochloric acid are described here; those with 5 and 10 per cent acid extracts are under investigation.)

*Anti-acetylcholine action.* In all of the twelve experiments carried out, there was a greater degree of inhibition of the action of acetylcholine in the presence of the higher concentration of the extract of *Rauwolfia* in the bath, when the former was applied 30–50 sec. after the administration of the extract to the bath fluid. A concentration of the extract of 5 × $10^{-5}$ gm./ml. and stronger completely annulled the effect of $10^{-8}$ gm./ml. acetylcholine.

*Anti-histaminic action.* The results with histamine applied 30–50 sec. after *Rauwolfia* extract were similar to those with acetylcholine mentioned above. The extract of *Rauwolfia* in concentrations of 5 × $10^{-5}$ gm./ml. and stronger inhibited the action of histamine ($10^{-8}$ or 5 × $10^{-8}$ gm./ml.). A stage of slight potentiation of the action of both acetylcholine and histamine was noted in a few cases during the phase of recovery of the action of acetylcholine and histamine on repeated changing of the bath fluid, after an earlier observation of the action in the presence of *Rauwolfia* extract.

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## 'Kernechtrot' or Nuclear Fast Red in the Histochemical Detection of Calcareous Corpuscles in *Taenia saginata*

*Taenia saginata*, like many other cestodes[1], is known to contain numerous calcareous corpuscles or calcium balls distributed throughout the parenchyma. These corpuscles, in addition to their calcium content, consist of an organic base, containing[2] deoxyribo- and ribo-nucleic acids, simple proteins, glycogen and a hyaluronic acid-type of polysaccharide. With Gomori's modified technique these corpuscles also gave a positive reaction for alkaline phosphatase. The presence of calcium in these balls was indicated by von Kossa's silver test for calcium[3].

McGee-Russell[4] has recently reported the selective affinity of 'Kernechtrot' or nuclear fast red (batch 3569) for soluble inorganic calcium salts and its use in the histochemical detection of calcium.

We have tried to confirm the specificity of this dye by using the proglottids of *T. saginata* with their calcium-containing corpuscles as test material. It has been observed that the dye stains these corpuscles, and in some cases their immediate neighbourhood, brilliant red (see Fig. 1). As an experimental control we have stained in a similar manner identical sections of the same tissues after previous treatment with citrate buffer (*p*H 4·5–5) to remove calcium. The corpuscles failed to take up the dye in this case. This observation therefore confirms the conclusion regarding specificity of the dye for detecting calcium in the tissues. A detailed account of this work will be published elsewhere.

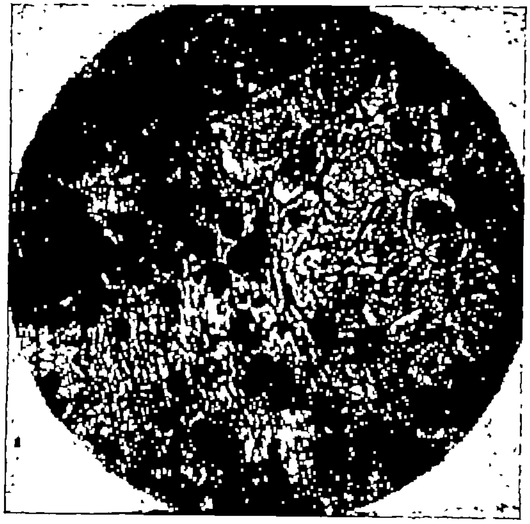

Fig. 1. Photomicrograph of part of a section of a proglottid of *Taenia saginata* showing the calcareous corpuscles stained with nuclear fast red. × 160

Our thanks are due to Messrs. George T. Gurr, Ltd., London, for supplying us with a sample of nuclear fast red for our investigations.

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## Inhibition Steps in Sulphonamide Bacteriostasis

The activity of several compounds, structurally unrelated to *p*-aminobenzoic acid, in reversing growth inhibition of *Escherichia coli* by sulphonamides, was explained by Shive and Roberts[1] as due to their being products of enzymes associated with *p*-aminobenzoic acid. Using increasing concentrations of sulphanilamide, these authors showed that it inhibits sequentially the synthesis of methionine and xanthine by the organism. Winkler and de Haan[2] extended this study to higher concentrations of the inhibitor, and reported further involvement of serine and thymine (the latter, interchangeably with pteroyl glutamic acid) in that order in the *p*-aminobenzoic acid action; further addition of valine was stimulatory to growth.

During studies on the reversal of growth inhibition of *Esch. coli* (McLeod) by sulphadiazine, we observed that, in a concentration of the drug up to 30 mgm. per cent, a combination of the foregoing five metabolites was necessary and effective; however, at its maximum solubility (50 mgm. per cent) in the medium employed[3] they could no longer overcome growth inhibition. When, in addition to them, mixtures of purines and pyrimidines, amino-acids, or the *B*-group of vitamins were tried (see Table 1), it was found that the amino-acid mixture, and to a less extent the vitamins, could reverse considerably the inhibition of growth by the drug. Using individual amino-acids, it was ascertained that the active member was either glycine or threonine; the former was more effective than the latter on a molar basis, and there was no additive effect among the two. Vitamin $B_{12}$ alone, among the B vitamins, showed a reversal effect. A combination of glycine and vitamin $B_{12}$ was nearly as active as *p*-aminobenzoic acid, and substitution of xanthine by a mixture of purines (xanthine, adenine and guanine) gave reversal of growth inhibition comparable to that with *p*-aminobenzoic acid (Table 1).

Table 1. Reversal Effects on Growth Inhibition of *Esch. co*
by Sulphadiazine

| Additions to 10 c.c. of basal medium[a] | Growth[b] without sulphadiazine | Growth[b] with sulphadiazine (5 mgm./10 c.c.) |
|---|---|---|
| 1 None | 47 | 0 |
| 2 *p*-Aminobenzoic acid (0·5 mgm.) | 47 | 46 |
| 3 Methionine (0·5 mgm.) + xanthine (0·25 mgm.) + serine (0·2 mgm.) + thymine (0·25 mgm.) + valine (0·5 mgm.) | 40 | 0 |
| 4 As in (3) + amino-acid mixture[c] | 72 | 53 |
| 5 As in (3) + vitamin mixture[d] | 46 | 25 |
| 6 As in (3) + purine-pyrimidine mixture[e] | 48 | 0 |
| 7 As in (3) + glycine (0·25 mgm.) | 48 | 27 |
| 8 As in (3) + threonine (0·4 mgm.) | 47 | 19 |
| 9 As in (7) + threonine (0·4 mgm.) | 48 | 28 |
| 10 As in (3) + vitamin $B_{12}$ (10 mμgm.) | 40 | 22 |
| 11 As in (7) + vitamin $B_{12}$ (10 mμgm.) | 47 | 40 |
| 12 As in (11), but with 0·1 mgm. each of adenine, xanthine and guanine in place of 0·25 mgm. of xanthine | 50 | 48 |

[a] Green and Sevag (ref. 3).

[b] Represents 48 hr. growth in terms of turbidity measured on Klett-Summerson photocolorimeter at 660 mμ.

[c] 0·2 mgm. each of alanine, arginine, asparagine, aspartic acid cysteine, glutamic acid, glycine, histidine, isoleucine, leucine, lysine phenyl alanine, proline, threonine, tryptophan and tyrosine.
In all experiments, racemic forms of the optically active amino acids were used.

[d] Thiamine hydrochloride, riboflavin, nicotinic acid, pantothen acid, and pyridoxine hydrochloride (10 μgm. each), pteroyl glutami acid (3 μgm.), 'Leucovorin', Lederle (3 μgm.) and vitamin $B_{12}$ (10 mμgm.).

[e] 0·1 mgm. each of adenine, guanine and uracil.

It would seem from the above that synthesis of glycine is yet another reaction mediated by *p*-aminobenzoic acid and blocked by sulphonamides. The organism *Esch. coli* is apparently capable of converting threonine to glycine (cf. ref. 4). Such a possibility is also indicated from the observation of Ravel *et al.*[5] that glycine and threonine both increase synthesis of 4-amino-5-imidazole carboxamide by *Esch. coli* under conditions of sulphonamide bacteriostasis.

It is difficult to explain the relationship observed here between the action of *p*-aminobenzoic acid and that of vitamin $B_{12}$ solely on the basis of an effect of the former on the synthesis of the latter[6]. Shive[6,7] had also reported on the potentiating action of vitamin $B_{12}$ on methionine, xanthine and serine, at each stage in their reversal of sulphanilamide action, and on the replaceability of thymine by pteroyl glutamic acid or by vitamin $B_{12}$.

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## Density Inversions in Canadian Eastern Arctic Waters

AMONG the hydrographic results of the *Calanus* expeditions of 1949–51 in Ungava Bay, Hudson Strait and Frobisher Bay, sponsored by the Fisheries Research Board of Canada, are twenty-two instances of density inversion showing unstable conditions in the sea. They were observed at twenty stations (two stations showing inversion at two different depths) out of a total of forty-eight stations occupied during the three seasons. Six of the inversion stations were in Ungava Bay, one in the Button Islands north of Cape Chidley, four in Hudson Strait between Wakeham Bay and Lake Harbour, and the remainder in Frobisher Bay.

Such instabilities, appearing in oceanographic results in the past, have usually been looked upon as fictitious, and attributed to errors in thermometer readings, sample labelling, titration or filing of results. In the present instance, titrations have been repeated where possible, and the methods used on board ship seem to preclude the possibility of other errors. Recently, Spilhaus *et al.*[1] have recorded similar inversions in the waters just south of Cape Cod, and have given evidence of some correlation of the times of observed instability with the times of lunar transit. I am informed by Dr. Carsola (personal communication) that inversions of short duration are common in shallow-water observations in progress at the U.S. Navy Electronics Laboratory at San Diego, and Dr. John Tait, of Aberdeen, has reported (at the 1952 meeting of the *Conseil Permanent* in Copenhagen) some more or less persistent instabilities observed during work in the Faero-Shetland Channel. There is a published record of another example, in the Okhotsk Sea, from the nineteenth century[2], and the *Michael Sars* expedition of 1910 found a density inversion at one station in the Atlantic (28° 37′ N.; 19° 08′ W.)[3].

The *Calanus* observations have been related to the state of the tide in each instance and are plotted on a tidal clock in Fig. 1. Tests ($\chi^2$) comparing the radial scatter of the stations with inversions, those without, and of all stations, respectively, with an equally distributed radial pattern, give the $P$ values shown. The latter two observed distributions are reasonably close to a random scatter, as would be expected; but the distribution of the instabilities verges on disagreement with random scatter, and the $P$ value for the comparison of the means (standard error of the difference of the means) of the inversion and non-inversion stations is on the margin of significant disassociation (difference is 2·02 times its standard error). It is, moreover, at once apparent on examination that, of the twenty inversion stations, half lie in one quadrant, in the first three hours of the ebb tide.

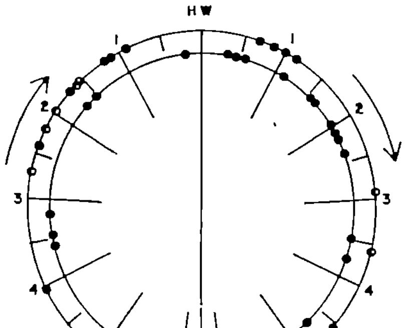

Fig. 1. A twelve ½-hour tidal clock, showing the times, with respect to tide, at which stations with density inversions (black circles) and without density inversions (open circles) were occupied. The $P$ values are explained in the text: ●, $P = 0·065$; ○, $P = 0·345$; ● + ○, $P = 0·565$; $S.E._d$, $P = 0·055$

The establishment of these unstable conditions, even for the short periods of time during which they probably exist, obviously requires considerable forces, which are apparently to be found in the extreme tidal movements of the area. Hudson Strait tides are very high (33 ft. at Ashe Inlet), the mean spring tide interval at Frobisher Bay is 32¼ ft., and a tide of more than 50 ft. has recently been recorded at the head of Ungava Bay.

The details of this work will appear in full in due course.

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Fisheries Research Board of Canada, and
Department of Zoology, McGill University,
Montreal. April 6.

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## Temperature-Ranges and Distributions of some Vascular Plants

ATTEMPTS to fit isotherms to certain limits of areas of plant distributions have sometimes been successful; but, for example, in the discussion of the areas given in the Biological Flora of the British Isles, only rarely is an isotherm limit shown. A July isotherm is given as an upper temperature limit for *Lobelia dortmanna*[1], and a July or August isotherm as a lower limit for *Halimione portulacoides*[2], and a January isotherm as a lower limit for *Arbutus unedo*[3]; and in addition to these and some other examples in the literature, I notice that the January (actual) isotherm 35° F. gives an approximate fit for the southern limit[4] of *Andromeda polifolia*. The fact of a broad coincidence between an isotherm and a limit of a distribution does not prove a relationship, but nevertheless a reasonable fit has usually been taken as indicating that temperature may probably be the limiting factor.

A limit of winter cold will obviously operate on a plant in a different way from a limit of July heat; and four possible sorts of temperature limits have been quoted above for particular cases. It could be supposed that for each plant species there may be, in broad terms, an optimum summer temperature, with upper and lower limits (beyond which the species is either damaged or else is at a disadvantage in competition with other species better adapted to the particular temperature-levels), and an optimum winter temperature, with upper and lower limits. Winter limits might be expected to operate most typically at the month of lowest temperature (as an approximation, January in the northern hemisphere); and although July might not always be the most operative summer month, in long-term means, deviations of adjacent months would at least be approximate functions of July deviations.

It does not, however, seem to have been generally realized how frequently plant areas can be represented by a combination of upper and lower limits respectively both for January and July (with January and July limits transposed for the southern hemisphere). The envelopes of the distributions I have used in Figs. 1 and 2 are of the same form as that referred to in a recent communication[5] as governing the world distribution of acarine disease of bees, and the general formula for the envelope is:

$$(\gamma_2 - \gamma_1)^2(2\alpha - \alpha_1 - \alpha_2)^2 + (\alpha_2 - \alpha_1)^2(2\gamma - \gamma_1 - \gamma_2)^2 = (\gamma_2 - \gamma_1)^2(\alpha_2 - \alpha_1)^2$$

where $\alpha$, $\alpha_1$, $\alpha_2$ are respectively January actual temperature and lower and upper limits of the temperature, and $\gamma$, $\gamma_1$, $\gamma_2$ are July actual temperature and lower and upper limits.

Forty-one distributions have so far been plotted, including the twenty areas given in Prof. J. R. Matthews's recent book[4], seven from the Biological Flora of the British Isles[6], and fourteen from other sources, reproduced by Cain[7] and Zander[8]. In this material, thirty gave really useful approximations to the given distributions, whereas in ten there were discrepancies which seemed of greater importance, and in one (*Lloydia serotina*) the fit was not satisfactory with the approximate and not very detailed isotherms which have so far been used. This is possibly due to the fact that these isotherms may not accurately represent the temperatures of the mostly isolated mountain sites where this species is found. There have been indications that the difficulty may be rather general with such species. Some of the other anomalies so far encountered seem to be partly explainable in terms of major rainfall differences between different parts of the areas.

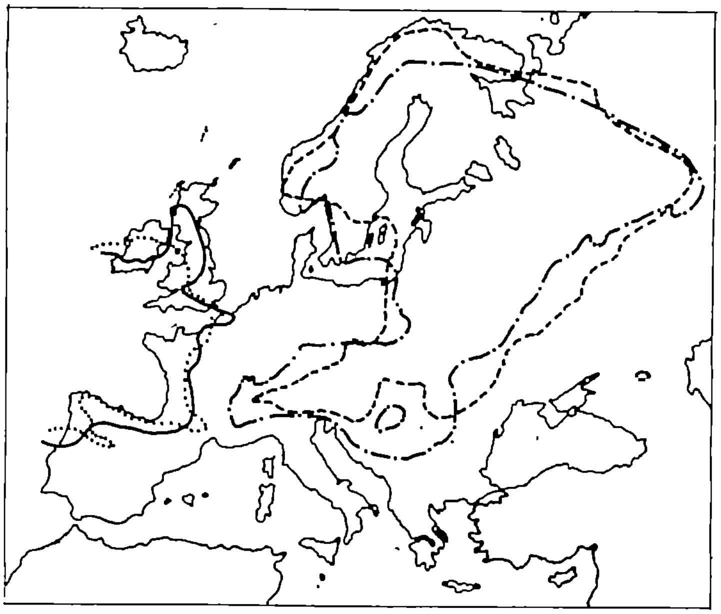

Fig. 2. *Ranunculus lenormandi.* ———, Distribution from Matthews, ref. 4, p. 130 (after Salisbury); ·······, approximate curve for $\alpha_1 = 38°$ F., $\alpha_2 = 48°$ F., $\gamma_1 = 58°$ F., $\gamma_2 = 68°$ F.
*Picea excelsa.* —·—·—, Distribution from Zander, ref. 8, p. 41 (after Hueck); - - - - -, approximate curve for $\alpha_1 = 2°$ F., $\alpha_2 = 30°$ F., $\gamma_1 = 52°$ F., $\gamma_2 = 69°$ F.

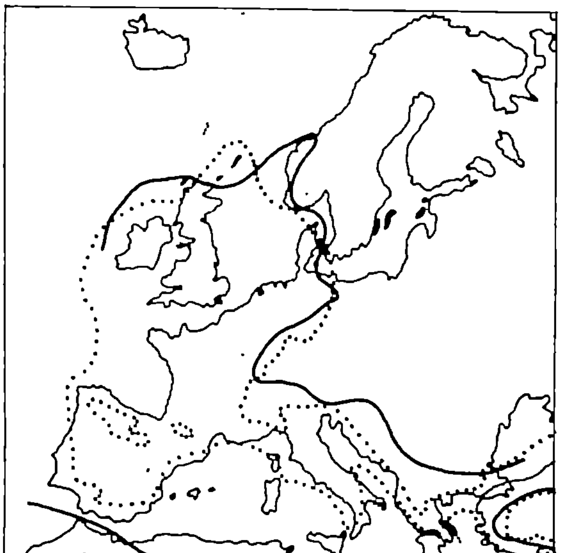

Fig. 1. *Ilex aquifolium.* ———, Distribution from Matthews, ref. 4, p. 128 (after Oltmanns); ······, approximate curve for $\alpha_1 = 30°$ F., $\alpha_2 = 44°$ F., $\gamma_1 = 54°$ F., $\gamma_2 = 86°$ F.

The more accurate plotting of these areas is now in hand, and further maps will in due course be published elsewhere.

It may be noted that this distribution is closely similar to, and in certain cases identical with, that obtained by a formula of the same form embodying a range of annual mean temperature and a range of January–July temperature differences. It can also be shown that, for the world as a whole, annual temperature-range is an approximate function of the annual precipitation ($P$), and if there had been an exact relationship between these quantities it would have followed that similar areas could have been obtained by a formula of the same sort embodying a range of annual mean temperature and a range of the function of $P$. This would have corresponded approximately with the usually accepted idea of temperature bands modified by different levels of humidity. Interesting and sometimes useful areas can be obtained in this way, but they have not generally proved so close as those obtained from temperatures alone.

I wish to thank Prof. J. R. Matthews for his interest in this work, and Dr. G. D. Morison and Prof. V. C. Wynne-Edwards for help in connexion with the literature, also Dr. D. J. Finney for mathematical advice.

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## Effect of Indian Ink on *Plasmodium berghei* Infections in Mice

INJECTIONS of indian ink, causing so-called 'blockade' of the reticulo-endothelial system, have, in the past, been classified with splenectomy and cortisone as agents calculated to lower the resistance of host animals to plasmodial infections. For example, Trager[1], working with chickens infected with *Plasmodium lophurae*, found that indian ink usually caused the development of heavy parasitæmias in the birds receiving it.

Recently, I have found[2] that cortisone does not produce higher parasitæmias in mice or hamsters infected with *P. berghei*, and this has been confirmed by Singer, who has also shown that this is equally true of splenectomy[3]. I have now found that indian ink has a strongly inhibitory effect on infections with this *Plasmodium*.

Mice were injected intraperitoneally with 0·2 ml. of a commercial indian ink, diluted with the same amount of physiological saline. This large dose was well tolerated, and was followed next day by intraperitoneal inoculation with infected citrated hamster blood. A similar number of control mice received saline followed by infected blood. Blood films were made daily and were stained with Giemsa.

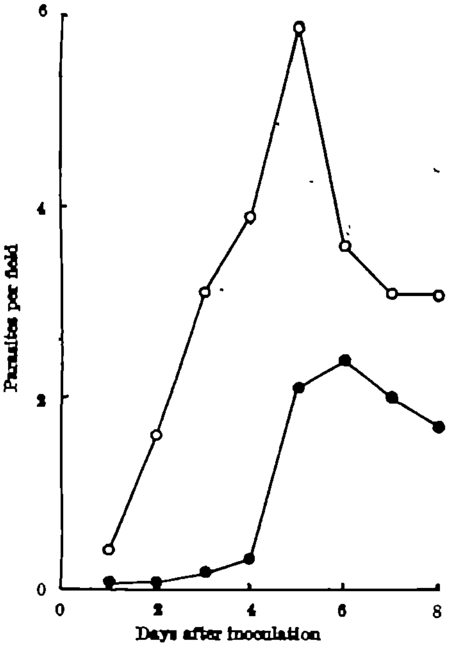

Fig. 1. Parasitæmia in mice treated with indian ink and infected with *P. berghei*. ○—○—, Average of five control mice; ●—●—, infection in one mouse, *M* 35, treated with indian ink

Of five mice treated with indian ink, one died on the day following infection, and of the others, three showed only occasional parasites throughout the eight days that the experiment lasted, while the fifth mouse had a very low parasitæmia. The infection proceeded normally in the control mice. For two or three days after the ink injections there were many polymorphonuclear leucocytes in the peripheral blood, but these soon fell to a normal level. Seven or eight days after infection, the experimental animals showed a considerable degree of anæmia, with greatly increased numbers of reticulocytes in the peripheral blood, but parasites were very rare.

Indian ink greatly stimulated the production of immature red cells, apart from its effect on the macrophages. In this experiment, the one mouse that had a low-grade parasitæmia had many reticulocytes in the peripheral blood—supposedly the preferred substrate for parasite growth—after several days, yet no great increase in parasitæmia occurred. Further investigations are needed before any definite conclusions can be drawn.

O. J. ROBERTS LOXLEY

Ross Institute of Tropical Hygiene,
London School of Hygiene and Tropical Medicine,
London, W.C.1.
May 20.

[1] Trager, W., *Amer. J. Hyg.*, 34, 141 (1941).

[2] Roberts, O. J., *Parasit.*, 44, 58 (1954).

[3] Singer, I., *J. Inf. Dis.*, 94, 159 and 164 (1954).

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## An Uncollected Record of the Great Sea-serpent

COMPILATIONS and bibliographies are double-edged weapons; though they facilitate access to some sources of information, they usually tend to intensify the concealment of others. Some two hundred reports of the sea-serpent have been collected and analysed in the works of Oudemans[1] and of Gould[2]; but the record which follows has so far escaped scientific notice. Though trivial by itself, it corroborates a number of more detailed accounts of a similar monster in the North Atlantic towards the end of the eighteenth century.

Thomas Holcroft[3] (1745–1809), in a letter written in 1799, describes an interview on board the *Kennet* (Captain Thompson). After recounting two second-hand stories of the Kraken and comparing these with Pontoppidan's versions, Holcroft continues:

"Finding this Leviathan so familiar to their belief, I next inquired if they had heard, or knew any thing of the sea-snake, by some called the sea-worm? To this question I received a still more direct answer. The Mate, Mr. Baird, who certainly was not a liar by habit, whatever mistake or credulity might make him, assured me that, about midway in a voyage to America, in the Atlantic, he had himself seen a fish, comparatively small in the body, of from forty to fifty fathoms in length; and that it had excited great terror in the Captain, who was well acquainted with those latitudes, lest it should sink the ship.

". . . and I think it a duty to collect evidence, and to remain on this question, as on many another, in a certain degree of scepticism."

DENYS W. TUCKER

British Museum (Natural History),
London, S.W.7.
June 1.

[1] Oudemans, A. C., "The Great Sea-Serpent" (Leyden and London, 1892).

[2] Gould, R. T., "The Case for the Sea-Serpent" (London, 1930); "The Loch Ness Monster" (London, 1934).

[3] Hazlitt, W., "Memoirs of the late Thomas Holcroft" (London, 1816). (The present extract taken from "The Complete Works of William Hazlitt", edit. P. P. Howe, 3, 252 (Dent, London, 1932))

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, October 10

King's College, London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. Gabriel Kron: "Tensor Analysis of Rotating Electrical Machinery". (Further Lectures on October 11, 12, 13 and 14.)

University of London (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. F. Safar (Baghdad): "Hatra—the City and its Inscriptions". (Further Lectures on October 12 and 14.)*

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. F. Danielli: "Physico-Chemical Mechanisms of Drug Action".*

University of London (in the Geology Lecture Theatre, Imperial College of Science and Technology, London, S.W.7), at 5.30 p.m.—Prof. B. Gutenberg (U.S.A.): "Low Velocity Layers". (Further Lecture on October 14.)*

## Tuesday, October 11

Zoological Society of London (in the Mappin Refreshment Pavilion, Mappin Terrace, Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

University of London (in the Hall of the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.30 p.m.—Dr. R. P. Linstead: "The Future of the Imperial College".

Society of Chemical Industry, Plastics and Polymer Group (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Physical Properties and Testing of Polymers".

University of London (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—Prof. V. G. Childe: "The Culture Sequence in Prehistoric Thrace". (First of two Lectures on "New Archæological Discoveries in Bulgaria". Further Lecture on October 18.)*

## Wednesday, October 12

University of London, School of Pharmacy (in the Beveridge Hall, Senate House, London, W.C.1), at 3 p.m.—Sir Ian Heilbron, F.R.S.: "The Chemist and Pharmacist on a Common Front" (Inaugural Address at the Opening of the 114th Session of the School of Pharmacy).

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Beno Gutenberg (U.S.A.): "The Energy of Earthquakes" (Eleventh William Smith Lecture).

Society of Chemical Industry, Corrosion Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. F. A. Champion and Mr. G. W. Walkiden: "The Composition of Sprayed Aluminium Coatings"; Mr. T. P. Hoar: "Sprayed Alloy Coatings".

Society of Chemical Industry, Food Group (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Meeting on "Factors Affecting the Choice of Food".

## Wednesday, October 12—Friday, October 14

Iron and Steel Institute (at Scunthorpe)—Special Meeting.

## Thursday, October 13

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. J. G. Capewell: "Some Episodes in the Geological History of the Lake District".*

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. J. Monod (Paris): "Specific Factors in the Biosynthesis of Enzymes".*

University of London (at Goldsmiths' College, Lewisham Way, London, S.E.14), at 5 p.m.—Prof. Sir Cyril Burt: "The Delinquent Child". (First of six Lectures on "Psychology and Education". Further Lectures on October 20, 27, November 3, 10 and 17.)*

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. J. Eric S. Thompson (Carnegie Institution of Washington): "The Rise and Fall of Maya Civilization". (First of three Special University Lectures in Anthropology. Further Lectures on October 14 and 17.)*

University of London (at Queen Elizabeth College, Campden Hill Road, London, W.8), at 5.30 p.m.—Sir Russell Brain: "Dr. Johnson and Science".

College of Preceptors (in association with the School Nature Study Union at 2 Bloomsbury Square, London, W.C.1), at 6 p.m.—Mr. H. R. Syms and Mr. A. Brownlee: "The Keeping of Animals for Observation".

## Friday, October 14

Textile Institute (at 10 Blackfriars Street, Manchester 3)—Mr. J. R. Whinfield: "Textiles and the Inventive Spirit" (Fifth Emsley Lecture).

British Mycological Society (in the Physics Lecture Theatre, Birkbeck College, Malet Street, London, W.C.1), at 11 a.m.—Meeting on "Diseases of Fruit and Hops".

Society of Chemical Industry, Microbiology Group (at th National College of Food Technology, Cranwood Street, Londo E.C.1), at 4 p.m.—Demonstration Meeting—"Some of the Mor Recent Techniques and Apparatus used in Microbiology".

North East Coast Institution of Engineers and Shipbuilder (in the Lecture Theatre of the Literary and Philosophical Society Newcastle-upon-Tyne), at 6.15 p.m.—Commander J. R. H. Bul R.N.: "Impact of the Development of Atomic and Thermonuclea Weapons on the Royal Navy".

## Saturday, October 15

Association of School Natural History Societies (in th Lecture Hall, British Museum (Natural History), Cromwell Road London, S.W.7), at 11 a.m.—Annual Exhibition.*

British Psychological Society (in the Gustave Tuck Theatr University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. J. S. Bruner (Harvard University): "Strategies in Thinking".

# APPOINTMENTS VACANT

Applications are invited for the following appointments on o before the dates mentioned:

Senior Lecturer (graduate) in the Department of Mathematic—Registrar, College of Technology and Commerce, The Newarke Leicester (October 12).

Lecturer in Anatomy—The Warden and Secretary, Royal Fre Hospital School of Medicine, 8 Hunter Street, London, W.C.1 (October 14).

Assistant Experimental Officer (with a pass degree or at leas general certificate of education (advanced level) in the Plan Pathology Section—The Secretary, National Vegetable Researc Station, Wellesbourne, Warwick (October 17).

Senior Lecturer (or Lecturer) in Mathematics—The Cler to the Governors, Chelsea Polytechnic, Manresa Road, London S.W.3 (October 19).

Head of the Mechanical Engineering Department; Hea of the Electrical Engineering Department; Head of the Physic Department; Senior Lecturer in Mechanical Engineering; and a Senior Lecturer in Chemistry—The Principal, College of Technology, Belfast, N. Ireland (October 21).

Assistant Biochemist (basic grade) (with a B.Sc. degree wit honours in chemistry or biochemistry, or an equivalent qualification—The Group Secretary, Royal Hospital, Wolverhampton.

Assistant (preferably with some special knowledge of histology in the Department of Physiology—The Secretary, The University, Edinburgh.

Lecturer (with an honours degree in electrical engineering or i physics (and/or a Chartered Electrical Engineer) and with industria experience in electronics or telecommunications) in Electrica Engineering—The Principal, North-West Kent College of Technology, Dartford, Kent

Research Assistant (with a good honours degree in geology, preferably with emphasis on mineralogy, petrology, or structural geology) in the Department of Geology—Prof. J. C. Brindley Department of Geology, University College, Science Buildings, Uppe Merrion Street, Dublin.

Research Entomologist, Senior Scientific Officer or Scientifi Officer grade (with an honours degree in biology and at least tw years postgraduate training or approved experience in scientifi research, with specialization in entomology and preferably wit statistical training or interest in statistics) at the West Africa Institute for Trypanosomiasis Research, for duties primarily in connexion with research upon the behaviour, breeding and longevity of the tsetse fly—Director of Recruitment, Colonial Office, Sanctuar Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/198/04

Scientific Assistant (with a science degree, a good reading knowledge of two European languages (of which one should preferably b other than French or German) and ability to write good English) fo work in scientific information service involving abstracting and indexing—The Director, Commonwealth Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts.

Scientific Officer (with first- or second-class honours degree in biological science, preferably with training or experience in microbiology), to assist in studies on alimentary microflora of farm animals—Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

Scientific Officer (with first- or second-class honours degree in mathematics, physics or electrical engineering or equivalent qualification) for the Air Ministry in London, Maidenhead, Berkshire and Norfolk, for operational research duties, theoretical studies and development work in the field of communications and general electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.113/5A.

Scientific Officers (with first- or second-class honours degree in mathematics or physical sciences or equivalent qualification) at the National Physical Laboratory, Teddington, for work in physics (including radiology), mathematics and electric computers (Ref. A.338/5A), and metallurgical chemistry (Ref. F.449/5A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

Senior Entomologist at the Glasshouse Crops Research Institute—The Secretary, Glasshouse Crops Research Institute, Rustington, Littlehampton, Sussex.

Senior Experimental Officer (with G.C.E., advanced level in science subjects, or equivalent qualifications) to take charge of the Technical Records Section at Dounreay Works, Caithness—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, Lancashire, quoting 1113.

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[illegible]

# THE PURPOSE OF UNIVERSITY EDUCATION

ALTHOUGH the importance of general education, and particularly of securing more breadth in raining the scientist, or indeed any type of specialist, was emphasized at least as much at the Conference of Rectors and Vice-Chancellors of European Universities last July in Cambridge as at the subsequent meeting of the British Association at Bristol, there seems to have been little progress in suggesting means of securing it. The Cambridge Conference, indeed, noted a progressive deterioration of the balance which should exist in the universities between specialization and general culture, and a report presented to the Conference urged a stand against the current inflation of the curriculum. There was, however, little support for a preliminary year of compulsory studies of general cultural subjects, or for any system which obliged arts students to study a scientific subject and science students an arts subject for much of their university career.

At this Conference the means generally favoured were optional courses in subjects of general cultural interest, which could be taken without a subsequent examination, or a general course designed more specifically to prepare the student for his specialized courses. It was also recognized that it is desirable to deepen the student's understanding of his own special subject in the context of a wider background. This method appeared to be regarded as the most promising means of restoring the traditional balance between specialization and general culture; but the discussions seemed to lack either real unity or the note of urgency which Dr. J. Bronowski contrived to bring into his address at Bristol and Dr. Eric James into his lecture to the Science Masters' Association on "Science and Citizenship".

Perhaps more notable was the absence of any suggestion that the proper place in which breadth and general education should be acquired is in the schools. This might have been even more regrettable but for the appearance in the following month of the report of the sub-committee appointed two years ago by the Committee of Vice-Chancellors and Principals to consider and make recommendations in regard to university entrance requirements in Britain. It is clear from this report that, except for recommending that only two subjects should be required at the Advanced level of the General Certificate of Education instead of three, there is little unanimity on matters of importance to sixth-form school and first-year university teaching. Agreement on this point was indeed reached at the outset of the six meetings of the sub-committee concerned; and while the sub-committee agrees that it may be desirable to continue to require three passes at the Advanced level on the science side, the report gives little indication of the reasons for a recommendation which admittedly makes real education very difficult or even impossible for the science student. The report is, on the contrary, mainly concerned with the reasons for the divergence of views, which have produced two minority reports.

One side maintains essentially that the present requirement of prescribed subjects should be maintained, and that unless this is done the curriculum at many schools will be narrowed to subjects which are clearly utilitarian and directly vocational. It is argued that it is unrealistic to say that the schools should take full responsibility for the general education of their pupils. On the other side, it is contended that, on the contrary, no number of passes at the Ordinary level ensures the standard of general education that university teachers desire their students to possess and that, while universities and schools have a common interest in promoting a broad and liberal education side by side with appropriate specialized studies, the responsibility for general education must be taken by the schools alone.

The poor reception of this report may well be due in part to the lack of urgency and realism which seems to have characterized its proceedings. If its members had been really convinced of the importance of general education, either for the specialist or the ordinary citizen, it is difficult to believe that such relatively small points could have kept the two sides apart. There is lacking, for example, the conviction which marked the addresses of Mr. J. F. Wolfenden and of Dr. Bronowski at Bristol, or the contributions of Sir Philip Morris, Prof. N. F. Mott, Prof. F. A. Vick and Dr. A. W. Barton to the joint discussion between Sections A and L on the training of physicists (see *Nature*, October 7, p. 678). The means will be discovered when it is believed that the end really matters; and if the universities are really interested in discovering the state of the general education of their students at the time of admission, they will not be prevented from ascertaining that state even if it is necessary to devise an entirely fresh means of doing so. Mr. T. W. Holland, headmaster of Reigate Grammar School, has suggested the institution of a general paper which would ensure that the student had read widely and to some purpose, that he had gone deeply into the history and geography of another country and that he was not "scientifically illiterate".

It is clear from the report that some members at least of the sub-committee lean towards such an idea, and the discussion at Bristol on the training of physicists indicated a far greater disposition to re-examine the underlying issues, both by schools and by universities, than is apparent from the sub-committee's report. Sir Philip Morris, for example, opening the discussion, took for granted much that Mr. Wolfenden had emphasized as to the necessity of a fully educated man possessing both the deep insight into human nature that is most conveniently and comprehensively acquired from the written and printed record, and the first-hand personal experience of human actions to be gained from deep and practical immersion in human affairs, personal, social and political. He agreed, too, as to the importance of the non-scientist having some understanding of the scientist's outlook on the physical universe; indeed, as

Mr. Wolfenden had put it, in our present civilization the view that more is required than just the human without the scientific, or just the scientific without the human, was not seriously challenged in the discussion that followed.

Sir Philip Morris posed some searching questions: Should science be taught in the secondary school as separate subjects? Do scientists value the acquisition by the general citizen of an understanding of the scientific outlook sufficiently to support the diversion of effort to that end from the acquisition of new knowledge? Is the structure of postgraduate education adequate or does it, too, require re-examination? Are we relying too much on research as a means of postgraduate training and education?

A noteworthy feature of the discussion at Bristol was the evidence it provided of a readiness to re-examine first principles, to experiment with new methods and to make drastic changes if required. Prof. Mott and Prof. Vick were as ready as Sir Philip Morris not merely to ask searching and leading questions, but also to seize opportunities of experimenting with new ways. They recognize the importance of close and new ways of co-operation between school and university and realize that suggestions thrown out must be put to the test—for example, that of Prof. Mott for allowing a general paper to play a major part in determining the award of scholarships. While Prof. Mott was emphatic that general education is the responsibility of the school, and in particular that it is essential for the sixth-form scientist, there appeared to be little difference between his point of view and that of Dr. A. W. Barton, who described some of his attempts at the City of London School to assist boys to make a wise choice of their sixth-form courses. Prof. Mott believes that it is desirable that the decision to read science should be made as late as possible in a boy's time at school; and this is quite consistent with Dr. Barton's claim that the sixth-former intending to read science should be allowed to spend a major part of his time on science, for Dr. Barton's plea was based on the assumption that adequate time had previously been given to general education. Furthermore, Dr. Barton argued that the school's function is to stimulate curiosity, to develop the critical faculty and impart some understanding of the scientific attitude and method.

If this is achieved, the ordinary sixth-former should acquire exactly the basis for his general education that he needs as a citizen of this modern world, whether he follows a scientific career or not. Moreover, he will also acquire very largely the broad and general education that Prof. Mott requires as a basis for a university course. Dr. Barton's ideas, moreover, lend some support to the view argued most eloquently by Prof. Vick that it is possible to build around physics as a major component an education for future Civil servants, politicians and industrialists as deeply and widely stimulating as that provided by the 'Greats' or 'Modern Greats' of Oxford. Prof. Vick maintained that in this way we could develop, for example, intellectual courage and honesty, the ability to assess a situation, to think logically and quantitatively, and to handle abstract ideas as well as impart some understanding of the meaning of scientific proof and recognition of the limitations of science. He was as confident of the practicability of working out such courses as Prof. Mott was that the general education for the sixth-form scientist is a matter of fitting the wider studies into the curriculum and making the reward for working at them sufficiently attractive.

There is thus much more reason than the report on University Entrance Requirements itself implies for believing that the schools and the universities of Britain are ready to come together in this matter, and to contemplate even drastic changes if necessary. The addresses and discussions at Bristol have made clear to a wider audience that the educated man to-day—and even more in the next two or three decades—must have a clear understanding of the outlook and method of science. The non-scientist must possess a framework into which to fit new knowledge, a vocabulary with which to handle it, standards by which to test and to tell genuine knowledge from nonsense, just as the scientist must possess an understanding of human issues and human experience. To insist that science must become part of our culture is not indeed to argue that the scientist should have the deciding voice in local, national or international affairs: it is simply to maintain that his training must qualify him to make perfectly clear to his fellow-citizens, at all stages and at all relevant points, what will be the consequences, in scientific terms, of any decisions which are contemplated, and equally that those fellow-citizens receive an education which enables them to understand what the scientist is saying.

The educated man must thus, as Mr. Wolfenden contended, be able to move with some facility in at least two spheres. He must be able to appreciate in something like perspective the achievements of the human race, in government, literature, art and social living, and, secondly, he must be able to move with some facility in the realm of abstract ideas. It does not matter which field he finds most congenial; but Mr. Wolfenden is clearly right in holding that we should seek not to give the same kind of education to all but, recognizing the differences between people, to educate them rather according to their ability, age and aptitude.

To do this might go far to assist in the adjustments that will be called for if we are to provide, not merely the educated men and women that will be required in industry and in the government service and for the continuous acquisition and application of new knowledge, but also the ordinary citizens who are capable of taking intelligent decisions in the many affairs of local or national politics in which scientific and technical issues are involved. Those adjustments, moreover, are unlikely to be made unless the objective is recognized as fully worth while, and education is seen as an inter-related whole. Qualitatively as well as quantitatively, the provision to be made for the education of the scholar and the scientist must be considered in relation to that made for the training of the administrator and man of affairs, the technologist, the technician and the ordinary citizen whose formal education terminates at secondary school level.

What does seem to be emerging from current discussions is the recognition of the possibility that available resources may be utilized to the best advantage if there is a more general disposition to consider the wider perspective and less tendency to push sectional claims to extremes. Those who insist most strongly on the importance of a general education for the scientific specialist, or of some understanding of the outlook and achievements of science on the part of those not entering on a scientific career, are not advocating any relaxation of university standards. They are, on the contrary, suggesting that university practice and standards should be adjusted to take closer account of the advances in human thought and experience which science has made possible. It is not enough for the teaching of specific disciplines like physics and chemistry to take account of the immense advances in their own fields. The technique of teaching itself requires adjustment, and the scope of university work must have regard both to the changes in the schools and in the level of education of the adult population. Extra-mural activities like adult education need reviewing in relation to the purpose and the resources of the universities, and in relation to the impact on adult education of such new media for the communication of ideas as broadcasting and television.

This is not to suggest that the universities bear the sole or even the primary responsibility for adult education, for example. Their responsibilities in that field can be neither defined nor discharged without the co-operation and support of other bodies, or without regard to what, for example, professional institutions and local authorities are doing, any more than they can fulfil their functions in regard to the general education of their students without regard to what the schools are doing or without close co-operation with the schools. Such co-operation will become the easier and closer when we have clear ideas both of the functions which the different institutions can best fulfil and their relation to the whole task of producing an educated community. The university must indeed always bear a major responsibility in that task; but its part may be more easily seen and the more effectively played if there is kept in mind the whole ideal of the university as a community of masters and scholars in pursuit of knowledge and learning, who also form a community of men and women living together and seeking the truth, and that not in their own narrow subject alone. When we regard the university, on the contrary, as merely a scholar's workshop and laboratory, a place for students to study, teachers to teach, and the investigator to carry out research, it fails to bring to its members or to the whole community the full service and inspiration that lie within its power. The nature of the university's contribution to the training of men and women to serve the community, to the equipment of the adult citizen to meet the needs of the modern world, may well need re-examination, and also the methods used to make that contribution; but it is above all essential that we should keep in mind that supreme function of the university as a community dedicated to the search for truth and the fearless communication of ideas.

In this sense the universities can never abdicate their responsibilities for leadership in the community without endangering their own existence. It is not simply that the community looks to them to give some broad indication of the implications for human thought and living of advances in knowledge and changing technologies—of the consequences, for example, of nuclear weapons or of the development of nuclear power and the spread of television. The community needs centres of independent thought and criticism, in which the value of international interchange of thought is clearly demonstrated, just as much as it needs institutions to provide it with the fully trained and really educated men and women capable of handling alike the scientific and technical problems of government and industry and the human and social issues that are also involved, and to provide the new knowledge upon which the advance of science and technology depends. It needs chiefly, however, men and women who are both able to draw imaginatively on past human experience, and are no less competent to face the future with vision, with understanding and courage, and to fashion and create the new institutions and new loyalties that changing needs demand. If that is to be done, the creative thinking and experiment must begin within the university itself. Testing and re-shaping where necessary its own methods and institutions—but safeguarding and upholding the highest standards and traditions of university life and work—the university must seek to further the mutual understanding with the society outside its walls which is essential both to the health and sanity of society and to the continuance of the external support upon which the university itself depends.

# PLANT ANATOMY RESEARCHES OF I. W. BAILEY

**Contributions to Plant Anatomy.**

By Prof. Irving W. Bailey. Pp. xxvi + 262 + 23 plates. (Waltham, Mass.: Chronica Botanica Company, 1954.) 7.50 dollars.

THIS volume includes reprints of a few of Prof. I. W. Bailey's papers, selected mainly to illustrate how techniques from other sciences have been adapted to botanical problems and to direct attention to the value of collaboration between the sciences. After a childhood in Peru, Bailey entered Harvard, where he became instructor in forestry in 1909 and professor of anatomy in 1927. In later years his width of experience made him an invaluable adviser in forestry research and an ideal director of the reorganization of Harvard's botanical resources.

Throughout Bailey's work the problem of the origin and evolution of the Angiosperms was much in his mind and provides the link between such diverse aspects of his work as wood anatomy, floral morphology and palæobotany. To my mind his most important researches were those on the cambium, and it is striking how many of the basic facts in botanical teaching owe their confirmation to his work. The cambium is a difficult tissue to handle, and the success of Bailey and his collaborators in solving outstanding problems is largely due to excellence of technique; it is one point to regret that he has never, to my knowledge, found it possible to give a full and precise account of his cambial techniques. The soundness of his work on the cambium is convincing, and his conclusions have stood the test of time. He was the first to establish the uninucleate condition of the long fusiform initials of the cambium in *Pinus* and to show that the same nuclear volume controls the cytoplasm of ray and fusiform initials, although the volume of the latter may be 500–1,000 times greater. The description of mitosis in pine fusiform initials is one of the most spectacular in botany, while the application of a modified vacuome technique enabled Bailey and Zirkle to demonstrate the highly vacuolated condition of these remarkable meristem cells.

A problem of tree growth which had long exercised the minds of botanists was the method of increase in number of fusiform initials in the widening cambial periphery; the precision of Bailey's technique and a comparison of a wide range of types enabled him to state that in Gymnosperms and many of the less-specialized Dicotyledons the increase is brought about by occasional, relatively transverse divisions and the elongation past one another of the products, while in the most specialized types radial longitudinal divisions occur. These studies occupied the period 1919–30; but some of Bailey's later papers on wood show his phylogenetic interests, as, for example, the consideration of the ways in which vessels have originated in Tracheophyta, with the conclusion that they have arisen independently five times, including different origins in Dicotyledons and Monocotyledons. Close study of wood anatomy in some living Gymnosperms directed attention to the importance of precise information on variability for comparison with fossil types.

Between 1934 and 1939 Bailey turned his attention to chemical and physical methods for the investigation of cell walls, collaborating with Kerr, Vestal and Berkley in different aspects of the work. Again, some of the results have become basic in teaching, such as the properties and non-cellulosic nature of the middle lamella and the distribution of lignin in the secondary wall in the interstices of the cellulosic matrix. In X-ray studies he was one of the first to elucidate some of the aspects of the structure of cellulose walls.

In floral morphology the development of clearing techniques facilitated study, and the extremely interesting type of stamen and carpel in the previously undescribed *Degeneria*, along with studies of the carpels of Winteraceae and related types, will attract carpel morphologists. On a different line, the study of myrmecophytic species of *Cecropia* provided interesting facts about feeding habits of Attine ants and led to an assessment of Schimper's teleologically based theory of myrmecophily.

A review of this book cannot omit reference to the most attractive sectional title pages, head pieces and vignettes. Inspired by Bailey's papers, Prof. B. G. L. Swamy has illustrated in this form some of the main evolutionary trends and topics discussed. Special reference must be made to the last vignette, which illustrates the evolution of tracheal elements in the form of a 'herb' diagram derived from a motif common in paintings of the Mogul School. The use of the pattern of the cross-section of the wood of a coniferous root for the cover lining is most appropriate.

This is an unusual book which should certainly find a place on botanical shelves as a guide to the work and scientific approach of one of America's greatest botanists. The volume contains a full list of Bailey's publications, and the frontispiece shows a characteristic photograph of the author.

L. I. SCOTT

# X-RAY DIFFRACTION IN PHYSICAL AND CHEMICAL LABORATORIES

## X-ray Diffraction by Polycrystalline Materials

Edited by H. S. Peiser, H. P. Rooksby and Dr. A. J. C. Wilson. (Physics in Industry.) Pp. 725. (London: Institute of Physics, 1955.) 63*s*.

THIS work recently published by the Institute of Physics will certainly come to be one of the most-used volumes in X-ray laboratories. It is written for 'diffractionists'—that is, those who work with X-rays as a tool for studying the physics and chemistry of solids but not for determining structures.

It is not at all a text-book, but one for workers in the laboratory. It can only be appreciated and properly used by a man of science having already a good grounding in crystallography and in the theory of X-ray diffraction. The arguments recapitulated in the first chapter will clarify the uncertainties of a beginner but do not pretend to introduce him to the subject of crystallography.

The aim of the authors has been to outline the methods actually in use in the study of crystalline powders. First place is given to descriptions of apparatus and techniques—above all, the most recent ones. Those who may be unhappy about their own collection of literature references need no longer worry: the authors have given them all the references that may be missing and, what is best of all, a summary, both brief and clear, of all the important works which have appeared during the past twenty years. It is a remarkable feat to have presented this considerable documentation in such an attractive manner and so well laid out. For example, if a scientist has to make a study of structures at high temperatures, he can find the method that is best suited to his needs and the original references which will give him the details for the construction of apparatus.

Certain chapters are original monographs—for example, those on counters, microbeams, diagrams of organic fibres, etc. The chapters of the last part of the book, on some applications, are particularly welcome: they appear to contain the essence of many investigations. Against this must be set the fact that certain points remain but slightly developed, despite the interest they have for those concerned with the physics of the solid state: such topics are the analysis of the shape of the lines from distorted crystals, and the determination of the parameters of order in solid solutions. It must be admitted, however, that mention is made of the study of the single crystals, and it is difficult to reproach as being incomplete a book which already runs to more than seven hundred pages.

The book is the collective work of some thirty authors. Thus each topic is dealt with by a specialist, and each author's personal experience of his subject explains the lively approach of the work. All annoying heterogeneity has been completely smoothed out by the three editors: Dr. H. Rooksby, on techniques; Dr. A. J. C. Wilson, on methods of interpretation; and Dr. H. S. Peiser, on applications. All the authors are British, and to me as a Frenchman this shows how numerous in Britain is the school of X-ray crystallographers continuing brilliantly the work of their teachers who founded this science.

A. Guinier

## ERASMUS DARWIN

The Temple of Nature; or, the Origin of Society
A Poem, with Philosophical Notes. By Erasmus Darwin. (In Russian.) Pp. 239 + 6 plates. (Moskva: Izdatelstvo Akademii Nauk SSSR., 1954.) 12 roubles, 80 kopecks.

It may be that the great admiration felt for Charles Darwin in the U.S.S.R. induced the Academy of Sciences to re-publish the Russian translation of this poem of his grandfather. "The Temple of Nature", by Erasmus Darwin, was originally published in 1803, a year after his death. The original Russian translation of this poem was published in 1911 in the *Journal* of the Ministry of Education in St. Petersburg. The translator, N. A. Kholodkovsky (1858–1921), was rather a remarkable man—a professor of zoology, a poet and a gifted translator of Milton, Shakespeare, Byron and Goethe.

"The Temple of Nature" is probably less known than "The Botanic Garden" by the same author. It is a didactic-scientific poem written in pseudo-classical style in heroic couplets. It is not a major poetic work, but it is not without certain charm and is full of humour, much of it clearly unconscious. Here is a fragment of it, chosen at random:

> "In earth, sea, air, around, below, above,
> Life's subtle woof in Nature's loom is wove;
> Points glued to points a living line extends,
> Touch'd by some goad approach the bending ends;
> Rings join to rings, and irritated tubes
> Clasp with young lips the nutrient globes or cubes;
> And urged by appetencies new select,
> Imbibe, retain, digest, secrete, eject."

The translator really did a wonderful job not only in bringing out the full meaning of the poem but also in preserving the style, rhyming sequence and metre of the original. To do this he had to expand the original 1,928 lines into 2,247 lines.

In addition to the full text of the poem, the volume contains Charles Darwin's life of his grandfather in translation, two sets of notes by Erasmus Darwin, also in translation, one set by the translator and one set by the editor, who also provides a biographical sketch of the translator. There are two portraits of Erasmus Darwin, one of the translator and other illustrations.

The book is carefully edited by E. N. Pavlovsky, director of the Zoological Institute of the Academy of Sciences in Leningrad, a significant fact especially when it is realized that the translator, N. A. Kholodkovsky, was also a prominent zoologist.

The poem is an expression of Darwin's scientific views on the origin and development of life, the evolution of the mind and the growth of society. Like his "Botanic Garden", this poem is an invaluable record of scientific thought at the end of the eighteenth century. The publication of the Russian translation of this is not intended as a homage to a minor English poet, but as an important contribution to the ever-growing Russian literature relating to the history of science.

S. I. Tomkeieff

## SYSTEMATIC ZOOLOGY

Methods and Principles of Systematic Zoology
By Ernst Mayr, Prof. E. Gorton Linsley, and Prof. Robert L. Usinger. (McGraw-Hill Publications in the Zoological Sciences.) Pp. ix + 328. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 51s.

Novelty usually brings rapid developments in a science followed by a spate, sometimes superabundant, of text-books and treatises. The novelty of the new systematics is, however, unspectacular either in methods or results, and development in taxonomy has been correspondingly slow, with the need for a comprehensive treatise growing equally slowly. The need has, however, been very acute for many years, and zoologists can count themselves fortunate that it has now been satisfied in proportion to its intensity. The three authors have brought to the task not merely the essential knowledge but also breadth of understanding and an ability for lucid and logical exposition.

The book, "a concise presentation of the methods and principles of zoological classification", is subdivided into three parts, of which the first, and shortest, deals with the history of taxonomy and proceeds logically to consider changed concepts and the status of the hierarchical categories. Part 2, taxonomic procedure, is a step-by-step guide from advice on the selection of the problem and assembling the pertinent material and information, to the preparation of the paper describing the results, selecting its title and seeing it through the press. Much of this part is, of course, elementary; but much that is complex is made to seem elementary, not by over-simplification but by clear thinking and presentation. The phenomena the taxonomist will, or may, encounter and the methods he will, or ought to, use for dealing with them are themselves treated in taxonomic fashion and grouped in logical categories. It is a sorry comment on human frailty that nomenclature, which should be merely the handmaiden of zoologists, has so beguiled some and bedevilled others that the section dealing with it needs the equivalent of a quarter of the whole book. But that is not the fault of the book, nor of its authors, and students will find the section very useful even though the important Copenhagen Decisions (1953) were not available in time for inclusion.

"Methods and Principles" is an essential text-book for all students of evolution and taxonomy and a valuable reference book for practising systematists however experienced they may be. Much of it should be read by any zoologist who would claim to have a broad and liberal understanding of his subject. There are, naturally, some expressions of opinion that are controversial, but errors are notably few and generally insignificant. The authors will therefore find it especially galling that the statistical section, which the non-mathematically minded may follow blindly, contains a slip; the numerical value of the standard error of the difference between means (p. 142) is not an index of significance.

H. W. Parker

# THE INTERNATIONAL WOOL TEXTILE RESEARCH CONFERENCE, AUSTRALIA, 1955

WOOL is a most versatile fibre, and many facets of interest to scientists and those concerned with its growth and processing were examined at the Wool Textile Research Conference, held successively at Sydney, Geelong and Melbourne, under the chairmanship of Dr. F. W. G. White, during August 22–September 9. The Conference was promoted, with much foresight and imagination, by the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) to mark the expansion of research into the wool textile field in Australia. Never before had so many wool scientists and technologists assembled together from many countries of the world. The excellent planning and organization of the many sessions held for the presentation and discussion of papers (some 140 or so in number) ensured the success of the Conference, despite the wide range of scientific investigations that the Conference encompassed.

Many of the fifty-three overseas delegates, from Great Britain, the United States, France, Sweden, Germany, Japan, India, South Africa, Canada and New Zealand, attended by invitation of the Australian Government, and all would wish to express their appreciation of the hospitality received from both organizations and private individuals during this memorable occasion.

In addition to the scientific sessions, tours of the Sydney–Geelong region were organized so that delegates could learn at first hand of wool-growing, pastoral improvement, and irrigation in Australia.

Wool research under the Commonwealth Scientific and Industrial Research Organization has rapidly expanded in recent years, chemistry and biochemistry being directed by Dr. F. G. Lennox at Melbourne, physics and engineering by Dr. Burgmann at Sydney and technical development by Dr. M. Lipson at Geelong; reference should also be made to the McMaster Animal Health Laboratory at Glebe, Sydney, the Sheep Biology Laboratory at Prospect, the Animal Health Research Laboratory at Parkville, and other stations of the Organization and university departments. Some hundred delegates attended from these institutes. The overseas visitors were able to see the work in progress, which included amino-acid and peptide analysis, the study of crimp and other physical properties of fibres, and a new approach to solvent-scouring of wool. Australian workers contributed more than fifty papers, while those from abroad included twenty from the Wool Industries Research Association of Torridon, Leeds, eighteen from the University of Leeds, nine from other delegates from Britain, thirteen from the United States, and twenty-three from other countries.

Several lectures, some to the delegates and scientific observers from universities and research centres and others open to the general public, were given during the Conference period. The public lectures each attracted an audience of five to six hundred, and this, together with other evidence, clearly indicated the public recognition of the contribution of the Commonwealth Scientific and Industrial Research Organization to the service of the community. The inaugural lecture at the Conference was given by Prof. W. T. Astbury, of the University of Leeds, who, in his own inimitable style, showed how early work on the structure of keratin fibres and materials had stimulated much of present-day thought and research on proteins. Dr. E. G. Carter, of the International Wool Secretariat, gave an excellent account of the part played by science in the study and use of wool to a large public audience at the University of Melbourne. Perhaps the most stimulating lectures, however, were those given by Prof. Robert B. Corey, Dr. F. Sanger and Prof. Emil L. Smith. Many of the overseas delegates had previously heard lectures from these investigators, but it is certain that even these delegates were again thrilled to hear a first-hand account of the masterly researches of Corey and Pauling on the configuration of the proteins, of Sanger on the structure of insulin, and of Smith on structure determinations of papain. Everyone present appreciated the significance of Sanger's statement that the molecular weight of insulin is 5733.

In addition to these Conference lectures, many delegates addressed local societies and other groups interested in scientific and technical advances in the use of wool. There was, in fact, a wide exchange of opinions and information and there is little doubt that many opportunities were taken to co-ordinate research between different countries.

It is impossible within reasonable space to give a detailed account of all the papers presented at the Conference; but a useful purpose will be served by giving, for each of the main sciences, the outstanding features, with special reference to new work, that were made available either by a single paper or by a group of contributions. Some idea of the amount of material made available to the Conference will be gained by the anticipated size of the Conference Proceedings, to be published in the near future, namely, more than 2,000 pages that will occupy five or six volumes.

## Chemistry

In the chemical studies, the emphasis was understandably on proteins. Dr. F. Sanger (University of Cambridge), in addition to describing the investigations carried out by his team of research workers on the distribution of the cystine residues in insulin, with special reference to the cyclic structure formed by intramolecular dithio linking, discussed cysteic acid peptides formed by oxidation and subsequent partial hydrolysis of wool; paper ionophoresis under high voltage indicates a very complex mixture in which serine– and glutamic acid–cysteic acid peptides predominate. Researches on the enzyme papain, parallel in many ways with those of Sanger and co-workers on insulin, were reported by Prof. Emil Smith. The crystalline protein and also its mercuric derivative have been studied and much of the amino-acid sequence has been elucidated. One interesting feature of this work is that, of the eight sulphur atoms present in the molecule, only six can be accounted for as cystine or cysteine and, in this connexion, it should be noted that in wool only 85–86 per cent of the total sulphur appears to be present as cystine–sulphur, due, according to Dr.

D. H. Simmonds (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne), to the presence of 14–15 per cent of elementary sulphur. This latter finding was reported in a paper by Simmonds in which were given complete amino-acid analyses for four samples of wool fibre.

The availability of a complete amino-acid analysis for wool would mark the end of the first stage in the study of the keratin molecule. Unfortunately, there are several problems to be resolved with regard to the data available. Simmonds's data agree reasonably well with those of Dr. A. Robson and M. C. Corfield (Wool Industries Research Association, Leeds), which were also reported to the Conference; but there are differences in the values for certain of the amino-acids that appear to be outside the tolerance of accuracy of the analytical methods used. In addition, the content of some amino-acids clearly differs with different wools; this is undoubtedly true of cystine and tyrosine, and possibly occurs with phenylalanine, glycine, aspartic acid and threonine. The data available account for 96 per cent (Simmonds) to 99 per cent (Robson and Corfield) of the total nitrogen, and hence the unknown sulphur fraction must exist as elementary sulphur—a theory not readily acceptable to most protein chemists—or to the presence of a polysulphide group in place of the cystine–dithio linkage.

Many papers were concerned with the constitution of the keratin molecule. Dr. S. Blackburn and G. R. Lee (Wool Industries Research Association, Leeds) reported that the method of hydrazinolysis of Akabori *et al.* shows glycine, alanine, serine and threonine to be carboxyl terminal groups in intact wool. Most workers in this field, however, are concerned with the obvious heterogeneity of the wool fibre and have attempted to separate, either from the whole fibre or some histological fraction, for example, cortical cells, a soluble protein or protein degradation product. Experiments in this direction, carried out by means of thioglycollic acid, were described by Dr. F. G. Lennox and by J. M. Gillespie (both of the C.S.I.R.O. Wool Textile Research Laboratory, Melbourne), while Dr. P. Alexander and Dr. L. F. Smith (Chester Beatty Research Institute, London) claimed that oxidative fission, achieved by peracetic acid followed by extraction with aqueous ammonia, affords products of a lower degree of peptide-chain degradation. I. J. O'Donnell and E. F. Woods (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne) reported a comparison between the reductive and oxidative methods, and Dr. B. S. Harrap (of the same Laboratory) examined some of these preparations for molecular weight by the spreading monolayer technique; for α-keratose he obtains values ranging from 7,500 to 70,000 depending on the *p*H and ionic strength of the solvent. Prof. H. Zahn and J. Meienhofer (University of Heidelberg) obtained products, which they call wool gelatin, by extraction of wool with cold water; but there is some doubt as to the wool keratin being the direct source of their material. The bearing of the nature of soluble protein material from wool on the regeneration of wool fibres was discussed by Dr. F. Happey (Bradford Technical College).

Much attention was given to the reactivity of the disulphide bonds in proteins and peptides. Alkaline treatment of wool results in formation of lanthionine, and this reaction was discussed by Prof. A. Schöberl and Annemarie Wagner (Veterinary School, Hamburg), by Prof. H. Zahn, and by Dr. S. Blackburn and G. R. Lee (Wool Industries Research Association, Leeds); these workers described a method for the determination of lanthionine based on the spectral absorption of the ninhydrin colour, whereas Dr. E. O. P. Thompson (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne) resorted to bromine oxidation. The separation of the diastereoisomerides of lanthionine was described by Schöberl and Wagner and by Blackburn and Lee. The mechanism of the formation of lanthionine and the preparation and properties of derivatives of lanthionine were given in papers by Zahn and by Dr. J. M. Swan and co-workers (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne).

The attention that has been given to the extraction products of high molecular weight and to the products of partial hydrolysis was reflected in the papers devoted to their separation. Thus Dr. R. L. M. Synge (Rowett Research Institute, Aberdeen) discussed the separation of larger peptides and advanced considerations that merit serious study, while the paper by Dr. A. J. P. Martin (National Institute for Medical Research, London) on the partition chromatography of proteins was a valuable contribution to this subject; in this connexion, Dr. Sanger recommended the use of paper ionophoresis at high voltages for use with peptides.

A fuller utilization of wool has been developed by chemical treatment of the fibre; this was shown by papers on this subject, especially those by Prof. J. B. Speakman and his co-workers of the University of Leeds, who gave a series of papers describing investigations on the chemical mechanism of permanent set, on cross-linking by the use of formaldehyde and of ninhydrin, and on the setting of stained fibres at low temperatures. Prof. Zahn, in a lecture to the Conference, described the use of mono- and bi-functional cross-linking agents and their effect on the resistance of the fibre to degradative processes, and a paper by J. E. Moore and Dr. H. P. Lundgren (U.S. Department of Agriculture) referred to dimaleimides as cross-linking agents. Prof. M. Oku and I. Shimizu (Kobe University, Japan) claimed that the stability and mechanical properties of wool are improved by formaldehyde cross-linking, achieved by treatment with hexamethylenetetramine.

A new approach to the chemical modification of the wool fibre was shown by Wikstrom and co-workers (Swedish Textile Research Institute, Gothenburg), who found that the surface reactivity of the fibre could be increased by treatment with chemical reagents, especially hydroxyl ions and organic solvents; it is of interest to note that W. G. Crewther (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne) noted in his paper that hydroxyl ions increase the susceptibility of wool fibres to proteolytic attack. A paper of practical importance in the shrink-proofing of wool, given by R. Bentham, C. B. Stevens and Prof. C. S. Whewell (University of Leeds), dealt with the action of hypochlorites on wool that had been modified by treatment with alkalis, acids, deaminating agents and dyes. All these contributions place emphasis on the part played by the cuticular layers of the wool fibre in chemical processes.

The general trend of work on the chemical modification was well exemplified in a lecture by Dr. H. P. Lundgren, who discussed the stability of the hydrogen-bonded wool structure, as shown by the reaction with β-propiolactone, the stability of the disulphide bonds, the behaviour of wool on heating or exposing to ultra-violet light and the protection of wool against such agents by the use of, for example, titanium alkoxides; one interesting observation in this lecture was that the yellowing of wool is promoted by suint, one active principle of which is urocanic acid (a glyoxalylacrylic acid).

## Physics

The application of reaction-rate theory of visco-plasticity to wool was the subject of a lecture by Prof. H. Eyring (University of Utah) and of one of the physics sessions. This theory often merely expresses the usual experimental results in an alternative form, but a stimulating paper by Dr. L. Peters (University of Leeds) attempted to relate the statistical parameters to a molecular model of the fibre. The interaction of wool and water again brought reaction-rates to the fore, and some beautiful experimental work from the C.S.I.R.O. Wool Textile Research Laboratory at Sydney provided data for the very rapid diffusion of water into single fibres. A paper by F. L. Warburton (Wool Industries Research Association, Leeds) showed how useful the wet-bulb theory could be for calculations of drying and conditioning on an industrial scale.

A review of the present position of research on worsted spinning was contributed by J. Ingham (Wool Industries Research Association, Leeds), and Dr. Margaret Hannah (University of Leeds) discussed problems of high-draft spinning. This session also considered woollen carding and spinning and the design of experiments when industrial plant has to be used. Fibre arrangement and the behaviour of fibres during mechanical processing were surveyed in a series of papers presented by British and Australian delegates. Wet processes, together with dyeing and finishing, were discussed in three sessions, the most interesting development being the solvent scouring system used at Geelong. Much information was also made available on the degradation of wool during wet processing, and the full report of the Conference should provide manufacturers with an excellent guide to precautions that are necessary when subjecting wool to acid or alkaline conditions. The sessions on manufacturing processes were concluded by a symposium at Geelong with some four hundred members of the local textile industry, where a lively discussion followed short addresses by Dr. A. B. D. Cassie, Dr. J. G. Martindale and Prof. C. S. Whewell.

## Histology

The fine histology of wool and the recent discovery of its bilateral structure provided much material for exchange of experience and opinion. There seems little doubt that the bilateral structure contributes largely to the crimp of wool, and because of the different reactions of the two structures to swelling, it may well be a principal factor in maintaining the bulkiness, and therefore the warmth, of wool fabrics. Although much was discussed about the wool follicle and its blood supply, no suggestion was made as to how this difference in keratinization, apart from references to Auber's work on detailed segmental keratinization, or possibly even in chemical composition, might arise. The histology of the wool fibre and that of its follicle are subjects that require much more research, possibly with entirely new approaches. The fine structure of wool is slowly being revealed by the electron microscope, and infra-red absorption spectra coupled with deuteration of the protein chains not locked in crystallites offer opportunities for considerable advance in our knowledge of wool structure. It must be remembered, however, that although the crystallographers may solve the problem of the crystal structure of keratin, they will have thrown only a little light on how wool works. The contributions by Dr. R. D. B. Fraser (C.S.I.R.O. Wool Textile Research Laboratory, Melbourne) and by G. King (Wool Industries Research Association, Leeds) on the infra-red spectra of swollen fibres were, therefore, most welcome.

There were also sessions on wool as a textile fibre, where students of genetics and nutrition sought guidance from the physicists and chemists on the fibre characteristics desired by the wool manufacturer. These discussions revealed again the uncertainty that exists concerning the uniformity of the physical and chemical properties of wool; and until greater accuracy is attained in such measurements, the biologist can only seek greater regularity of length, diameter and crimp. Many of the difficulties facing the physicist and chemist in finding variations in the properties of wool are probably due to the heterogeneous samples that normally come their way, and one outcome of the Conference has been the establishment of contacts that will provide wool samples from flocks of a definite type of sheep, or even from different parts of one or more fleeces: in this connexion, a scheme has been proposed for the preparation of, for example, large samples of finely cut, clean wools so that workers all over the world may have a common source of material for amino-acid analysis, etc.

As a final note, it is appropriate to consider the Conference in its wider perspective, made possible by the numerous and long-distance tours that the delegates, either individuals or in parties, were able to make during their stay in Australia. Here was a vast expanse of land, much of it scrub and with large tracts of uncultivatable soil. Yet to-day approximately 127 million Australian sheep are producing more than 1,200 million lb. of greasy wool, 74 per cent of which is merino. This is merely a reflexion of the strength and endeavour of the Australian people who, as described in the Conference Handbook, "live in a dynamic economy". Since the introduction at the end of the eighteenth century of the first merinos into Australia and Tasmania, the land has been cleared and the pasture improved in order to raise such an immense number of the descendants of the original small stock. The arduous task of developing the refractory land was first achieved by the early settler, but to-day the Australian Mutual Provident Society is organizing and financing land clearance on a large scale. Terrain capable of feeding one-half or less sheep per acre is improved to levels of two or more per acre. This improved pasturage has been made possible by the work of the Commonwealth Scientific and Industrial Research Organization, which has investigated the vital questions of soil fertilization, selection of grasses, clovers, etc., the problems of metal deficiency in soils, and the many factors in the breeding and care of sheep.

Irrigation also presents a serious problem in a country where the rainfall is generally meagre and irregular. The delegates saw vast areas in Victoria and South Australia where there was serious flooding and where, in the summer months to come, the land will be dry and parched. Extensive schemes of irrigation and water conservation have been carried out or are nearing completion, and delegates had the opportunity of appreciating the magnitude of these schemes by visits to the Snowy Mountains and to dams under construction, such as that at Warragamba.

To-day there are stud farms where the merino stock is maintained, and the delegates were able to visit such studs near Deniliquin and those in the Macquarie Valley region in Tasmania, where a very pure strain of fine-woolled merinos is maintained. Research on genetics and growth of sheep by the Commonwealth Scientific and Industrial Research Organization has been most active. The occurrence of 'steely wool' and malnutrition of the sheep was traced to cobalt deficiency. The wide need for phosphate fertilization of the soil was demonstrated, and to-day problems such as 'staggers' due to *Phalaris tuberosa* are being investigated.

The people of Australia in general and the graziers in particular have come to appreciate the invaluable work of the Commonwealth Scientific and Industrial Research Organization, and the importance of the Conference to Australia was indicated by the presence of the Prime Minister and several colleagues at the inaugural dinner, and by the reception of all delegates by the Governor-General and Lady Slim at Canberra.

A. B. D. Cassie
F. O. Howitt

# SOIL MECHANICS, GEOLOGY AND CIVIL ENGINEERING

During the recent meeting at Bristol of the British Association, a most informative joint meeting between Section C (Geology) and Section G (Engineering) took the form of a symposium to discuss the interdependence of geology, civil engineering and the new science of soil mechanics. Mr. F. H. Edmunds, of the Geological Survey of Great Britain, introduced the discussion. He pointed out that the civil engineer, in order to make an appreciation of the likely reactions of the rocks to his activities, requires as full geological information as possible concerning a new site, particularly in regard to the physical characteristics of rocks as determined from small samples (their hardness, cohesion, porosity of the rock); the arrangement of rock masses and strata at an engineering site (whether they lie horizontally or are inclined or buckled or folded, etc.); and the potentialities of water storage in, and movement through, the rocks. Detailed geological information is more necessary to-day than in former years for two main reasons: through advances in technique and machinery, many civil engineering works of to-day are immensely larger and more complex than those of past days; and whereas the old engineers usually had the choice of site, present-day works often have to be constructed at sites imposed on the engineer. These may be on alluvial tracts, in coastal areas, or in other difficult situations where the ground is occupied by thick beds of unconsolidated material, in many instances saturated with water.

Up to thirty years ago, geological science had more or less ignored petrological studies of soft sediments. The physical characteristics of soft rocks and, in the case of clays, differences of behaviour relative to the variable factor of the amount of adsorbed water in them, had received scant notice; but these points are of vital importance to engineers. In the circumstances, engineers and physicists set out themselves to get information of the kind required. From their work has evolved the science of 'soil mechanics'.

The word 'soil' in this connexion connotes soft unconsolidated material irrespective of its thickness or of its depth below ground surface; it has but little connexion with the top several inches of the earth's crust associated with agriculture. Generally speaking, what the engineer calls 'soils' are the 'soft rocks' of geological terminology, for example, sand and clay. Their essential feature, however, is lack of consolidation.

Much of soil mechanics investigations is a matter of physics undertaken in the laboratory, but laboratory tests by themselves are incomplete. To obtain the fullest information from them the small samples used need to be related to the stratigraphy of the beds from which they are taken.

Mr. P. L. Capper, of University College, London, described the fundamentals of soil mechanics. Soil—used in the engineering sense—necessarily forms, in its natural condition, the foundation for all works of construction, except where these can be founded directly upon solid rock. It is also used extensively as a constructional material, for example, in embankments, dams and earth roads. In designing any members of an engineering structure, four points have to be considered: the load or external forces applied to the member; the internal forces and stresses set up in the member; the deformations produced; and the way in which failure will take place if the member is overloaded. The same applies to soil; but compared with other materials of construction, soil presents greater difficulties on account of its lack of uniformity and its susceptibility to changes in its properties arising from variation in the water content. Soil mechanics comprises three main divisions: mechanics of soils, that is, the loss of equilibrium induced by engineering work, stress distribution and movement of water in soil; site investigation and the testing of soil for the determination of the relevant properties; the application of the findings under the first two headings for civil engineering design and construction.

The first division of soil mechanics includes the study of the conditions of stability of masses of soil, the determination of the internal stresses set up in soil under the action of external and gravitational forces and study of the laws governing the movement of water in soil. As with other engineering materials, the solution of stability and stress-distribution problems in soil involves an application of statics combined with assumptions as to deformation characteristics such as elasticity or plasticity.

In deciding upon the depth to which an investigation should be carried out, the chief point is to estimate the depth of soil which will be appreciably affected by the applied loads, and this depends upon the extent of the loaded area. The concept of the bulb of pressure illustrates this principle. The most important soil properties from the engineer's point of view are compressibility, shear strength and permeability. The compressibility of soil, in the broadest sense of the word, may be defined as the relation between compressive deformation and the pressure producing it. The deformation may result from one or more of the following factors: it may be elastic, recoverable when the pressure is removed; plastic, due to plastic flow of material; or may result from consolidation or closer packing of the particles resulting from the expulsion of water. In clay soils the settlement due to consolidation may be of considerable magnitude but is a very gradual process.

The shear strength of soil is assumed to be made up of two components: intergranular friction and cohesion. Generally speaking, sands and gravels derive their strength almost entirely from friction, whereas in clay soils cohesion predominates.

Reviewing the rapid development of soil mechanics, it is seen that a vast amount of knowledge, theoretical and practical, has been accumulated in a comparatively short period of time. If this knowledge is to be used to the best advantage in civil engineering, careful study must be made of 'case history', that is, observation of engineering works during construction and while in ordinary use. Also, every opportunity should be taken of investigating thoroughly any failures which are attributable to the soil. Soil mechanics is not, and never can be, an exact science, and its successful application always calls for experience and common sense.

Two papers on direct applications of soil mechanics and geology to civil engineering followed, delivered respectively by Mr. A. H. Toms, of the Civil Engineer's Department, British Railways, Southern Region, and by Mr. D. F. C. Henry, of the University of Leeds.

It was not until about 1937–38 that the scientific study of the physical and engineering properties of soils was taken up by one or two selected civil engineers of British Railways with the view of obtaining better understanding of the many landslips and other soils problems with which British Railways are faced. In the case of landslips, calculation, taking into account the mechanics of the slipping masses, the water pressures and the resistances offered by the soil, now often enables a far more rational approach to be made to the remedial measures than was possible before the advent of the science of soil mechanics.

The biggest single landslip problem affecting British Railways is that of the coastal landslips of the Folkestone Warren, Kent. There the railway runs for two miles continuously across a great expanse of slipped chalk and Gault clay resulting not from a lubricated surface between the Chalk and the Gault as formerly assumed, but from shear failure of the Gault in its basement bed on top of the Lower Greensand. The Middle and Lower Chalk form cliffs rising to + 550 ft. O.D. behind the wide stretch of slipped ground, while the Gault underlies the whole of the affected area. In 1938, research was commenced into the nature of the slips, which were then once again beginning to threaten the stability of the railway. Test boreholes were sunk over a wide area down to depths of 300 ft. and many soil samples were extracted for visual inspection and special testing. In this work fossil identification and the recognition of stratigraphical horizons by the geologist proved of the utmost value in supplementing the information obtained from soil mechanics tests.

As a result of the research at the Warren, an extensive programme of stabilization works has been put in hand consisting of: (1) new sea walls farther out to sea, with filling behind protected by concrete slabs in order to provide toe weight on the foreshore; (2) drainage of water out of the slips by means of a new tunnel heading; (3) overhaul of all existing drainage headings and groynes; and (4) repair to old groynes and provision of new ones.

It has been found by experience that in many cases of substation buildings, signal boxes and bridges the design of the foundations is determined, not by the shear strength of the ground but by its consolidation settlement under the load. One of the most difficult problems which arises in connexion with the estimation of the probable settlement of structures is that in which a group of piles may be required to transmit the foundation load to a layer of soft compressible soil, the thickness of which is too great to permit the piles to penetrate to firmer material below. Nevertheless, it has proved possible to arrive at reasoned estimates of probable settlements in such cases, a typical one being that of proposed pile groups for new side spans to the Kingsferry Bridge over the Swale, where there is a great depth of soft alluvium overlying London Clay of varying strength.

Typical of the application of soil mechanics to the solution of tunnel stability problems is the case of Bo-peep Tunnel, Hastings. This double-lined tunnel passes through the Wadhurst Clay. A few years ago it was noticed that the tracks near the western end of the tunnel were rising, the side walls were closing in and houses over the top started to subside. Steps were taken at once to put temporary supports in the tunnel to arrest the movement. Very careful investigations revealed that the movements were due to shear failure of the ground in the side-wall footings. This had been brought about by very slow progressive softening of the ground under the tracks on account of the combined action of percolating water and the dynamic effects of rail traffic.

Following this instance, extensive soil mechanics investigations were made in both Hastings and Ore tunnels, and major strengthening works were put in hand.

Mr. Henry described some soil mechanics aspects of the design of pad, strip and raft foundations located on the surface of the ground or at a relatively shallow depth. Recent experimental investigations include those of Golder, who in 1941 carried out tests on axially loaded model footings ranging in size from 6 in. × 6 in. to 30 in. × 6 in. on the surface of clean dry river sand contained in a 3 ft. 6 in. × 3 ft. 6 in. × 14 in. deep box. Tests were also carried out on footings ranging from 3 in. × 3 in. to 18 in. × 3 in. on remoulded London Clay in a 2 ft. 6 in. × 1 ft. 8 in. × 8 in. deep box. Meyerhoff made some tests on footings on sand contained in a box with a glass front; the inside of the glass was smoked so that the movements of the grains under load were automatically scribed on the glass. In another series of tests, vertical and eccentric loads were applied on footings of various lengths and 1 in. wide on the surface of, and at shallow depths in, loose and medium Ham River sand and remoulded London Clay.

More experimental evidence based on larger footings tested on the surface of, and at a depth in, sand and clay and loaded with axial and eccentric loads is desirable. In planning tests, the elimination of restraint due to confinement of the soil is necessary, and the results must be carefully analysed in the light of what is known concerning the behaviour of soils under stress and the modes of failures of footings.

Mr. Henry concluded that the present position of soil mechanics aspects of foundation design is reasonably satisfactory. Where soil conditions are straightforward or the structure is not large—for example, a domestic house or a small retaining wall—then simple investigations of the site and tests coupled with elementary soil mechanics theories are sufficient for practical work. On the other hand, considerable practical experience and theoretical knowledge is required where soil conditions beneath projected important structures are complex, and the interpretations of investigations and recommendations are best placed in the hands of specialists.

The engineer will never be able to escape the fact that soil is the most variable material with which he has to deal, and even where a mass of soil is apparently of uniform type, its physical properties may vary considerably. Apart from general changes in physical properties which may occur across a site, there are innumerable local variations which would entail much work to determine and take into account directly. In suitable cases such local variations can be catered for in the design of important structures by means of a coefficient of variation, in the nature of a factor of safety, based on the magnitude and frequency of properties revealed by soil mechanics tests.

The symposium was attended by a large audience and admirably exemplified the value of joint meetings between sections, a feature that becomes yearly more desirable with the rapidly increasing degree of inter-digitation of the different sciences. Interest in the meeting was accentuated by the kindness of *Engineering* in providing pre-prints of the several papers, and of the Soil Mechanics Department of the University of Bristol in furnishing apparatus for purposes of demonstration. F. H. EDMUNDS

# LIGHTING AND VISION

THE discussion on lighting and vision in Section I (Physiology) of the British Association during the recent Bristol meeting was opened by four speakers whose papers dealt with some important aspects of the subject.

In the first paper, H. C. Weston, director of the Medical Research Council's Group for Research in Occupational Optics, gave a brief account of some of the studies of human responses to varieties of lighting that have been made in recent decades with the object of providing scientific knowledge as a basis for planning lighting, particularly for building interiors. A number of these studies which have influenced present concepts of good lighting practice have been made in Great Britain, under the ægis of the Medical Research Council and the Department for Scientific and Industrial Research. They were primarily prompted by concern for the welfare of people at work and for their occupational efficiency.

Thus, in the early twenties, Elton, Weston and Wyatt each studied the effects of lighting upon the performance of weavers, which was shown to vary with the amount of illumination available up to about 30 lm./ft.$^2$. Weston and Taylor varied the illumination provided for printing compositors, and found that the rate and accuracy of working was proportional to the logarithm of the illumination value up to a level of 25 lm./ft.$^2$. They also showed that if the lamps used were so placed as to be glaring, work was impeded and the effectiveness of a given value of illumination on the work was reduced.

McDermott determined the desirable illumination for the work of typists, and Adams studied the response of persons doing visually unexacting work under different conditions of lighting. By such field-studies in occupations, chosen because their visual demands seem typical of whole classes of occupations, it was hoped to determine a scale of values of illumination adequate on physiological and psychological grounds for diverse purposes. This is a lengthy and difficult procedure, and a more fundamental approach was suggested by Beuttell in 1933. Pointing out that the visibility of all objects depends on certain of their characteristics, chiefly their size, contrast and luminance, he proposed that the relations between these variables be ascertained experimentally, so that levels of illumination could be computed for any visual task the critical components of which could be measured.

Using a suitable series of standardized tasks, Weston determined these basic relations, and his data are widely used internationally in prescribing illumination for good visual performance. He has also shown the effect of age upon the performance of these visual tasks and how it varies with different levels of illumination.

A much studied aspect of lighting is glare. Current rules of practice for the avoidance of this evil are due largely to the experimental studies of Stiles and, more recently, of Hopkinson and others at the Building Research Station. Responses to a variety of other features of lighting have been and still are being studied scientifically. Although recent advances in knowledge of lighting requirements, as well as in lighting techniques, are being applied fairly extensively, there is no doubt that the present lighting of many homes, schools, hospitals, offices, factories and other places is poor; not very rarely it is almost incredibly bad.

The investigations described by W. R. Stevens, head of the Illumination Group, General Electric Company's Research Laboratories, Wembley, were made by Foxell and Stevens to explore the dependence of the capacity for seeing detail upon the luminance of the object looked at and the luminance of fields of different size surrounding the object. Lythgoe (1932) showed that, except at low values of test-object luminance, the visual acuity attainable is better when the surrounding field of view has a luminance not very much below that of the test-object than when this field has zero or almost zero luminance.

On the basis of this finding, it has been widely held that lighting for good seeing should brighten the whole apparent environment almost as much as it brightens the given object of attention. However, Lythgoe did not study the effect upon acuity of luminous surrounds of test-objects when the surrounds do not entirely fill the visual field. Foxell and Stevens have done this, and have also measured acuity at higher values of luminance than Lythgoe used. They made, altogether, about 100,000 observations, using a Landolt broken ring as test-object. The ring was presented in contrast with a central field subtending an angle of 0·5° at the eyes of the observers. The luminance of this field was varied up to a value of 10,000 ft. L. Visual acuity was measured with the remainder of the visual field dark and also when the small central field was surrounded with a more extensive bright field. Measurements were made using three such surrounds the angular subtense of which was, respectively, 6°, 38° and 120°. The effect of the bright surround was studied when its luminance was made either equal to or different from the luminance of the central field.

It was found that at low luminances of the central field, visual acuity was unaffected by the size and luminance of the surround except, as Lythgoe also found, that it was reduced when the surround luminance exceeded that of the detail to be detected. At all luminances of the central field exceeding 1 ft. L., the presence of a luminous surround improved acuity, and the best effect was observed when the central field and the surround were matched in luminance. The beneficial effect of a bright surround upon acuity was not significantly greater with surround sizes of 38° and 120° than with the 6° size. Although this comparatively small luminous surround suffices for the achievement of high acuity, in ordinary circumstances a general distribution of light is usually necessary in buildings because detail has to be seen in many positions.

Foxell and Stevens found that maximum acuity was reached at a central field luminance of about 1,000 ft. L., with a 6° surround of equal luminance. At higher levels of luminance and for all surround conditions, acuity decreased. Some experiments were also made with equal-luminance red–green combinations of test-object and central field to determine the acuity due to colour contrast. Quite high values of acuity were attained, but the maximum was inferior to that reached with a high-contrast neutral test-object.

In his contribution, dealing with some effects of filament and of fluorescent lighting on visual performance, Dr. W. F. Floyd, senior lecturer in physiology, Middlesex Hospital Medical School, London, presented the results of a number of tests applied to clerical workers subjected to these forms of lighting alternately. Among the questions which have been posed concerning fluorescent lighting, that of its efficiency as a visual stimulus is one to which an answer is of particular interest to large employers of labour, who must provide artificial lighting on a large scale. Another question is what, if any, is the effect of the usually unnoticeable cyclic variation in light output of fluorescent lamps ? Dr. Floyd's investigations were primarily intended to find an answer to these two questions.

Dr. Floyd first made an experiment with twenty-two persons of normal sight, who performed Weston's speed of visual discrimination test illuminated to 10 lm./ft.$^2$ alternately by filament lamps and by fluorescent lamps. The mean performance of the subjects under each illuminant did not differ significantly. Multiple tests of a similar kind were then performed by another group under 6 lm./ft.$^2$ of filament lighting and also under 6 lm./ft.$^2$ of fluorescent lighting; again there was no significant difference between the respective mean performances. In another experiment, seventeen persons were exposed to lighting which was automatically and instantaneously changed from filament to fluorescent at intervals of a few seconds. The filament lighting provided a fixed illumination, but the illumination given by the fluorescent lamps could be varied by the subjects, who were asked to match it to the filament lighting for 'equal comfort'. The mean level of fluorescent lighting chosen in this way was slightly higher than the control level, although the difference was physiologically insignificant.

So as to make a long-term comparison between filament and fluorescent lighting, three comparable groups of clerical workers carried out their normal daily work, interspersed with various tests of performance and of certain visual functions, for thirteen weeks under three forms of lighting. One group had filament lighting, another had fluorescent lighting operated by an a.c. power supply and the third group had d.c.-operated fluorescent lighting free from cyclic variations. The working illumination in each office was standardized at 12 lm./ft.$^2$. None of the tests applied to the three groups afforded any evidence that the three forms of lighting had different effects. Thus, from all these experiments, it appears that, for equal illumination, visual performance is just as good under fluorescent lighting, with or without 'flicker', as it is under filament lighting.

Discussing the lighting of streets and vehicles, J. G. Holmes, technical director of Holophane, Ltd., pointed out that its function is to give road users confidence in their visual impressions as trustworthy guides to action. In a suitable state of adaptation, the sensitivity of the eye to light is remarkable; but, while very low illumination may enable familiar objects to be recognized fairly quickly, the rapid recognition of unfamiliar and unexpected objects, which is often essential for the safety of road users at night, requires much better illumination. An almost instantaneous assessment of the quickly changing scene confronting both pedestrian and vehicle driver has to be made and suitable motor responses initiated.

Under modern conditions in busy traffic areas, there is a bewildering variety of lights, among which those intended to give vital information or warning to road users sometimes lack conspicuity or add to the general confusion. The essential information should be given clearly with the right emphasis, and misleading information must be avoided. The variety of suitable colours and shapes of road signal lights seems now to be exhausted, hence the recent recourse to flashing lights so as to achieve conspicuity.

There is a tendency to increase the power of lights to gain attention to them, but this device also increases dazzle. An example is the red 'stop' lights on numerous modern cars. Some of these are of 100 candelas or more, and this is out of proportion to the general level of street lighting. They appear with shattering suddenness, often only a few yards in front of a following vehicle driver, and they tend to promote irritation and strain rather than visual confidence. Flashing beacons at pedestrian crossings give a welcome and timely warning of the need for special care; but where a number of them are visible at multiple road junctions they are disconcerting if out of step. Flashing car-direction lights take longer to interpret than semaphore indicators.

Mr. Holmes directed attention to the importance of siting street lamps so as to define the direction of roads unambiguously and to reveal the presence of roundabouts and centre reservations. Although improved street lighting tends to encourage greater traffic density and somewhat higher vehicle speeds, there is some statistical evidence that the night accident-rate is reduced, and there is no doubt that it increases the confidence of road users. As to the question of yellow versus white headlamps, careful experiments have led to the conclusion that, for equal beam intensity, there is no significant difference in revealing power nor in estimates of glare, and it is not true that yellow light penetrates fog better than white.

The general discussion evoked by the papers which have been summarized was confined to the subjects of fluorescent and of street and vehicle lighting. The chairman, Dr. R. S. Creed, mentioned that difficulty in reading meniscus gauges under fluorescent lighting was within his knowledge, although this may have been due simply to misplacement of the lights. Dr. Floyd pointed out that lamps of different colour temperature give different colour-rendering and, occasionally, a critical contrast might be weakened by the light from one type of lamp although not by another. He had investigated a variety of complaints against fluorescent lighting, but they were often expressions of dissatisfaction with other conditions, or they were due to conditions of lighting not necessarily produced by using fluorescent lamps. In reply to speakers who asked whether ocular ill-effects resulted from long-term exposure to fluorescent lighting, Mr. Weston said that there is no evidence of this. There had been a few cases of ocular affections occurring soon after a change from filament to fluorescent lighting, and those affected had wrongly blamed the lighting; he mentioned one such case which was demonstrably due to a bacterial infection. When, as now, many changes to fluorescent lighting are taking place, it would be surprising if there were no merely coincidental occurrences of ocular troubles. From his own investigations, he could confirm Dr. Floyd's conclusion that complaints against fluorescent lighting often proved to have a different basis. Referring to flashing beacons at pedestrian crossings, a speaker thought it unfortunate that they do not adequately illuminate anyone using or waiting to use the crossing. As to the red 'stop' lights on cars, another speaker claimed that experiments have demonstrated that these should be of 50 candelas for seeing at a distance of 50 yards when a driver is dazzled by opposing headlights.

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# GENETICS AND PLANT BREEDING

A JOINT session at Bristol of Sections K (Botany) and M (Agriculture) of the British Association was devoted to a symposium on "Genetics and Plant Breeding". The range of contributions to the symposium emphasized not only the scientific bases of present-day plant-breeding programmes, but also the dependence of advanced communities on a constant, integrated attack on those limiting factors to yield and quality which can be overcome by the genetical approach to crop improvement. A guaranteed standard of living, which advanced peoples have come to regard as a birthright, and which is now recognized as an international responsibility so far as the less-developed peoples are concerned, demands maximum efficiency from the germ plasm in food production. Not only must crop plants produce maximum yields at economic levels, but also quality, variety and long-term reliability of the material in the face of epidemics and environmental variations must also be among their attributes. The interaction of food production and soil fertility over large areas of the world presents grievous problems which can only be solved satisfactorily by escaping from an exhaustive form of monoculture to a rotational culture based on species of plants yet to be isolated from Nature's repertoire. If it is to continue to serve advanced communities, the science of plant-breeding has to respond quickly to human progress in all directions, in changes of dietary needs, in advances in agronomy, in farm mechanization as well as in the grading and processing of the final product.

Dr. D. Lewis, of the John Innes Horticultural Institution, Bayfordbury, in his opening paper, suggested how genetics, although unable to produce plants to order, can offer a systematic approach towards such problems and possibilities by initially 'blue printing' the foundation genotypes as well as outlining methods whereby a desired genetic architecture can be constructed stepwise. The limits to the construction of gene recombinations are frequently set by close linkage, involving gene effects with opposing or compensating functions. The eventual attainment of genotypes as near as possible to the ideal often depends on the breakdown of these linked units of inheritance. This problem is one with which crop-improvement projects are constantly being faced, and reliable methods such as a temporary passage through a tetraploid condition or the application of physical environmental stresses at meiosis might profitably be perfected to achieve an immediate and permanent release of undesirable gene combinations. Similarly, the breakdown of the natural breeding system of a species can often aid materially in releasing variability as well as in ensuring reliability of cropping. Thus in cherries, mutations induced by X-rays have yielded fully self-fertile genotypes which crop well even under adverse conditions for pollination by insects.

The importance of the part played by the breeding system in controlling variability and therefore in deciding the genetical approach to its improvement is nowhere better exemplified than in the genus *Rubus*, which was surveyed by Dr. G. M. Haskell (John Innes Horticultural Institution, Bayfordbury). Here apomixis is widespread, but in some instances variations in the mechanism allow of segregation and recombination among maternal chromosomes. Such sub-sexual processes give rise to greater variability than is often realized, and selection becomes possible. The segregation of quantitative characters within the sub-sexual apomict *R. nitidioides* (Merton Early) indicates that the improvement of economic characters such as earliness and intensity of prickles is possible, though the speed of selection will necessarily be slower than in fully sexual groups. Many apomictic species are also polyploids of various kinds, and a complete change to sexuality may reveal an unbalance characteristic of some polyploid groups. Thus in the *Eubatus* section of *Rubus*, broadly divisible into the mainly tetraploid group *Moriferi veri*, and the *Corylifolii*, which are largely pentaploid and are descended from the apomictic *R. caesius*, apomixis is widespread; whereas in the section *Idaeobatus*, consisting predominantly of diploid species, sexual reproduction is normal. The breeding behaviour of both inter- and intra-group hybrids is therefore often complicated, and only the most thorough study of joint segregations of groups of characters will ensure the detection of sexual progeny from the sub-sexuals and the apomicts. It is through such investigations on breeding behaviour and on the genomic constitution of species and varieties that the breeder can make full use of all the variability potential of his material.

Among the most helpful genetic concepts in plant breeding that have been developed in recent years are those elaborated by Prof. K. Mather in his studies on variability, in which variation is classified as free or potential. In homozygotes, all the variability is free and, discounting mutation, it is in a fixed state. If the breeding system allows, populations of homozygotes possessing maximum immediate fitness will be developed. Heterozygotes, however, contain potential variation which can only be freed at meiosis in sexual reproduction. Where the number of heterozygous loci is large, and where close linkage preserves gene combinations in a heterozygous condition, as it inevitably must in many cases, the problems of freeing the potential variation in heterozygous material become very real. Dr. A. J. Bateman (Christie Hospital and Holt Radium Institute, Manchester) emphasized that the upper limits of selection are governed by the methods that are used to realize the potential store of variability in heterozygotes. Using methods designed to exhaust the genetic potential, notions on the selection limits of certain characters in living organisms often have to be radically revised. This has been clearly demonstrated in laboratory experiments on *Drosophila* and the mouse, while in Nature it has become expensively obvious in another direction among the parasitic Basidiomycete fungi. Such laboratory and natural successes from new releases of variability underline the need for studying every aspect of plant-breeding procedure to ensure that crop improvement programmes shall not be allowed to rest on what well may turn out to be false selection limits.

One successful method of transcending selection limits has been the utilization of heterosis both in animals and plants. It is consistent with many aspects of the historical growth of science to find that immense benefits have followed the practical use of heterotic hybrids in food production, while we are still debating the nature of the precise genetic mechanism underlying the phenomenon. Mr. Watkin Williams (John Innes Horticultural Institution, Bayfordbury) developed a theme from which it could only be concluded that it was unnecessary and undesirable to partition heterosis into mutational euheterosis, balanced euheterosis, and luxuriance, after the scheme of evolutionists—notably Dobzhansky. Although it seems likely that the underlying genetic mechanisms controlling vigour are essentially the same in all these artificial categories, it does not follow that heterosis is always governed exclusively by any one mechanism in any given organism. Indeed, this is most unlikely, if only from analogy with the numerous mechanisms that are known to control discontinuous variation. The question of deciding between the two main theories of heterosis, namely, dominance with linkage as against the over-dominance theory, has hitherto presented an insoluble problem. However, the failure of certain selection procedures in the American hybrid maize programme indicates that the dominance hypothesis alone is insufficient to explain all the facts, while data on the biochemistry of heterozygotes, such as those of Pauling and Irwin, indicate the physiological mechanisms through which overdominance could operate. Thus an exclusive approach to heterosis is at present to be avoided, if maximum utilization is to be made of the various mechanisms which govern quantitative variation.

In no field of crop improvement is the basic approach so important as in selecting for resistance to disease. The breakdown in resistance which we have come to expect following the release of new varieties on a commercial scale has raised doubts in many minds as to whether the interplay between host and parasite can be settled in favour of the host. Dr. Lewis, from a survey of the literature, has concluded that genetic control seems more likely with insect pests than with fungal disease where chemical control appears to be more effective. An important consideration in this connexion was contained in a contribution by Dr. R. L. Knight (East Malling Research Station), in which it was suggested that the ease with which parasites form biological races may be correlated with a simple genetic mechanism controlling resistance in the host. Resistance based only on a few major genes may be more easily circumvented by a single mutation in the parasite. Complex resistances based on major genes, and reinforced by modifiers and polygenes introduced from a wide range of material, are on the contrary much less likely to be overcome by biological specialization in the parasite. The manipulation of complex resistances of this nature has been successfully accomplished with the cotton variety, Sudan Sakel, which is susceptible to attack by jassids. Here a bridging genotype had to be synthesized by back-crossing, to give a modified Sakel which in turn was used as the recurrent parent for the intensification of resistance through further transferences of polygenes affecting length and density of epidermal hairs. The scanning of a genus or of a species for sources of resistance involves the acquisition of a wide collection of genotypes from both wild and cultivated sources, and the maintenance of a large and expensive genetic museum of material. Nevertheless, in genera such as *Solanum* and *Gossypium*, where collections have been organized, valuable economic improvements have been achieved.

The regimentation of Nature's store of variability into collections for the ready use of the science of plant breeding needs to be interpreted in the last analysis as necessary organization for the benefit of humanity. Dr. G. D. H. Bell (Plant Breeding Institute, Cambridge) outlined the need for crop improvement in terms of the demands and responsibilities of the more advanced nations. World food production is now recognized as a world problem, and communities of people as they advance expend less and less of their energies on primary food production. Thus with vast new areas awaiting development on one hand, and shrinking acreages such as those of the British Isles demanding that maximum production be achieved at an economic level on the other, the plant breeder to-day is vital to survival. This sense of urgency has already been recognized both by sovereign countries and by international organizations such as the Food and Agriculture Organization and the Organization for European Economic Co-operation.

Notwithstanding such considerations, Dr. Bell emphasized that it is the need for the application of more scientific methods, and the great complexity of the problems to be solved, that have made necessary the provision of adequate and intelligent facilities for plant breeding. No longer can we afford to rely on a division of science into the pure and the applied, and wait for a piece of research to be completed in its appropriate pigeon-hole before further progress is attempted. Nor can we expect a science without scientists, and the training of a plant breeder presents yet another of those educational problems which most university curricula have so far failed to solve.

WATKIN WILLIAMS

# UNIVERSITY OF OXFORD SCHOOL OF FORESTRY

ON October 1, the University of Oxford School of Forestry celebrated its golden jubilee in the Imperial Forestry Institute, which has been its home since 1950, and in St. John's College, which has been very closely associated with it throughout the fifty years of its existence. When the Royal Indian Engineering College at Coopers Hill (near Windsor) closed in 1905, training for the Indian Forest Service which had been given there since 1888 was transferred to Oxford, temporary accommodation having been secured to serve until the building promised by St. John's was ready. The director, Dr. (afterwards Sir William) Schlich, and his assistant W. R. Fisher brought over the current class of twelve probationers and thus opened the first university forestry school in Britain (or indeed the British Empire), though Edinburgh already had a lecturer in forestry. The senior of this group, A. E. Osmaston, officiated at the planting of a jubilee oak tree at the recent celebrations. This was done in Bagley Wood, which has been continuously available to the School through the generosity of St. John's, the owner of the wood for four centuries. Mr. Osmaston is one of a famous forestry family of which seven members are serving or have served in the Forest Services of India, Britain and the Colonies ; three were present on this occasion. He was assisted by one of the present students, and a gathering of about 130 persons, nearly all former students or members of the staff, witnessed the ceremony.

The jubilee address was delivered by Sir Harold Glover, one of the first students to read forestry in Oxford, his year being headed by the late Lord Robinson, sometime chairman of the Forestry Commission. Many of that year took degrees in natural sciences, as well as the Forestry Diploma. Sir Harold joined the Indian Forest Service, Oxford having been for some years the only training centre for Indian Service probationers ; between 1907 and 1932, when recruitment in the United Kingdom ceased, 213 out of the total intake of 306 had passed through the School. The last five inspectors-general in India have been Oxford graduates, including the present holder of that important post.

In 1924, the School was strengthened by the establishment of the Imperial Forestry Institute to provide a centre for higher education and research for those parts of the Empire which needed such facilities : though the Institute was in no sense a part of the School, many facilities such as the library were shared, and members of the Institute staff undertook some of the teaching. The two organizations were amalgamated in 1938 to form the University Department of Forestry. In the early years, only a diploma was awarded on the work of the two or three years the course covered, but a pass degree was granted in 1918, and finally an honours degree in 1944.

The School has provided 144 recruits to the Colonial Forest Service, and since the opening of the Institute, practically all members of that Service have attended postgraduate courses in Oxford. The proportion of the officers of the United Kingdom Forestry Commission trained at Oxford has been lower, but forty-four are serving at present, and the Commission's research staff worked at Oxford before the research station at Alice Holt was established.

A lunch was given in St. John's College, the speaker being Sir Henry Beresford-Peirse, deputy director-general of the Forestry Commission. He made particular reference to the very wide range of subjects covered in a university forestry course, giving it an educational value much beyond a technical training.

The average number of students over the past three years has been fifty-eight, and the number graduating twelve. There are at present students from the United Kingdom, Canada, New Zealand, South Africa, India, Pakistan, Burma, Ceylon and several Colonies. The staff now consists of the professor, one reader, sixteen demonstrators, twenty technical assistants, twelve secretarial and librarian employees and six others, and the annual expenditure approximates £50,000.

H. G. CHAMPION

# OBITUARIES

## Prof. H. K. Mookerjee

THE death occurred very suddenly on August 18 of Prof. H. K. Mookerjee, professor and head of the Department of Zoology of the University of Calcutta. Born in 1898, Mookerjee's undergraduate days were spent in the Presidency College, Calcutta. He won the University Gold Medal in zoology in 1924, and joined the University as assistant lecturer in 1925. As the Guruprasanna Ghose Scholar, Mookerjee went to London in 1926, and worked in the Imperial College of Science and Technology under the late Prof. E. W. MacBride. His work on the development of the vertebral column attracted considerable attention. He was Sara Marshal Scholar in the Imperial College during 1927–28, and Ghose Travelling Fellow of the University of Calcutta during 1928–29. He was awarded the D.Sc. of the University of London in 1930. He rejoined the University of Calcutta on his return, and in 1933 became the University professor of zoology, which post he filled with great credit until the end of his life.

Prof. H. K. Mookerjee's important contribution in the field of embryology and evolution was based on the study of development of the axial skeleton of practically all groups of the chordates starting from *Balanoglossus* right up to man. He pointed out further that the centrum of all the chordates is formed in the same manner according to a basic plan ; in the development of the vertebral centrum of all the chordates, from *Amphioxus* up to the mammals, only notochord, chord sheath, and the pericordal tube formed around the latter, take part, according to Mookerjee, but not the arch-bases or other elements claimed previously. Besides this hypothesis, Mookerjee also pointed out the many characteristic changes that take place in a non-plastic organ like the vertebral column along with change of environment. Very recently, he had shown that the so-called notochord of *Balanoglossus* is really the true dorsal nerve cord with a definite neurocœl. He utilized this finding to draw up the affinity of the *Balanoglossus* in a recent paper.

Prof. Mookerjee was elected president of the Zoology Section of the Indian Science Congress in 1936 and was elected a Fellow of the National Institute of Sciences of India in 1939. He was associated with various learned bodies and connected with different Indian universities in various capacities. He acted as a secretary of the Asiatic Society in the Natural History Section and was the founder-president of the Zoological Society of Bengal. He was an important member of the senate and syndicate of the University of Calcutta.

Prof. Mookerjee was responsible for initiating fishery research in the University, and himself made notable contributions to the life-history of freshwater fishes of Bengal. He was admired and respected by all who came in contact with him. He leaves his mother, wife and one son and three daughters and a host of friends and admirers who mourn his loss.

S. R. Bose

## Mr. Howard Evans

The death occurred, suddenly, on September 11, of Mr. Howard Evans, superintendent of the Laboratory of the Development and Research Department of the Mond Nickel Co., Ltd.

Mr. Evans was born in 1907. He was educated at the Grammar School, Penistone, after which he was for five years junior chemist at the Penistone Iron and Steel Works of Cammell Laird and Co., Ltd. During this period he was a student at the University of Sheffield, and graduated A.Met. with the award of the Mappin Medal and Premium in 1930. From 1930 until 1938 he was employed as research metallurgist in the Physics Section of the Research Department of the Metropolitan-Vickers Electrical Co., Ltd., Manchester, except for one year, when he was working on iron–aluminium alloys on a George Senior fellowship at the University of Sheffield. It was during this period that he co-operated with Dr. C. Sykes in his classic work on order/disorder transformations.

In 1938, Mr. Evans joined the Development and Research Department of the Mond Nickel Co., Ltd., as a research metallurgist in the Birmingham Laboratory, under Dr. L. B. Pfeil. After a period of activity on various research projects relating to steel, including work on steel castings and on temper brittleness, he became closely associated with war-time investigations undertaken by that company on behalf of government departments. To all this work he brought outstanding energy and enthusiasm, a meticulous attention to detail and insistence on an excellence of performance from which he would never depart.

In 1945 he was appointed principal assistant to the superintendent, and in May 1954 superintendent of the Laboratory. In these capacities he was connected with a wide variety of research projects in both the ferrous and non-ferrous fields, and his indefatigable zeal was a constant inspiration to those with whom he worked.

Mr. Evans was elected a Fellow of the Institution of Metallurgists in 1946 and was a member of many metallurgical organizations, to which he presented numerous technical papers. During the year 1954–55 he was president of the Birmingham Metallurgical Society.

A notable feature of Mr. Evans's activities was his sincere interest in the training and education of junior members of his staff, many of whom have profited by his sympathetic guidance and encouragement when embarking upon a metallurgical career. His interest in technical education led him to undertake part-time lecturing for some years at the Birmingham College of Technology, despite his very heavy duties in other fields. He joined with typical wholeheartedness and no little skill in the recreational life of his colleagues and continued to take part in many of their sporting activities right up to the time of his death.

In all the many circles in which he moved, Howard Evans will long be remembered for his enthusiasm, initiative and ability to get things done.

W. Steven

# NEWS and VIEWS

### Editor of *Science* and *The Scientific Monthly*: Prof. G. DuShane

Prof. Graham DuShane, of Stanford University, has been appointed editor of *Science* and *The Scientific Monthly*, the two journals published by the American Association for the Advancement of Science. Prof. DuShane, who is forty-five years old, took his Ph.D. degree at Yale in 1934 for embryological work and then did two years of research in the University of Iowa and in Stanford University. The following ten years were spent in the University of Chicago, teaching in the Department of Zoology and carrying out research on problems of amphibian morphogenesis. In 1946 he moved to Stanford University where, in addition to his work in embryology, he devoted himself to the development of the University's programme in general biology and gave freely of his services for editorial consultation and faculty committee activities and as the president of the Stanford chapter of the American Association of University Professors. Prof. DuShane goes to the editorship of *Science* and *The Scientific Monthly* initially on the basis of a year's leave of absence from Stanford. The breadth of his scientific knowledge, his facility in writing and editing, and his interest in the accurate communication of the findings and conditions of science are good auguries for the future of the Association's journals.

### United Kingdom Agricultural and Food Representative in the United States: Mr. O. G. Williams

Mr. Owen G. Williams, provincial grassland officer for the East Midland Province of the National Agricultural Advisory Service, has been appointed to the new post of United Kingdom assistant agricultural and food attaché in Washington, D.C. The post of agricultural adviser (technical) has been discontinued, but its main functions will be incorporated in the new assistant attaché post. Mr. N. F. McCann, the former agricultural adviser (technical), will take up a new appointment as deputy director of the

National Agricultural Advisory Service in the Yorkshire and Lancashire Province. Mr. Williams, who is forty-three, graduated in agricultural botany from the University College of North Wales, Bangor, in 1941. Before his university studies he had considerable practical experience, including eight years on his father's mixed farm in the Conway Valley and a year as manager of a large dairy farm. He joined the Ministry of Agriculture and Fisheries in 1942, becoming two years later a technical development officer for the county of Buckinghamshire. Mr. Williams has taken particular interest in the development of herbage seed growing in Buckinghamshire and the East Midlands, and has been a member of the Management Committee and vice-chairman of the Certifying Committee of the Lincolnshire Seed Growers' Association. He has also been a member of various young farmers' clubs advisory committees and has lectured frequently to farmers' clubs and societies. He was one of the official United Kingdom delegates to both the Fifth International Grassland Congress held in Holland in 1949 and the Sixth Congress held in the United States in 1952, and at the latter he afterwards toured extensively in the Middle West, visiting farms and research stations.

## Royal Aeronautical Society: Mr. E. T. Jones, C.B., O.B.E.

Mr. E. T. Jones, principal director of scientific research (air), Ministry of Supply, has been elected president of the Royal Aeronautical Society for the year 1956–57 and will take office at the annual general meeting of the society, to be held on May 10, 1956. Mr. Jones, who is fifty-eight, was a pilot and flying instructor in the R.F.C./R.A.F. during 1915–19, and then graduated from the University of Liverpool. During 1923–30 he was with the Aerodynamics Department, Royal Aircraft Establishment, and for eight years was with the Marine Aircraft Experimental Establishment, Felixstowe. During the Second World War he was chief superintendent of the Aeroplane and Armament Experimental Establishment, Boscombe Down; in 1947 he was appointed director of instrument research and development at the Ministry of Supply, and was promoted to his present position at the Ministry in 1949. Mr. Jones was created an O.B.E. in 1942 and C.B. in 1953.

## American Academy of Arts and Sciences: Award of Francis Amory Prizes

Francis Amory prizes of 3,500 dollars each, for the invention or discovery of measures for the relief or cure of diseases affecting the genito-urinary system, have been awarded by the American Academy of Arts and Sciences as follows: Frederic E. B. Foley, Lowry Medical Arts Building, St. Paul, Minnesota, for outstanding inventive and surgical genius in the treatment of those afflicted with urological disease; Choh Hao Li, University of California, Berkeley, California, for his work on the relation of the anterior pituitary hormones to the maintenance and functioning of the human reproductive organs; T. R. R. Mann, Molteno Institute, University of Cambridge, for his basic contributions to the biochemistry of reproductive functions providing basic data stimulating research and clinical progress; Terence J. Millin, Queen's Gate Clinic, London, for his contribution to surgery; Warren O. Nelson, College of Medicine, State University of Iowa, for his studies of the structural relationships of the male sex organs and of the factors that determine the functional activities of their components; Frederick J. Wallace, American Cystoscope Makers, Inc., New York, for his co-operation with the urological profession in developing diagnostic and therapeutic instruments which have contributed materially to the technical advances in this specialty; Lawson Wilkins, Johns Hopkins University, Baltimore, Maryland, in recognition of his contributions to fundamental knowledge of the growth and development of secondary sex characteristics in man and his application of the adrenal cortical hormone to their management and treatment.

## New Headquarters for the Institute of Biology

The Institute of Biology, having spent the first five years of its existence in rooms at Tavistock House, has moved to new premises at 41 Queen's Gate, London, S.W.7 (Tel.: Western 2229). The new rooms are in the house of the Royal Entomological Society, and the meeting room of this Society is to be made available to the Institute of Biology for certain of its meetings. The removal marks a stage in the development of the Institute, which has now achieved a membership of twelve hundred full members, seventy probationer members and three hundred student members. The new headquarters will provide facilities not previously available to members. In particular, a members' room has been provided in which members will be able to meet friends, conduct interviews and hold small discussion groups. A telephone and ample space for writing and reading will be provided. A selection of works of reference will be available, and there will be a frequently changed display of recent books on biological subjects, maintained by a leading scientific bookseller. While it is not proposed to attempt to build up a comprehensive library because of the existence of the neighbouring libraries dealing with various branches of biology, the Institute may establish a collection of books on the broader aspects of biology which will include copies of the classic works of the past. It is hoped that the new rooms will be found useful, possibly in different ways, by members from the Colonies spending long leaves in Britain, by the many members in the London area who have no access to similar facilities in central London and by those from other parts of Britain paying brief visits to London.

## Television Transmitter at Meldrum, Aberdeenshire

The opening on October 12 of a new B.B.C. medium-power transmitting station at Meldrum, Aberdeenshire, brings television within the reach of about half a million people living in the north-east corner of Scotland, south of the Moray Firth. This transmitter replaces the temporary low-power transmitter at Redmoss, Aberdeen, the useful service-area of which did not extend much beyond the city boundaries. The 5-kW. vision and 1·25-kW. sound transmitters, manufactured by Marconi's Wireless Telegraph Co., Ltd., feed a three-stack 'batwing' aerial mounted at the top of a 500-ft. steel mast. The mast and station are situated on a hilltop, so that the aerial is about 1,300 ft. above sea-level. About half-way up the mast is an eight-tier slotted aerial from which the B.B.C. Home, Light and Third programmes will be radiated when frequency-modulated very-high-frequency transmitters are installed early in

1956. No studios are provided at the station. The video signal from the Kirk O' Shotts transmitter is picked up at a Post Office receiving station at Cupar and relayed to Old Meldrum via a two-stage microwave link. Additional microwave aerials and receivers are available for use with outside broadcast units. The audio signal comes over Post Office landlines with some inevitable loss of the higher audio frequencies. A low-power (500 W. vision, 125 W. sound) transmitter, manufactured by Standard Telephones and Cables, Ltd., is installed for use should the main transmitter fail. It is supplied from a diesel alternator. The main transmitter can draw its power from either of two independent 11-kV. ring mains operated by the North of Scotland Hydro-Electric Board, and the customary stand-by diesel alternator has been dispensed with.

## Patent Office Library Centenary

The Patent Office Library, at 25 Southampton Buildings, Chancery Lane, London, W.C.2, has just celebrated its centenary year with an exhibition of literature illustrating the development of the industrial arts through the century of its existence. The exhibition showed industrial development by decades and included specifications of basic inventions, manufacturers' catalogues and scientific and technical periodicals which appeared in each period of the century covered. The material displayed was an attempt to demonstrate the resources of the Library and to illustrate the importance of patented inventions in the foundation of great industries. Some original examples of manufactured products, now widely known and used, were displayed as a focus to the exhibition of literature. A special tribute was paid in the exhibition to Bennet Woodcroft, F.R.S., the first clerk to the Commissioners of Patents and founder of the Library.

## Documentation of Spectra by Punched Cards

The documentation of new scientific data so that it remains within readable bounds presents a growing problem, and the difficulties are especially acute in those fields of pure and applied research where the solution of a particular problem demands a preliminary exhaustive search in the literature for physico-chemical reference data. For example, there is a recognized urgent need for spectral data in a compact form. This applies especially to infra-red and Raman data for use in physical or organic chemistry and for analysis, all the more since lack of space and costs now prevent full publication of such material in the scientific journals. A joint Anglo-German scheme for the documentation of molecular spectra, recently announced by Butterworths Scientific Publications (88 Kingsway, London, W.C.2) and Verlag Chemie (Weinheim/Bergstrasse), is therefore welcome news for many academic and industrial laboratories. The spectra of pure compounds, and of other technological products, will be provided on punched cards, with much other structural and spectral information. A detailed code which applies to the punched holes has been designed so that the cards can be used to provide the answers to a wide variety of questions which often occur in research. The spectral cards are also linked to a current literature survey, which adds to their intrinsic value. Details of the scheme, which is expected to begin in 1956 with about two thousand cards annually, can be obtained from the publishers.

## Hair Embroidery in Siberia and North America

No. 7 in the series of Occasional Papers on Technology of the Pitt Rivers Museum, Oxford, deals with the subject of "Hair Embroidery in Siberia and North America" (pp. 83+16 plates; from the Museum, 1955; 15s.). Mr. Geoffrey Turner, who has been closely associated with the Museum for many years, has made a deep study of the North American Indians and their material culture, and no one in Great Britain is better at placing a given specimen. Moose and reindeer hair embroidery are often confused with porcupine quill work, and Mr. Turner shows how they may be distinguished, also explaining how the various techniques are carried out and where they are found. In addition, he outlines what is known of the historical background, showing the effect of French influence on the development of the craft in North America. The paper will be indispensable to all museum curators who have North American or similar Asiatic material under their care, and it is to be hoped that more of Mr. Turner's learning will be published in future numbers of the series.

## Illuminating Engineering Society

At the first meeting of the Illuminating Engineering Society for the 1955–56 session, Mr. A. G. Higgins, assistant secretary of the Institution of Gas Engineers, took office as president. Mr. Higgins formerly held a number of positions with the South Metropolitan Gas Co., including that of outdoor lighting superintendent.

The following awards have been made for papers presented to the Society during the past year: *Leon Gaster Memorial Premium*, to Dr. W. E. Harper (Plastics Division, Imperial Chemical Industries, Ltd.) and Mr. A. G. Palmer (North Thames Gas Board) for their paper entitled "Lighting of Hazardous and Corrosive Locations in Industrial Plants"; *Silver Jubilee Commemoration Award*, to Mr. K. R. Ackerman (British Broadcasting Corporation) for his contributions to lighting design and brightness patterns.

## Royal Institution: Lectures

The programme of lectures at the Royal Institution up to Christmas includes seven Friday Evening Discourses, beginning October 28, as follows: Sir Edward Salisbury (director of the Royal Botanic Gardens, Kew), fruit and seed production; Sir Graham Sutton (director of the Meteorological Office), weather forecasting—the future outlook; Dorothy L. Sayers (author), 'Œdipus Simplex'—freedom and fate in folklore and fiction; Dr. C. F. A. Pantin (reader in zoology, University of Cambridge), the primitive nervous system; Dr. B. F. J. Schonland (deputy director of the Atomic Energy Research Establishment, Harwell), lightning and the long electric spark; E. J. H. Corner (lecturer in botany, University of Cambridge), botanical collecting with monkeys; and Sir Lawrence Bragg (resident professor and director of the Laboratories at the Royal Institution), the discovery of useful electricity. In addition to the Discourses, Prof. J. B. S. Haldane (Weldon professor of biometry, University College, London) will deliver the Woodhull Lecture on October 27 at 6 p.m., speaking on "The Prospects for Eugenics". R. H. Macmillan (lecturerer in engineering, University of Cambridge) will give four lectures on Tuesdays (at 6 p.m.) beginning October 25, on the subject of automatic control and production. On November 3, 10 and 17 (at 6 p.m.), Dr. R. C. Sutcliffe (deputy director of the Meteorological

Office) will give three lectures on large-scale weather processes. Both these sets of afternoon lectures are open to the public (2*s.* 6*d.* per lecture). The Christmas Lectures will be given by Prof. H. W. Melville, Mason professor of chemistry in the University of Birmingham, who will speak on "Big Molecules". Lectures, illustrated by experiments, have also been arranged for school children, and refresher courses for science teachers will be given. Details of these have been sent to education authorities in the London area and it is hoped that this new venture in science teaching, which Sir Lawrence Bragg started so successfully last year, will become an important part of the Royal Institution's work.

### Iron and Steel Institute

The eighth Hatfield Memorial Lecture of the Iron and Steel Institute will be given on October 7, at 6.30 p.m., in the Firth Hall of the University of Sheffield by Dr. E. C. Bain, vice-president, research and technology, of the United States Steel Corporation, his subject being "Trends in Metallurgical Research in the United States". Admission will be by ticket only, obtainable from the Registrar, University, Sheffield 10. A half-day meeting of the Iron and Steel Engineers Group will be held at the Engineers' Club, Manchester, on the morning of October 20, in connexion with the National Fuel Efficiency Exhibition; Dr. W. S. Walker (Round Oak Steel Works, Ltd.) will present a paper on "Fuel Efficiency in the Iron and Steel Industry". The autumn general meeting of the Institute will be held during November 16–17, at the offices of the Institute, 4 Grosvenor Gardens, London, S.W.1.

### Commonwealth Fund Fellowships for Advanced Study and Travel in the United States

A number of Commonwealth Fund fellowships are again being offered by the Commonwealth Fund of New York to British subjects, for study and travel in the United States. All expenses of travel, study and living will be met, with some adjustment of stipends for married men. The fellowships, which are open to British men and women who are not normally resident in or near the Americas and who have not previously worked or studied for more than a few months in the United States, are offered annually in six categories as follows. *General:* twenty fellowships to graduates of a university in Great Britain or Northern Ireland; candidates must be available in London for interview in March 1956; age, 23–32; tenure, 12–21 months; applications by December 15. *Home Civil Service:* five fellowships to permanent members, in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades; age, preferably less than 40; tenure, 9–15 months; applications by December 10. *Australian and New Zealand Civil Services:* five fellowships to Civil servants in the Governments of Australia and New Zealand; age, less than 40; tenure, 9–15 months; applications by November 1. *Oversea Civil Service:* two fellowships to Civil servants in the Governments of British Colonies, Protectorates and Trust Territories; age, less than 40; tenure, 9–15 months; applications by November 18. *Journalism:* three fellowships to journalists practising in the United Kingdom and engaged on the opinion-making or broadly editorial side of their profession; age, 23–35; tenure, 9–15 months; applications by December 31. *American Studies:* four fellowships to faculty members appointed to or holding posts in American studies in universities in the United Kingdom; candidates to be nominated by their universities; tenure, 4–15 months (these fellowships are not limited by previous study in the United States). Application forms and further information can be obtained through British universities or Government departments, or from the Warden, Harkness House, 35 Portman Square, London, W.1.

### Announcements

Prof. R. C. Garry, regius professor of physiology in the University of Glasgow, and Mr. H. J. Seddon, director of studies in the Institute of Orthopædics, University of London, and clinical director of the Royal National Orthopædic Hospital, London, have been appointed members of the Medical Research Council.

On the occasion of a visit to Great Britain by Prof. J. Heyrovský, of Prague, an advanced course on polarography will be given at the Royal Technical College, Salford, Lancs, during November 18–19. A number of lectures will be given, including two by Prof. Heyrovský; and there will be a demonstration of apparatus. The fee for the course is one guinea. Further information can be obtained from the Head of the Department of Chemistry and Applied Chemistry at the College.

Mr. W. H. Rutherford has been appointed assistant secretary of the Royal Society of Edinburgh in succession to Mr. G. A. Stewart (see *Nature*, October 8, p. 675). Mr. Rutherford, who has been on the staff of the Society since 1940, has served as Mr. Stewart's deputy since 1948. Educated at the High School of Dundee, he was elected a fellow of the Society of Secretaries in 1951, an associate of the Corporation of Secretaries in 1954, and is a member of the Royal Institute of Public Administration.

Prof. F. J. Llewellyn, professor of chemistry in Auckland University College, New Zealand, and formerly senior lecturer in chemistry at Birkbeck College, London, and I.C.I. Research Fellow in the University of Birmingham, has been appointed rector of Canterbury University College, Christchurch, in the University of New Zealand.

Dr. F. H. K. Green has resigned from the secretaryship of the (European) Scientific Advisory Committee of the Lady Tata Memorial Trust, which he has held since 1934, on his appointment as scientific secretary of the Wellcome Trust. He will be succeeded by Dr. David Galton, of the Chester Beatty Research Institute, Fulham Road, London, S.W.3.

At the October meeting of the Board of the Institute of Physics, it was unanimously resolved to record in the minutes that it had noted that the British physicists, under the leadership of the president (Sir John Cockcroft), played a prominent part in the recent United Nations Conference on "The Peaceful Uses of Atomic Energy", and was happy to see this further contribution to one of the Institute's principal objects, namely, the advancement and diffusion of a knowledge of physics, pure and applied.

Reference was made in *Nature* of August 13, p. 297, to a paper on the drying of skins, published in *Colonial Plant and Animal Products.* The authors of this paper were Dr. M. H. French and Dr. R. L. Sykes; we regret that Dr. French's name was omitted.

# CINEMATOGRAPHY IN SCIENTIFIC RESEARCH

PROGRESS in scientific research depends on precision instruments, because accurate quantitative data alone can form the ultimate basis of new discoveries. Although infinitely versatile, our human sense organs are very limited when accurate measurements are needed, be they of size, or length or of weight. The invention of the microscope, the micrometer and of the chemical balance have each opened large fields of research, and their accurate measurements have greatly advanced biology, engineering and chemistry. Without such instruments, and the ciné camera is one of them, scientific research would scarcely have progressed beyond the speculative and descriptive stage. To demonstrate the latest results achieved by scientific cinematography, the Scientific and Technical Group of the Royal Photographic Society arranged a special morning session on September 3 at the British Association meeting in Bristol. In spite of many other attractions, it was extremely well attended, and the audience numbered more than three hundred.

The meeting was opened by R. J. Hercock, chairman of the Scientific and Technical Group, who introduced the programme, and by Prof. N. F. Mott, who took the chair during the morning. Prof. Mott was of the opinion that research films are well suited to bring together scientific workers from many different disciplines, and that this is one of the main functions of the British Association. He was followed by Dr. A. R. Michaelis, who had been responsible for the organization of this session. Dr. Michaelis gave a brief outline of the history of the subject, of E. J. Marey's classical contribution and his insistence on the quantitative nature of all scientific cinematography, which he hoped would be stressed by all the other speakers. He mentioned the many cinematographic techniques which have been used in scientific research and gave a few classical examples of their applications in different fields.

The use of high-speed cinematography in physical and engineering research was the subject of W. D. Chesterman's (Royal Naval Scientific Service) paper and research film. A wide range of problems was shown on the screen, particularly noteworthy being underwater sequences of cavitation phenomena, partly recorded on models in hydrodynamic flow channels and partly recorded in the open sea. Spark cinematography at frequencies up to 100,000 frames/sec. was demonstrated in ballistic research work and showed in detail the impact of projectiles on armour plating. Mr. Chesterman concluded with a plea for the wider use of underwater cinematography by marine biologists, who might well use this established technique for the study and recording of their subjects in natural surroundings.

An example of the use of high-speed cinematography in industrial research was presented by D. J. Dearnley (Central Research Establishment I, National Coal Board). Froth flotation of fine-coal particles was cinematographically recorded at 2,500 frames/sec. in order to elucidate the mechanism and efficiency of grain attachment to air bubbles. A field-splitting optical system was developed in order to record each bubble simultaneously from two directions at right angles, and from the resulting research film, received with applause at the meeting, it proved possible to measure collection efficiency and contact times as well as to plot the trajectories of particles and bubbles.

The most outstanding research film shown at the meeting was the one dealing with the behaviour of living cells in tissue culture, presented by E. J. Ambrose (Chester Beatty Research Institute, London) and recorded in collaboration with M. Abercrombie (University College, London). Combining the new technique of Smith (Baker) interference microscopy with time-lapse cinemicrography, Dr. Ambrose was able to show a colour film which left a deep impression on all who saw it and which was received with much applause. The advantage of this new technique was the demonstration of changes in thickness of cells, shown by marked colour changes, and thus providing an extra dimension in the depth of the recorded image. In the film, the behaviour of normal and cancer cells was contrasted, showing that, when two normal cells make contact, adhesions occur on their surfaces which do not take place in the case of tumour cells. Particularly outstanding was the record of the behaviour of cancer cells in the presence of ribonuclease; this enzyme stimulated the free movements of the cancer cells even further and led to their death through over-digestion of the enzyme.

High-speed cinematography through the microscope, a rare and extremely difficult research technique, was demonstrated with three examples by R. McV. Weston (Simpl, Ltd.). After explaining the technical problems of the technique, Mr. Weston showed its use for recording the movement of mercury in a clinical thermometer, for examining the lever escapement of a watch and for the discharge of elaters and spores from a liverwort. The first two films showed hitherto unknown defects, and the third allowed quantitative evaluation by Prof. C. T. Ingold (Birkbeck College, London), for whom it was taken. In the absence of Dr. J. S. Courtney-Pratt in the United States, Mr. D. P. C. Thackeray (Research Laboratory on the Physics and Chemistry of Surfaces, Cambridge) presented a brief paper and a research film made by the Courtney-Pratt image-sampling technique; the subject of the film was the explosion of single crystals.

X-ray cinematography, both of the direct and the indirect method, was shown by G. E. H. Foxon (Biology Department, Guy's Hospital Medical School, London); the ingenious use of 'Meccano' gears was greatly admired in a film more devoted perhaps to an exposition of technique than of results. J. Underwood (G.K.N. Group Research Laboratory) gave the last paper, describing further examples of the use of high-speed cinematography in industrial research: his first high-speed film showed the passage of liquid in a heat-exchanger model; his second the initiation of a welding arc under an argon shield by a condenser discharge; and his third, taken at 5,000 frames/sec., allowed the determination of the acceleration characteristics of the blades of a flying shear. Altogether, thirteen films were shown at the meeting, which concluded with excerpts from the American research film, "Color Motion Pictures of the Whole Sky".

Four German research films which had been specially sent over for this meeting were projected two days later during the general festival of scientific films. Two of these were "Netzbau der Kreuzspinne" and "Pervitinwirkung bei der Kreuzspinne"; both were made by Prof. H. M. Peters (Zoological Institute, University of Tübingen). The second of these two was particularly noteworthy, as it allowed the quantitative evaluation of the action of benzidrine on the spider *Aranea diadema*; this was achieved by plotting against time the intervals along the radial threads of the web. "Biologie des Hamsters", Parts 1 and 2, were produced by Dr. I. Eibl-Eibesfeldt (Department of Animal Behaviour, Max-Planck Institute for Marine Biology, Buldern, Westphalia) and showed some remarkable instances of mating behaviour of hamsters as well as of their young. These four films were lent by the Institut für den wissenschaftlichen Film, Göttingen, through the courtesy of its director, Dr. G. Wolf.

There can be no doubt that this first collective presentation of research films from many disciplines at a meeting of the British Association was a great success, as the frequent and often lengthy applause by the audience amply demonstrated. The hope can only be reiterated in this article that, at the meeting next year in Sheffield of the British Association, all those who have made research films in the meantime will use the opportunity to present their results; the films should be submitted to either the Scientific and Technical Group of the Royal Photographic Society or to the Scientific Film Committee of the British Association.

A. R. MICHAELIS

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# RADIOCARBON DATING

## CONFERENCE IN CAMBRIDGE

THE second conference on radiocarbon dating held in Europe took place in Cambridge during the week July 25–30. Dr. H. Godwin, head of the Cambridge dating laboratory at the University Sub-department of Quaternary Research, Botany School, was the host and inspiring organizer of a most successful and instructive symposium. He assembled a small group of scientists representing almost all the dating stations in Europe, plus a few physicists who are in the process of setting up dating equipment. Thanks to a generous grant from the Wenner-Gren Foundation, New York, it had also been possible to invite a few of the leading Americans in this field. Thus, the conference was a first step towards the goal set in Copenhagen a year ago, where the establishment of closer personal contact with American colleagues was considered essential for future discussions—in Europe—of the implications of radiocarbon dating.

The Cambridge conference was devoted almost exclusively to the discussion of new methods, which have undergone rapid development in the past two years. The classical Libby method of 'counting' solid carbon in the screen-wall counter is being abandoned, mainly because the widespread contamination of the atmosphere with radioactive dust—although probably too low to be of significance as a health hazard—represents a serious menace to accurate low-level assay. This is particularly true in the case of 'black carbon' samples with their extremely large surfaces and high adsorption capacities.

In the United States and in Europe, a number of new approaches to the measurement of natural radiocarbon have been made simultaneously; for example, gas counting of carbon dioxide, acetylene and methane, and scintillation counting in which the sample to be dated is incorporated into the scintillator. Each of the methods mentioned was discussed in detail at the Cambridge conference, and a comparison of the merits of various techniques was attempted, especially as regards the ease and speed of operation, the accuracy achieved within a given counting time, the relative sample sizes, etc.

Just as at last year's conference in Copenhagen, the question of errors of radiocarbon ages was the subject of lively discussions. In the solid carbon method, the statistical error of the net count represents the largest contribution to the error of the final result. As this error is being suppressed by improving the ratio $S^2/B$ (sample over background), other factors such as isotopic fractionation during processing of the samples, variations in the natural isotopic constitution of the unknown and the reference sample, and the uncertainty in the half-life of radiocarbon, etc., begin to play an appreciable part in estimating the accuracy of radiocarbon measurements. Different errors have been combined in a variety of ways, and very few publications contain a concise statement as to how the errors listed have been computed.

A solution of this problem acceptable to all participants could not be found during the Cambridge meeting; but it was agreed that the manner in which the error is calculated should be stated explicitly in future publications.

Moreover, the standardization of the form of publication of dating results was discussed. All investigators present agreed that dating results should be collected at regular intervals for publication in either *Nature* or *Science*. They should preferably appear in the form of date lists similar to those issued by Libby, containing only a brief description of the sample, its current laboratory number and the station's identification prefix letter (cf. below). Obviously, publication of date lists will not replace presentation of the same results in their proper context in any other scientific journal; however, it will make the dating results of various stations more readily accessible to those interested in any one of the widely differing fields of application of the radiocarbon dating method. Also, the results of inter-laboratory cross-checking and standardization, as well as of mass-spectrometric monitoring, are of interest to many workers in this and related fields, and all data should be made available to the widest possible circle of readers. A list of the dating stations in operation or close to completion, and the identification prefix letters used or accepted for use by these stations, is given in Table 1, and additional information will be appreciated.

Table 1. DATING LABORATORIES

| | | | |
|---|---|---|---|
| *BM* | British Museum, London | *P* | Philadelphia |
| *C* | Chicago | *Q* | Cambridge, England |
| *GRO* | Groningen | *R* | Rome |
| *G* | Gothenburg | *GL* | Royal Institution, London |
| *H* | Heidelberg | *S* | Stockholm |
| *K* | Copenhagen | *T* | Trondheim |
| *L* | Lamont (N.Y.) | *W* | Washington |
| *M* ? | Michigan | *Y* | Yale |
| ? | Manitoba | ? | New Zealand |
| | | ? | Poznan, Poland |

In this connexion it may be mentioned that an informal exchange of scientific information between European dating laboratories has been in existence for almost two years, and an effort is being made to maintain and widen such contacts among scientists actually engaged in radiocarbon dating.

The meeting in Cambridge has given ample evidence of the great need for and interest in small conferences, where experience and progress within this rapidly developing field are discussed informally. The method of radiocarbon dating is still new, and further technical improvements are likely to come. On the other hand, its wide range of applicability has not yet been fully understood and appreciated. Therefore, joint meetings of physicists and chemists with archæologists, geologists and other users of dating results are bound to be mutually instructive and stimulating, provided the groups can be kept small and scientists with as remotely related interests as atomic physics and history of human cultures can discuss the essentials, each making an effort to understand the others' problems. HILDE LEVI

# ANIMAL PRODUCTION FROM GRASS

THE theme of "Animal Production from Grass" proved a most successful choice for the fifth 'study meeting' of the European Association of Animal Production, which was held at Reading during July. Representatives of seventeen countries were present, and all stayed in two of the University's halls of residence; this contributed on the social side towards the success of the meeting.

As a preliminary to the meeting, most of the visiting European delegates took part in a tour beginning with a visit to the Royal Show at Nottingham, where the Council of the Royal Agricultural Society extended its hospitality to the visitors. Particular interest was shown in the display of British breeds of livestock. Afterwards, visits were made to the research farm at Thurgarton and the Veterinary Research Unit of Messrs. Boots, and to Mr. Maurice Passmore's farm at Wormleighton.

At Reading, the theme for discussion was introduced by two main papers, each being followed by shorter reports on current research in the various countries. On the first day, Prof. M. M. Cooper, of King's College, Newcastle upon Tyne, delivered the chief contribution on "Animal Management for Intensive Production from Grass". This comprehensive review of the present position in farm practice and in the experimental field was both stimulating and provocative and delivered with characteristic vigour. Prof. Cooper directed attention to the discrepancies that exist between the recorded output from grassland under experimental conditions and that obtained on most farms, even those under more progressive management. For this the farmer must not be judged harshly. Many lack the capital to ensure better utilization, while generally there is a lack of the technical knowledge of how to produce grass with "the composition of a watered concentrate for eight or nine months of the year in sufficient quantities to meet the nutritive demands of high-producing cows"; and there is no simple recipe the adviser can give the farmer to enable him to do so.

In Britain the well-distributed rainfall and the fact that eighty acres is the size of the typical farm have made the higher efficiency of the dairy cow a dominating factor, and she is the pivot of a system of mixed farming. The meat-producing sheep is important on large arable farms and on the large, preponderantly grass farms of the north, where cattle may be merely mowing machines to keep the grass in good condition for maximum mutton production. One of the current problems is the extent to which sheep can be integrated into dairy farming. Some sheep on a typical large dairy farm are a necessity for proper pasture management; and in establishing a directly re-seeded pasture, they are invaluable in effecting consolidation and controlling weeds in the early stages. Used sensibly, they can augment the quality of grazing for the dairy herd; but in such circumstances, they are essentially scavengers, which is also their proper role on a large arable farm with limited grass.

Prof. Cooper also discussed systems of grazing, pointing out that trials in New Zealand gave better live-weight gains, carcass weights and lamb grading from rotational grazing where the stocking-rates were high than from non-rotational grazing, but that at low rates of stocking the reverse was true. On conservation of grass we have much to learn from Continental countries. Though we should aim at maximum use *in situ*, with the reduced conservation losses, lower handling costs and better return of animal excrement to maintain fertility, conservation is also essential and is a means as well as an end in intensive pasture management.

Finally, Prof. Cooper appealed for a better assessment of nutrient off-take from pasture. It is absurd to credit full value to concentrates and other foods of known analysis, leaving grass and grass products to carry all the errors of estimate. Such a system, now current, discounts the value of grassland under a system where both grass and concentrates are fed, and makes intensive grassland management appear less efficient than it actually is.

The first of the subsidiary papers was by Dr. W. Holmes and D. S. MacLusky, of the Hannah Dairy Research Institute. They reviewed the effects of pasture management methods on the production and feed consumption of dairy cows in trials on the Institute's farm. Production per acre was in many cases the final objective, and for this purpose maximum herbage consumption per cow might not be the best policy, as it might be obtained at the expense of efficient food conversion. Possibly slightly more mature herbage than the ideal may sustain more cattle per acre with only negligible reduction in yields per cow. Provided weather and good management ensure a constant supply of good grass, the strip-grazing method without cutting the grass or providing supplementary feed appear to give the most satisfactory results.

In a report of "A Comparison of Systems of Sheep Grazing Management" carried out at Wye College, Kent, H. Cornforth dealt with two sheep-grazing trials. Where nitrogenous fertilizers were used, rotational grazing gave the best utilization. Three days appeared to be the maximum that fattening sheep should remain on each plot. Gang-mowing had an advantage under continuous grazing where no nitrogenous fertilizer was used, but not where nitrogen was applied. Rotational grazing of a sward treated with nitrogen gave almost 700 lb. live-weight gain per acre, which is 27 per cent better than from a continuous grazing treatment on the same light chalk soil.

Other papers in this section were from Yugoslavia, Germany, The Netherlands, Austria, Portugal and Switzerland. That from P. B. De Boer, a Netherlands farmer, outlined his methods of intensive grassland farming, designed to try to eliminate the estimated

3 per cent loss of grown herbage in the process of grazing and conservation. This is done by strip grazing for limited periods and housing the cows at night. Each field is cut or grazed five or six times per season, nitrogenous fertilizer being applied following each cut or grazing period. By alternating cutting and grazing, palatability is improved. Dung is only applied to fields the crops of which are to be cut for silage the following season. The yield of cows shows that grass grown in September or October is not so productive of milk as that grown earlier in the summer. Starchy foods are used to balance the grass and give better utilization.

The second session of the meeting was devoted to the "Agronomic and Physiological Considerations governing Grassland Utilization". For this subject the principal paper was in two parts, the first on the physiological aspects being given by A. M. Frens, of The Netherlands State Agricultural Experiment Station at Hoorn, while the second, on the economic principles of grassland farming, was given by H. Dijkstra, of The Netherlands Agricultural Economics Research Institute.

Mr. Frens, in a clear and persuasive paper, pointed out the difficulties with which cattle on intensively managed pasture have to contend in dealing with the physical structure and high moisture content of young tender grass on which they are expected to live for long periods. Where the feed is low in fibrous and stemmy components, it tends to pack too closely in the rumen, and optimal microbial activity does not develop. This may lead in extreme cases to a deficiency of those nutrients of microbial origin which are essential to the animal's well-being. Not only so, but also the large quantities of water that have to be dealt with by animals living on luscious young grass strain their resorptive capacity, and water resorption from the intestines may be less effective than it physiologically should be. This results in soft fæces, in which an excess of minerals is excreted. Cattle which are scouring, moreover, tend to have a greater sodium and copper requirement, and the grass may contain insufficient to meet the extra demand caused by the increased loss by excretion. Supplementary food to give additional fibre to cattle on highly stimulated pastures can be an advantage, even if the grass contains all the nutrients needed for the animal's level of production. It should be chosen carefully, so that it does not prevent a high intake of grass, and the inclusion of extra sodium, copper and perhaps magnesium may be worth while.

Mr. Dijkstra's paper was the only one dealing with economic aspects. He laid down three conditions that must be fulfilled for the most economical production: (*a*) grass and grass products must be adapted, in the most economical way and along with any purchased feeding-stuffs, to the feeding requirements of the farm livestock; (*b*) the farm equipment, seeds, fertilizers and labour used must be so applied that no greater net output could be obtained by utilizing them in any other line of production; and (*c*) the primary products of the enterprise (grassland products) must be converted as efficiently as possible into the secondary products (milk, meat, etc.). These three conditions are not independent of each other, but have a mutual influence.

There were twelve subsidiary papers in this session, of which two were contributed from the United Kingdom. W. F. Raymond, of the Grassland Research Station, reviewed the problems involved in the "Estimation of Herbage consumed by Grazing Stock". At the Grassland Research Station, as in New Zealand, the fæcal index method is being developed. It is felt that this method is likely to give greater accuracy than others being tried in America; and that from it an estimate of the grazing intake can be made and a measure of the herbage quality obtained. While the technique is simple to operate, it is dependent on adequate sampling, and to this greater attention has still to be given. J. L. Corbett, of the Rowett Research Institute, dealt with "Some Aspects of the Nutrition of Grazing Dairy Cows" and gave details of trials in which the effects of supplementary foods on herbage intake were studied.

Other contributions were from France, Portugal, Switzerland, Belgium, Germany, The Netherlands, Finland and Italy. Dr. L. Seekles, of The Netherlands, dealt with grass or lactation tetany, to which he prefers to give the name 'nutrition tetany'. He criticized the suggestion frequently made that intensively fertilized pasture is a prime cause, since it may occur both on lush pastures and in stall-fed cattle. In addition to the visible symptoms of tetany, there is also gastro-intestinal disfunction. It is possible that certain poisons of intestinal origin interfere with the magnesium-regulating centre in the brain, causing a shift of magnesium from the blood to the tissues. This may be initiated by abnormal functioning of the digestive tract due to its overburdening with excessive food, whether it be lush pasture or other foods. More than one contributor directed attention to the importance of developing the correct bacterial flora for the best digestive utilization of silage. Invariably, animals to which silage is introduced make little or no progress for some time, though later they may recover the lost ground. This appears to be due to the time taken for the correct bacteria for digestion of silage to develop. Further study of this aspect of digestion and of the best utilization of various forages is needed.

A characteristic of both sessions was the vigorous discussion, which was ably directed by the president, Prof. A. M. Leroy. The meeting concluded with the adoption of a resolution calling for intensified research on international lines on the problems of producing a high yield of good-quality grass and of its utilization. There is still, except in some circumstances, a failure to use the full potentiality of the grass crop.

A. R. WANNOP

# INSTITUTE OF MEDICAL LABORATORY TECHNOLOGY

## SEVENTH TRIENNIAL CONFERENCE

THE seventh triennial conference of the Institute of Medical Laboratory Technology was held in the University of Nottingham during August 29–September 2. In opening the conference, Dr. G. E. Godber, joint deputy chief medical officer to the Ministry of Health, spoke on the development of the pathology services in Great Britain. He began, appropriately, by showing the build-up of laboratory services in the North Midland Region since the beginning of the Second World War, during which the Emergency Pathology Service became the forerunner of the existing network. In spite of war-time improvements, the pathological services over the whole country were far short of requirements when the National Health Service took over in 1948.

Between then and 1954 the amount of pathological work has doubled; almost two thousand technicians and about the same number of student technicians were employed last year in National Health Service laboratories. This increase of laboratory work should be looked upon as part of a process established before the Health Service or even before the War. We have moved from the conception of a hospital which was primarily to provide beds in which patients recovered with varying degrees of assistance from their attendants, to one in which the hospital is a diagnostic and treatment centre, where most patients are out-patients, their needs being met without admission. Admission to the ward is now regarded as a stage in the patient's life and illness which should in his own interests be cut as short as is compatible with speedy and effective cure. Briefly, the hospital is a special kind of service which stands behind, and supports, the great bulk of curative work that is done in other places—surgeries, clinics and the patients' own homes.

Naturally, the bulk of the most complex and highly scientific work is done for patients attending consultative out-patient departments or admitted to the wards. This should not hide the importance of the laboratory's share in diagnosis and treatment in other places, and it is necessary that this side of its work should be expanded. The work of general practitioners is of great importance because so much of it can lead to earlier diagnosis, prevention of serious illness, and the reduction of the load on other departments of the hospital. There is ample evidence that the availability of the pathology laboratory to the general practitioner does not swamp the laboratory with work at the expense of the requirements of the hospital itself: it may even have the opposite effect. That every practitioner should be able to refer his cases direct to the laboratory is a prime necessity.

Speaking of the capital development plan for hospitals, Dr. Godber said that it is commonly believed that a new hospital must necessarily cost more to run than an old one, and it may be that a new one will cost more per bed per year; but if the new hospital makes it possible to treat three patients in the number of bed-days formerly required for two, then there is a margin for increasing cost per patient-day and still reducing the cost per patient treated. A modern pathological service can do much to enhance this process, and particular care is needed in hospital planning to ensure that such departments as pathology and radiology are on a sufficient scale to meet all requirements efficiently and at the same time with economy in man-power.

The laboratory, continued Dr. Godber, is part of the hospital and should not be divorced from it; the clinician relies upon laboratory workers for accurate and expert information which gives him the assurance that enables him to control the complicated armamentarium of treatments. Diagnosis is, after all, rarely a simple process of exact definition and needs a balance of evidence from a variety of sources. Likewise, modern treatments often need the most exacting control, and for these reasons there needs to be close contact between the laboratory and the clinician. Along with the use of more complicated and more accurate apparatus, there has been an increasing devolution of responsibility to the technical staffs of medical laboratories. The Institute of Medical Laboratory Technology has played a great part in facilitating the changes which have taken place in the past few years by its promotion of education and its qualifying examinations and by maintaining and achieving a status for the medical laboratory technician which is now recognized in Britain throughout the national hospital service and all other laboratories.

There were five sessions of scientific lectures at the conference, about two-thirds of which were given by Institute members and the remainder by guest speakers. Dr. M. Lumb spoke on the influence of antibiotics on modern clinical bacteriology; the influence of these substances in the treatment and bacteriology of tuberculosis occupied part of the talk given by Prof. Robert Cruickshank, president of the Institute. Some of the most interesting of the recent problems in this disease have been raised by the type of lesion in which the tubercle bacillus can be demonstrated microscopically but not culturally. Prof. Cruickshank ended his observations with a very necessary warning to laboratory workers. Many laboratories are now handling tuberculous material, and the need for antibiotic control has resulted in a great increase of living culture work. The incidence of the disease in laboratory workers is disturbing, and every possible care should be taken to guard against laboratory infection.

Prof. E. J. W. Barrington, of the Department of Zoology in the University of Nottingham, was able to show a common meeting-ground for those who work in pathology departments and those who work in other specialties, when he spoke of the place of histology in endocrinological research. Certain of the new cytochemical methods, he said, are of equal value in the earthworm and in man. Mr. F. A. Ibbott gave a provocative paper on the error induced in volumetric glassware by drying and sterilization with heat; his own experiments, some of them drastic, have shown that no significant changes were produced by dry heat in certain of his own standard apparatus. Dr. J. C. White, of the Postgraduate Medical School of London, gathered together recent advances in our knowledge of the human hæmoglobins, while Dr. N. P. Burman dealt with methods of detecting and counting antagonistic micro-organisms in soil and described some of his own methods for simplifying a tedious and time-consuming process.

Prof. K. E. Cooper, professor of bacteriology in the University of Bristol, took modern trends in microscopy as his subject and illustrated the principles of phase-contrast, electron and interference microscopy. Speaking of ordinary microscopy, Prof. Cooper deplored the tendency of some workers to set up a very good microscope with a poor illuminating system, so not making full use of their instrument. Mr. J. S. Simpson showed methods employed in the microbiological assay of antibiotics, vitamins and amino-acids, and was able to demonstrate how the use of large sandwiches of agar between glass plates saves the use of considerable quantities of Petri dishes. Dr. G. R. Osborn, director of pathology, Derbyshire Royal Infirmary, gave many examples of the use of modern cytological techniques in the early diagnosis of cancer, and he was followed by Miss M. E. Attwood, who has applied such techniques to the problem of diagnosing uterine carcinoma in particular.

Among other papers were those of Miss V. A. L. Brews, who dealt with electrophoretic patterns of blood sera and the flocculation tests, while Miss E. L. Bown gave a résumé of semi-micro methods used in pædiatric biochemistry. Dr. H. M. Rice, director of pathology, General Hospital, Nottingham, made observations on the sensitivity of the hæmolytic system in complement fixation tests and showed the greater reliability of modern modifications in the tests, for example, for syphilis. Mr. I. Dunsford, of the Sheffield Blood Transfusion Service, was able to draw on an extensive practical experience in discussing the difficulties encountered when selecting suitable blood for transfusion purposes. His main point was that no one test should be relied upon when cross-matching blood but that saline and albumin techniques should always be employed, with the addition of the Coombs test in cases where there was a risk of the patient having been immunized by previous transfusions or pregnancies.

In addition to these and other papers, numerous demonstrations were on view all the week. For the first time at an Institute conference a large number of foreign laboratory workers were present, and an evening was spent on discussion of matters of common interest. Another innovation was a demonstration for the public who, generally speaking, are not very knowledgeable about what takes place in the hospital laboratory. This demonstration, the result of much co-operation between local pathologists, technicians and many others, was open for only three hours on each of two successive evenings; but the success of the experiment may be judged by the fact that during this short time more than a thousand people visited it.

# PRESERVATION OF FOOD BY IONIZING RADIATIONS

THE traditional methods available for the preservation of food are several and varied in their nature. The almost prehistoric method of drying involving the use of solar radiations—unrecognized as such—was the subject of much research some years ago, and this work was very useful to Great Britain during the Second World War when there was a great shortage of shipping space. Some of the chemical preservatives, studied by the 1924 Departmental Committee of the Ministry of Health, often 'blunderbuss' in function, are virtually unused outside the British Isles where those of more recent introduction have been found acceptable both by the industry and the authorities. The availability of antibiotics—some very specific in their action—has created new problems for those who advise our legislators on the desirability of permitting additions to the schedule of preservatives, for such they are. In the realm of food science, experimentation and development, although more sedate in their progress compared with some of the other branches of science, often outstrip the ability of the manufacturers to take advantage of them.

The initial discovery by Röntgen in 1895 that X-rays can damage and destroy living cells has in more recent years been extended over the broader field of ionizing radiations in general. The situation to date, as recorded in various journals mainly of American origin, is that radiations derived from electrical generators, radioactive elements and nuclear reactions are available which exert a lethal effect upon micro-organisms and insects. Parallel with these observations have been reports of reactions initiated by the exposure of food components to such radiations—breakdown of amino-acids, fats, vitamins and so on. The food technologist faced with a new series of units representing the dosage of the product under treatment has often been in difficulty in grasping the significance of the evidence given in these reports, and the very long list of journals in which such reports are sometimes hidden only adds to his confusion. With considerable foresight, the Food Investigation Organization of the Department of Scientific and Industrial Research, as befits its name, has come to the aid of food technologists in providing, through the efforts of Dr. R. S. Hannan, a wealth of information and, let us not delude ourselves, of instruction in its Special Report No. 61 on "Scientific and Technological Problems involved in using Ionizing Radiations for the Preservation of Food"*. The bibliography of some four hundred odd references in this publication will satisfy every collector of reprints and is alone worth every penny of the modest price.

In his survey, Dr. Hannan deals with the ionizing radiations, their generation, their properties and the technical problems associated with their use. Having described the positive advantages of the use of this modern weapon, he very wisely presents for the reader's consideration the various gaps in our knowledge which must be filled before we are able to contemplate using it. The most suitable type of radiation and its optimum dose, the possibility of reactions initiated by such dosage involving the production of undesirable and maybe toxic substances or the destruction of some essential constituent—all these will need to be studied *in extenso* and by teams of workers. We are grateful for the information and for the guidance as to future research, and we look forward to the results of the further researches of Dr. Hannan and his colleagues.

F. H. BANFIELD

* Department of Scientific and Industrial Research. Food Investigation Special Report No. 61: Scientific and Technological Problems involved in using Ionizing Radiations for the Preservation of Food. By Dr. R. S. Hannan. Pp. viii+192. (London: H.M.S.O., 1955.) 7*s.* 6*d.*

# PHYSICS OF THE IONOSPHERE

THE rapid advances being made in many fields of scientific research leads to a vast amount of published literature in which it is not easy for the student and research worker to discover the real milestones of progress. As a means of partly mitigating this difficulty, there is now an established practice of organizing a conference or symposium at which a particular subject or field of investigation is reviewed and discussed, mainly by those working in the subject. Such a conference forms a suitable focus and also acts as a stimulant to those who otherwise may be rather dilatory in describing their own contributions or putting forward well-founded views on the work of others. The results of such a conference are made of immensely greater value when all the papers which were read and discussed are collected together and published in some recognized standard form.

The conference on "The Physics of the Ionosphere", held under the auspices of the Physical Society at the Cavendish Laboratory, Cambridge, in September 1954 (*Nature*, 174, 866; 1954), meets all these requirements with the publication of the report which is now available*. The report comprises fifty individual papers from authors in Australia, Canada, France, Germany, Great Britain, India, Japan and the United States. It is divided into four parts, each of which is introduced by a survey paper, with a most useful selected list of references.

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* Physical Society. Report of the Physical Society Conference on the Physics of the Ionosphere, held at the Cavendish Laboratory, Cambridge, September 1954. Pp. iv+406. (London: Physical Society, 1955.) 40*s.*

In the first paper in Part 1, entitled "The Lowest Ionosphere", Prof. A. H. Waynick summarizes the recent radio data which may be used as a guide to the possible physical characteristics of the lowest regions of the ionosphere. These characteristics are primarily concerned with the absorption of short waves and their partial reflexion from the lower ionosphere, and the height of reflexion of very long waves. It is pointed out that great advances in our knowledge of the lower ionosphere is likely to occur in the near future. Recent rocket measurements of X-ray intensities in the neighbourhood of 50 A. suggest that this radiation may well be the primary source of energy associated with the formation of the *E* region. In addition, there now appears to be evidence for postulating the existence of a portion of the *E* region due to meteoric ionization. The remaining nine papers in Part 1 describe work conducted in this field in Great Britain, North America, Germany and India.

The second part of the report, "Irregularities and Movements in the Ionosphere", opens with a survey of existing knowledge by Mr. J. A. Ratcliffe. At all heights in the ionosphere there are randomly distributed irregularities in the electron density. Information on these irregularities—their size, shape and movement—is obtained from a study of the fading characteristics of waves reflected from, or transmitted through, the appropriate part of the ionosphere. The study of the fading observed at spaced receiving stations has contributed greatly to our knowledge of the movement of these irregularities. During recent years, measurements of the propagation of very-high-frequency waves by scattering from the *D* and *E* regions and from aurora are finding increased application. Observations on the scintillation of radio stars also enable drift movements in the *F* region to be investigated. The sixteen papers collected with the survey in this part of the report form a very complete and up-to-date appreciation of the state of experimental and theoretical knowledge of this subject.

"A Survey of Present Knowledge of the *F*2 Region", by Dr. D. F. Martyn, is the first paper in Part 3, and describes the salient features of the *F*2 region, including the production of its ionization, the recombination coefficients, winds and travelling disturbances, and the storms and anomalies associated with this region. While the other eight papers in this section summarize the present state of knowledge, including theoretical speculation, of conditions in the *F*2 layer, a brief reference is made, in an addendum to the survey, to the wealth of information which was obtained by a rocket ascent in May 1954 to a height of 219 km. A mass-spectrograph was used and data obtained on the composition and pressure in the upper atmosphere. While the results await confirmation, this is undoubtedly an indication of the success of a new technique for exploring the ionosphere.

The fourth and final part of the report deals with "The Mathematics of Wave Propagation through the Ionosphere", and is surveyed by Mr. K. G. Budden. With thirteen other papers, this section describes the mathematical technique used in the study of the properties of the ionosphere, and particularly the variation of ionization density with height, the resulting refractive index and the paths of radio waves in traversing the various ionospheric layers. This section is complementary to the previous three and makes the whole report a comprehensive work of reference which will be of the greatest value to students and research workers for many years to come. The publication of the report must be a very gratifying conclusion to the efforts of Mr. Ratcliffe and his colleagues who were responsible for the conception and organization of this conference.

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# AUXIN AND PROTOPLASMIC STREAMING

It has now been known for some considerable time that indoleacetic acid and other growth-regulating substances increase the rate of protoplasmic streaming, but no generally accepted explanation of the phenomenon has yet been advanced. J. M. Kelso and J. S. Turner (*Austral. J. Biol. Sci.*, **8**, 1, 19; 1955) have now reported on the action of various growth-regulating substances on streaming in single cells of the staminal hairs of *Tradescantia virginiana*.

As the rate of protoplasmic streaming in these cells is not affected by change of oxygen concentration in a hanging drop enclosing the hairs over the range 1·5–100 per cent of oxygen in the surrounding gas phase, experiments can be carried out without continuous renewal of the water drop. It was observed that, over the physiological range of concentrations, indoleacetic acid, indolebutyric acid, naphthaleneacetic acid and 2,4-dichlorophenoxyacetic acid, all modify the rate of protoplasmic streaming. These substances, added alone, bring about changes in the rate of streaming within 10 min.; maximum effects are reached in 30 min., and the rates return to the normal in 60–70 min. (exceptions to this rule are noted for naphthaleneacetic acid (high concentrations) and 2,4-dichlorophenoxyacetic acid (low concentrations)). Low concentrations of the auxins stimulate the streaming, high concentrations depress the rate, and intermediate concentrations are without effect.

Auxins thus affect streaming much as they do the growth of stems, the optimal concentrations for stimulation being similar for both processes. The 'total effect' for each growth substance may be estimated as the total extra or diminished distance travelled by a protoplasmic particle in the presence of the applied substance. The maximum positive total effect is given at 1 mgm./l. (1 p.p.m.) for indoleacetic acid and indolebutyric acid, and at 5 mgm./l. for naphthaleneacetic acid. There is a marked *p*H effect for the reaction of streaming to indoleacetic acid, increase in *p*H rendering the applied solution much less effective over the whole range of concentration. The temporary effects of indoleacetic acid on streaming, both stimulation and inhibition, are stabilized near their maximal values, if fructose or malic acid is added with the auxin. These results largely confirm those obtained by Thimann and Sweeney for the *Avena* coleoptile, except that the concentration for indoleacetic acid giving maximal total effect for *Avena* is as low as 0·01 mgm./l. Moreover, for *Avena*, malic acid not only stabilizes the auxin effect but also alters the threshold of response.

# COSMIC RADIATION EFFECTS IN METEORITES

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AND
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Clarendon Laboratory, University of Oxford

RECENT studies of meteorites[1] showed that they contain an appreciable amount of helium-3 produced by cosmic rays. The interactions of high-energy cosmic-ray particles with the meteoritic matter will produce effects which are propagated to great depths by secondary particles as well as primaries. Nuclei of a wide range of mass numbers less than that of the original should occur in varying proportions, either as evaporation products or as residual nuclei.

We have investigated the production of nuclei of mass 3 and 4 [1] (evaporation products); we now report some measurements on the neon isotopes (residual nuclei) in iron meteorites. The data for helium and neon from four irons are given in Table 1.

Because the amount of neon is two orders of magnitude smaller than the amount of helium, only in the case of Thunda was enough neon available for mass-spectrometric analysis; the precision of this analysis is better than 5 per cent. The measurement is complicated by the presence of instrumental background peaks at mass 20 and 22, due to $H_2{}^{18}O^+$ and $CO_2{}^{++}$ respectively. The former was considerably reduced by replacing oxygen-18 by oxygen-16, the latter by using an (electron) ionizing voltage of 35 V. The method of helium and neon separation has been described elsewhere[2], but special care was taken to remove adsorbed atmospheric neon from the containing vessel before commencing dissolution of the meteorite sample. The amount of atmospheric neon contamination was less than $10^{-9}$ c.c., which represented less than 1 per cent of the meteoric neon finally measured.

It would appear from the isotopic analysis of the extracted neon that all its isotopes arise from the original iron nuclei after the direct ejection and evaporation of nucleons are completed. Such events as these are the 'stars' recorded in photographic emulsions exposed at high altitudes; and we have used the statistical data obtained from photographic plates to estimate the rate of production of neon by cosmic radiation. The degradation of the iron nucleus ($Z = 26$) to neon ($Z = 10$) involves the emission of 16 units of charge from the parent; but since some of the emitted particles will carry a multiple charge (helium nuclei), it seems, taking the He/$p$ ratio of about 0·3 derived by evaporation theory[3], that the events with which we are concerned will appear on the photographic plate as stars of about thirteen prongs. Taking the rate of star production by cosmic rays in photographic emulsions as about 2,500 stars/c.c./day at the top of the atmosphere[4], this is increased by a factor of 2 to give the rate of production in iron, and by a further factor of 2 to obtain the rate away from the earth's shielding effect. From the data given by Lord[4], it would seem that about 2 per cent of the total stars produced are thirteen-pronged events. Even if any cut-off of low-energy particles due to the earth's magnetic field does exist, one would not expect the figure of 2 per cent of the total stars giving neon to be very much altered in space, since only high-energy particles will give rise to thirteen-pronged events. Thus we calculate a rate of production of neon of about twenty-five neon atoms/gm. iron/day. In addition, one would expect the isotopes sodium-20, 21 and 22, and fluorine-20 and 21 to be produced in such quantities that, in decaying into a neon isotope, and more than replacing the loss due to neon-19 and 23, they will approximately double the yield of neon, making a total of fifty neon atoms/gm. iron/day.

We have already suggested[5] the possibility that the cataclysmic break-up of a parent planet formed the meteorite fragments about $2 \times 10^8$ years ago. On the basis of the above data, one would expect the neon produced in an unshielded fragment to be about $1·35 \times 10^{-7}$ c.c./gm. iron, and the isotopic composition and large yield of the helium extracted from our sample of Thunda would indicate that this piece was relatively unshielded from the cosmic radiation. Since it seems that the helium-3 and neon in a meteorite are all produced by cosmic radiation, one would expect approximately the same ratio of neon to helium-3 in any unshielded sample. This ratio for the four samples concerned is given in Table 1 and the values obtained prove to be closely similar. The calculations of Le Couteur[3] suggest that about 37 per cent of the total yield of particles from 'evaporation stars' will be in the form of helium-4, helium-3, or tritium, all of which will be recorded as helium after a suitable lapse of time. Taking the average number of prongs per star as ten at the average cosmic-ray energy concerned, and using the measured ratio ($^3$He + $^3$H)/$^4$He of 30 per cent, we can deduce a figure of about a hundred atoms of ($^3$He + $^3$H) per hundred stars. (The tritium we eventually measure as helium-3.) Using again the figure mentioned above of two to four neon atoms per hundred stars, we would expect the neon/helium-3 ratio to be between 2 and 4 per cent, comparing favourably with the measured value.

Table 1

| Meteorite | Helium ($10^{-6}$ c.c./gm.) | Neon ($10^{-8}$ c.c./gm.) | Ratio He/Ne | $^3$He/$^4$He (per cent) | Ne/$^3$He (per cent) | Per cent neon-20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|
| Thunda | 29·05 | 18·9 | 154 | 30·7 | 2·71 | 43 | 36 | 21 |
| Toluca (Durham) | 18·6 | 11·4 | 164 | 29·7 | 2·60 | | | |
| Carbo (3 cm.) | 20·94 | 12·3 | 171 | 28·6 | 2·63 | | | |
| Carbo (0·5 cm.) | 22·36 | 13·2 | 169 | 28·4 | 2·69 | | | |

We have also compared our results with those obtained from recent laboratory experiments on high-energy reactions induced by protons in copper[6]. In Table 2 are listed the estimated production cross-sections (from copper) of the

Table 2

| Isotope | Estimated cross-sections (m.barns) |
|---|---|
| Sodium-20 | 0·6 |
| Sodium-21 | 1·0 |
| Sodium-22 | 2·0 |
| Neon-20 | 4·0 |
| Neon-21 | 3·0 |
| Neon-22 | 2·5 |
| Fluorine-20 | 2·5 |
| Fluorine-21 | 0·5 |

nuclear species which end in neon isotopes. The variation of cross-section with $Z$ for a given element was estimated from the average shape of the curve for all neighbouring elements, as discussed by Batzel *et al.*[6].

Taking these values, the isotopic composition of the neon produced should be: neon-20, 44 per cent; neon-21 and neon-22, 28 per cent. Our measured isotopic ratios given in Table 1 are in reasonable agreement with these estimates, considering the uncertainties in the cross-sections, and in the energy spectrum of the cosmic rays.

With the data of Table 2 we may make an independent calculation of the rate of production of neon. Because we are considering reactions in iron (8 mass units from copper), we increase the cross-section values by 20 per cent; that is, we take 20 m.barns as the total cross-section for neon production. For a cosmic-ray intensity[4] of 0·3 particle/cm.$^2$/sec./sterad., $2 \cdot 6 \times 10^4$ atoms of neon are produced per gm. of iron per year; or in $2 \times 10^8$ years, about $2 \times 10^{-7}$ c.c. neon/gm. iron, a value once again close to the measured neon content.

It seems that the cosmic radiation to which the fragments have been subjected since the parent was broken up has produced measurable quantities of many nuclides lighter than iron, the study of which should lead to a better understanding of the radiation and the high-energy processes involved. We are continuing our investigations, particularly for samples of greater depth, and extending them to cosmogenic argon.

We would expect that the events which produce argon ($Z = 18$) from iron ($Z = 26$) would appear as six- or seven-pronged stars, and again using the data of Lord[4], we find that argon should be produced about four to five times as abundantly as neon, suggesting a cosmogenic argon content for unshielded meteoritic iron samples of about $6 \times 10^{-7}$ c.c./gm. In addition, it is to be expected that the isotopic composition of cosmogenic argon would differ markedly from that of atmospheric argon, with argon-36 and argon-38 much more predominant in the former source than in the latter.

If this proves to be correct, it should be possible to predict the amount of many other cosmogenic isotopes in meteorites, and to decide which of these will lend themselves most readily to experimental determination.

We are grateful to Dr. W. O. Lock and Dr. S. J. Goldsack, of the University of Birmingham, who helped to interpret the photographic emulsion data; and to Dr. J. L. Symonds, of the University of Birmingham, who provided the data derived from high-energy proton-induced reactions. We would also thank Prof. F. A. Paneth for his interest in the work and for providing samples of meteorites.

[Aug. 23

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# MECHANISM OF SOME REDUCTION PROCESSES ILLUSTRATED ON A COENZYME I MODEL SUBSTANCE

By Dr. GABRIEL STEIN and GAD STIASSNY
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THE enzymatic reduction of coenzyme I (diphosphopyridine nucleotide) has been the subject of many investigations and discussions recently[1]. The product obtained by reducing coenzyme I with hydrosulphite can be reoxidized enzymatically, as of course can the reduced coenzyme I formed by enzymatic reduction. It was recently shown that the reduction product obtained[2] from coenzyme I when reactive intermediates produced from, for example, ethanol in irradiated aqueous solutions were used as the reducing agents was not identical with the product of hydrosulphite reduction[3]. This reduction product was enzymatically totally inactive. Borohydride reduction yields a product which could be reoxidized enzymatically to the extent of about 50 per cent[4].

The chemistry of these processes has been investigated on N′-alkyl nicotinamide derivatives, which represent the active group of coenzyme I[5]. Karrer[6] isolated the hydrosulphite reduction products of several such derivatives and compared them with reduced coenzyme I, which they resembled closely. Such a substance was used in electrolytic and polarographic investigations of coenzyme I model systems[7,8].

Using such a model substance, it was also shown[3] that as, in the case of coenzyme I, when reactive intermediates formed in irradiated aqueous solutions were used as the reducing agent, a reduction product is obtained which is closely related to, but not identical with, the product of hydrosulphite reduction.

The work of Colowick[9] and Swallow (results in the press) indicate that the enzymatic and hydrosulphite reductions of coenzyme I proceed not through a free-radical intermediate, as sometimes assumed, but through an ionic addition mechanism. On the other hand, the mode of action in the irradiated system was assumed[3,10,11] to be due to the intermediate formation of free radicals. The ionizing radiation would in the main act on the bulk of the aqueous solvent, producing radicals according to[12]:

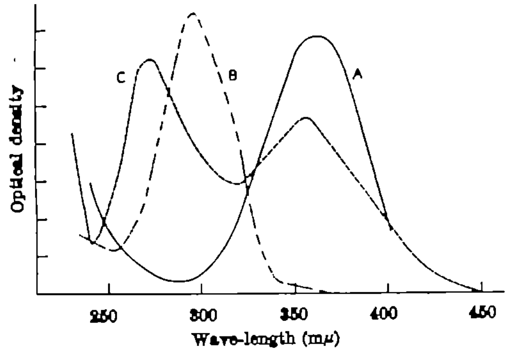

Fig. 1. Absorption spectra of: (*A*) product of hydrosulphite reduction; (*B*) product of acid treatment; (*C*) product of reduction in irradiated solution. Optical density in arbitrary units

$$HOH \rightarrow H + OH \qquad (1)$$

OH radicals attack the ethanol according to:

$$RH_2 + OH \rightarrow \dot{R}H + HOH \qquad (2)$$

The organic free radicals, $\dot{R}H$, thus formed are apparently efficient reducing agents of coenzyme I, themselves being oxidized to acetaldehyde.

Thus it appeared possible that, in the present case, closely related but not identical products are produced through different mechanisms of reduction. Accordingly, using nicotinamide-N′-propyl iodide as the model substance, we have examined some modes of reduction.

Using hydrosulphite, a pure crystalline reduction product could be isolated, melting point 86° C. Elementary analysis and oxidative titration showed it to be a dihydro-isomer. The absorption spectrum of the product in carbonate alkaline solution is shown in Fig. 1, curve *A*. In acid solution the spectrum changes to that shown in Fig. 1, curve *B*.

On irradiation with X-rays in aqueous solution (ref. 3 and unpublished work by the authors and Swallow) containing 0·5 *M* ethanol and approximately $10^{-3}$ *M* nicotinamide-N′-propyl iodide, another product was obtained, the spectrum of which is shown in Fig. 1, curve *C*. The product isolated was crystalline, melting point 99–103° C. Elementary analysis and oxidative titration indicated that it is a dihydro compound. In acid solution it gave a spectrum as shown in Fig. 1, curve *B*, identical in all respects with that obtained from the other product.

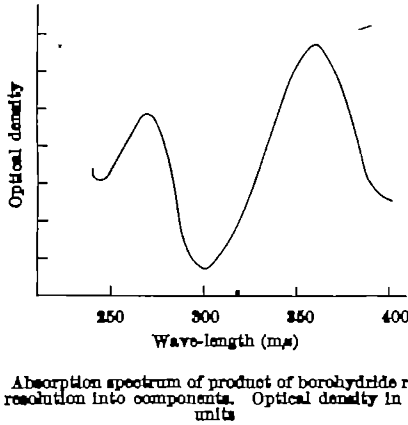

Fig. 2. Absorption spectrum of product of borohydride reduction, before resolution into components. Optical density in arbitrary units

In view of these findings, it was of interest to investigate the results of borohydride reduction. Here, in the case of coenzyme I, a product exhibiting enzymatic behaviour midway between the products obtained by the other two methods is obtained. On borohydride reduction of the nicotinamide we obtained a product having the spectrum shown in Fig. 2, a composite of the other two. From the product two pure components could be separated. One, a crystalline product having melting point 103° C., gave a spectrum like Fig. 1, curve *C*, whereas the other gave a spectrum like Fig. 1, curve *A*. Thus borohydride reduction apparently gives a mixture of the products obtained by the other two methods.

Regarding the product of electrolytic reduction, Leach[7] obtained the $E^0$ values of the product in solution, but did not isolate it. Fundamental work on the mechanism of organic electrolytic reduction processes became available recently[13], indicating that in this method radical intermediates may result.

On electrolytic reduction of nicotinamide-N′-propyl iodide in alkaline carbonate solution, a product was obtained the spectrum of which is identical with that of the radiation product and one of the borohydride products, as shown in Fig. 1, curve *C*.

We find, then, that electrolytic and radiation reduction, both of which are assumed to proceed by a free-radical intermediate, yield the same dihydro derivative. Hydrosulphite reduction, proceeding by an ionic addition intermediate, yields another dihydro derivative. Borohydride, the mode of operation of which is not entirely certain yet, but is often assumed to involve hydride ($H^-$) ions, yields a mixture of two such derivatives, which can be separated into its components.

If Pullman's[14] views are accepted and if hydrosulphite does indeed yield the same isomer as the enzymatic process, as is often assumed, then the product of these two methods would be the *para*-dihydro isomer. Two *ortho*-dihydro isomers are possible, and judging by the behaviour of the N′-alkyl nicotinamide models, Karrer thought the enzymatic product to be an *ortho*-dihydro derivative.

We hope to gain further information on this point from an investigation now in progress in collaboration with Dr. A. J. Swallow (unpublished work), whom we thank for valuable discussions and co-operation. The radiation chemical aspects of the present work and of work on some other systems of biological interest are being reported separately[11].

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Respiratory Chain Phosphorylation in Extracts of *Azotobacter vinelandii*

Respiratory chain phosphorylation has been demonstrated in crude extracts of a few bacterial species[1–4], and in one case the extract was separated into three components which were all necessary for phosphorylation coupled with the oxidation of reduced diphosphopyridine nucleotide[2]. However, the elements supporting the system of enzymes responsible for oxidative phosphorylation in bacterial cells is still unknown. The present communication describes some preliminary experiments in which a crude water-extract from *Azotobacter vinelandii* was fractionated by high-speed centrifugation into particles and 'soluble' fractions. This organism was chosen because it is strictly aerobic (cf. ref. 2) and has a very high respiratory activity.

Table 1. Oxidative Phosphorylation in Extracts of *Azotobacter vinelandii*

See text for method of preparation of fractions. In experiments 2–4, fraction *P* was washed by resuspending in 0·05 *M* phosphate, pH 7·0, and repeating the high-speed centrifugation.

Reaction mixture: phosphate, pH 7·4, 0·04 *M*; magnesium, 0·005 *M*; adenosine monophosphate, $6 \times 10^{-4}$ *M*; adenosine diphosphate, $6 \times 10^{-4}$ *M*; glucose, 0·03 *M*; versene, 0·001 *M*; succinate, 0·02 *M*, or fumarate, 0·005 *M*; hexokinase. In experiments 2, 3 and 4, fluoride (0 04 *M*) was present. Reaction volume, 1 ml., 25° C., 30 min. Δ (esterified phosphorus) and (oxaloacetate + pyruvate) measured as described previously (ref. 3)

| Exp. | Fraction | Protein (mgm.) | Substrate | Oxygen uptake (μ atoms) | Δ (esterified phosphorus) (μmoles) | P : O | Δ (oxaloacetate + pyruvate) (μmoles) |
|---|---|---|---|---|---|---|---|
| 1 | $P$ | 0·35 | Succinate | 1·37 | 1·19 | 0·87 | — |
| | $S$ | 9·4 | Succinate | 3·61 | 0·56 | 0·16 | — |
| | $P + S$ | 9·7 | Succinate | 11 9 | 5·42 | 0·46 | — |
| 2 | $P$ | 1·5 | Succinate | 2·10 | 0·49 | 0·23 | 0·13 |
| | $S$ | 12 | Succinate | 0·67 | 0·22 | 0·33 | 0 |
| | $P + S$ | 13·5 | Succinate | 6·94 | 2·32 | 0·33 | 0·08 |
| 3 | $P$ | 1 2 | Succinate | 3·78 | 0·52 | 0·14 | 0·03 |
| | $P$ | 1·2 | Fumarate | 0·16 | 0·02 | — | 0 06 |
| 4 | $P$ | 0·7 | Succinate | 1·80 | 0·45 | 0·25 | 0 02 |
| | $S$ | 5·0 | Succinate | 0·61 | 0 14 | 0·22 | 0 |
| | $P + S$ | 5 7 | Succinate | 3 35 | 1·41 | 0·42 | 0·05 |
| | $P + S$ | 5·7 | Fumarate | 6 90 | 2·83 | 0·41 | 2·25 |
| | $P + S$* | — | Succinate | 2·84 | 0·81 | 0·29 | 0 04 |
| | $P + S$† | — | Succinate | 1·94 | 0·48 | 0·25 | 0 07 |

* Dialysed against 0·05 *M* phosphate, pH 7 0, at 4° C., for 2 hr.
† Heated 100° C., 3 min., centrifuged, and supernatant used.

The extract was prepared essentially according to a procedure already described[5]. In Table 1, fraction *P* consists of particles not sedimented by 20 min. centrifugation at 10,000 *g*, but sedimented at about 120,000 *g* for 90 min. Fraction *S* is the clear supernatant taken from the top of the tube, after the high-speed centrifugation. The small particles oxidized succinate with phosphorylation, the phosphorus/oxygen (atoms) ratios varying between 0·14 and 0·87 in the experiments reported in Table 1. The reason for the wide variation between different preparations is not known; it is not due to instability of the enzyme systems in the extract, since neither the oxygen uptake nor the esterification of phosphate were affected by standing 24 hr. at 4° C. or 10 min. at 25° C. Fraction *S*, which contains proteins of molecular weight less than $10^4$, possesses considerable 'soluble' succinic oxidase activity, especially in exp. 1, with some phosphorylation. When the two fractions were mixed, both the oxygen uptake and the phosphorylation were stimulated far beyond that expected from an additive effect. The phosphorylation was usually increased more than the oxidation, so that the phosphorus/oxygen (atoms) ratio was increased.

The stimulation of the oxygen uptake is similar to an effect already described in extracts of *E. coli*[6]. It can be explained in our experiments by the ability of the supernatant to promote the oxidation of fumarate formed from the succinate. Fumarate is only very slowly oxidized by fraction *P* (exp. 3 in Table 1), so that the oxidation of succinate proceeds only a single step. However, fumarate is rapidly oxidized by the two fractions combined (exp. 4).

The increase of the phosphorus/oxygen (atoms) ratio brought about by adding fraction *S* to fraction *P* is partly explained by the fact that the proportion of the total oxygen uptake which is associated with the succinate → fumarate step, a reaction yielding relatively little phosphorylation, is decreased. However, it is unlikely that this is the complete explanation. Dialysis of fraction *S* had a marked effect on the phosphorylation, with relatively little action on the oxygen uptake. Heating fraction *S* abolished its activating effect. It is possible that fraction *S* contains soluble enzyme(s) and coenzyme(s) which may activate the relatively deficient particles in fraction *P*. This can be tested by further fractionation of fraction *S*.

The phosphorylation was only partially inhibited by dinitrophenol (Table 2). Pinchot[6] found that the phosphorylation with *A. faecalis* extracts was also little affected by dinitrophenol. It has previously been suggested[7] that the action of dinitrophenol on

Table 2. Effect of Dinitrophenol

Reaction mixture as in Table 1, with succinate as substrate and fluoride added. Fraction *P* (0·7 mgm. protein) + fraction *S* (4 8 mgm.)

| Dinitrophenol (*M*) | Oxygen uptake (μ atoms) | Δ (esterified phosphorus) (μmoles) | P : O |
|---|---|---|---|
| 0 | 4 35 | 1·74 | 0·40 |
| $3 \times 10^{-5}$ | 4 26 | 1·29 | 0·30 |
| $10^{-4}$ | 3 72 | 0 96 | 0 26 |

mitochondrial phosphorylation might be indirect. It may not be revealed in the very small particles in extracts of micro-organisms.

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## Isolation of $\Delta^9$ Heptadecenoic Acid from Lamb Caul Fat

APART from the fats of dolphins and porpoises, which contain considerable proportions of *iso*valeric acid, it has been customary to regard animal fats as consisting of triglycerides of straight-chain even-numbered carbon saturated and unsaturated fatty acids. However, recent work in this laboratory has shown that there occur also trace amounts (up to 1·0 per cent) of saturated fatty acids in the form of odd-numbered *iso*-acids and *ante-iso*-acids[1], even-numbered *iso*-acids[2], polybranched acids[3] and odd-numbered straight-chain acids[4]. Odd-numbered straight-chain unsaturated acids, however, have not hitherto been found in natural fats.

Appel, Bohm, Keil and Schiller[5] have earlier shown that when synthetic fats containing odd-numbered carbon saturated *n*-fatty acids within the range $C_9$–$C_{19}$ are fed, these acids are deposited in animal fats, including the depot fats of the goat and the rat, and the milk fat of sheep. Moreover, the animal is able to desaturate these acids so that, in addition to the presence of odd-numbered saturated *n*-acids, there are also found the corresponding $\Delta^9$-unsaturated fatty acids within the range $C_{11}$–$C_{19}$ inclusive. In view of the ability of the animal to dehydrogenate odd-numbered *n*-fatty acids, it could be anticipated that having established the occurrence of uneven-numbered carbon straight-chain fatty acids in natural fats[4], the corresponding $\Delta^9$-unsaturated fatty acids would also be found. This is now confirmed by recent work in this laboratory.

The methyl esters of the liquids (1,054 gm.) prepared by crystallization three times from ten volumes of acetone of the mixed fatty acids of lamb caul fat (2,578 gm.) at − 35° were fractionally distilled *in vacuo* to yield a fraction *L*2,6, 41·5 gm., sap. equiv. 284·4, iodine value 65·8, $[\alpha]^{20^\circ}_D$ + 0·99. After removal of the more saturated constituents by crystallization of the acids (36·90 gm.) from 40 volumes of light petroleum (b.p. 40–60°) three times at − 40°, the soluble portion, 28·16 gm., iodine value 88·9, $[\alpha]^{20}_D$ + 0·44, was converted to methyl esters and subjected to repeated fractional distillation to remove the methyl esters of $C_{16}$ and $C_{18}$ acids. Eventually, there was obtained a fraction (7·94 gm.) consisting almost entirely of methyl esters of $C_{17}$-acids. Repeated low-temperature crystallization of the acids (6·68 gm.) from acetone resulted in the following fractions arranged in order of increasing solubility:

| Fraction | | Iodine value |
|---|---|---|
| 1 | 1·21 gm. | 13·4 |
| 2 | 1·05 | 72·4 |
| 3 | 1·19 | 74·7 |
| 4 | 1·03 | 80·9 |
| 5 | 1·88 | 99·2 |
| 6 | 0·532 | 119·9 |

Fractions 2, 3 and 4 were combined, and after conversion to methyl esters (3·09 gm.) were chromatographed on a 30-mm. diameter column packed with a mixture containing 106 gm. silica gel and 26 gm. of 'Celite'. Fourteen fractions were eluted with petroleum ether and the residue with methyl alcohol. Of these fractions, 1–6 were of relatively high melting point and showed optical rotation. Fractions 7–13 melted within the range of − 32° to − 30·5° showed negligible optical rotation and were therefore bulked, giving 1·846 gm. Hydrogenation of 0·30 gm. on conversion to the acid (0·25 gm.) had a melting point of 59·9–60·5°. When admixed with authentic margaric acid of melting point 60·8–61·0°, the mixture melted at 60·0–60·6°. Oxidation of 0·403 gm. with 2 gm. finely powdered potassium permanganate in acetic acid at 50° C. gave 0·078 gm. of unoxidized material. From the oxidation products insoluble in light petroleum there was obtained on crystallization from water 0·100 gm. of acidic products, melting point 102–103·5°, saponification equivalent 94·1. On admixture with authentic azelaic acid, melting point 104·5–105·5°, the melting point was raised to 103–104°. These results accord with the presence of $\Delta^9$-heptadecenoic acid in lamb caul fat.

In the present sample, the iodine values of the methyl esters of the liquids corresponding to those of $C_{17}$-acids was unusually high (65·8). In another sample of mutton tallow from older animals the iodine value associated with the $C_{17}$-fraction was of the order of 15, which suggests that the ratio of unsaturated to saturated $C_{17}$-acids shows a wide variation. In the sample under examination the iodine value of the $C_{18}$-fraction was of the order of 12 units, showing that the $C_{18}$-acids had been much less desaturated than the $C_{17}$-acids.

It is therefore concluded that, in addition to the types of fatty constituents mentioned above, it is likely from the evidence provided that there occurs also in natural fats a series of straight-chain $\Delta^9$-unsaturated fatty acids with an uneven number of carbon atoms.

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## Molecular Weight of Ovalbumin and of Bovine Serum Albumin in Urea Solution

Since 1902, when Ramsden[1] described the effects of urea on "proteids", there has been much speculation regarding the molecular weights of proteins in urea solution. Some workers have claimed that aggregation does not take place in the urea denaturation of ovalbumin and bovine serum albumin. In spite of this, it is well known that their urea solutions frequently form gels when the protein concentration is high. Recently, Kauzmann *et al.*[2,3] have studied the viscosity changes accompanying the urea denaturation of these proteins and the gelling time for ovalbumin. Under certain conditions an aggregation dependent upon concentration occurred, and this was interpreted in terms of hydrogen bonding and intermolecular disulphide bonds (the latter through the —SS— and —SH exchange reaction of Huggins, Tapley and Jensen[4]).

During the past three years, a physicochemical study has been made in this laboratory of proteins in urea solution. Observations on sedimentation and diffusion for ovalbumin and bovine serum albumin are briefly reported here. Data for the denaturation of 1 per cent (w/v) protein in 7 *M* urea (with buffer and sodium chloride to Γ/2 of 0·1) at 25° C. are summarized in Table 1. Sedimentation coefficients (*s*) and diffusion coefficients (*D*) are given in C.G.S. units and have been multiplied by $10^{-13}$ and $10^{-7}$ respectively, and refer to the urea solvent at 25° C. unless otherwise stated. Where molecular weights have been calculated, the partial specific volume was taken to be the same as the native protein (the justification for this will be given elsewhere). The molecular weight of native ovalbumin was determined to be 39,000 ($s_{20,w}$ = 3·11, for 0·5 per cent; $D_{20,w}$ = 7·67) and bovine serum albumin 68,000 ($s_{20,w}$ = 4·07, for 1 per cent; $D_{20,w}$ = 5·49) in agreement with other workers[5].

Table 1. SEDIMENTATION AND DIFFUSION

| Ovalbumin | | Serum albumin | |
|---|---|---|---|
| *p*H | Homogeneity | *p*H | Homogeneity |
| 3·3 | Homogeneous. No aggregation. *s* = 0·66 ($s_{20,w}$ = 1·36). *D* = 2·33. Mol. wt. = 42,000 | 3·6 | Homogeneous. No aggregation. *s*, *D* will be discussed elsewhere |
| 6·2 | Heterogeneous. Progressive increase of faster components with time. *s* = 0·8 and 2·1 to 4·5 (peaks diffuse) | 6·4 | Homogeneous. No aggregation. *s* = 1·20 ($s_{20,w}$ = 2·43). *D* = 2·21. Mol. wt. = 71,000 |
| 9·4 | Heterogeneous. *s* = 0·8 and 1·5. Sedimentation peaks diffuse. Aggregation not eliminated by —SH reagent but sedimentation peaks sharpened | 9·5 | Very little aggregation after 4 hr. reaction. Increasing heterogeneity after 26 hr. Aggregation eliminated by —SH reagent |

The results in Table 1 (supported by optical rotation studies) suggest that unfolding (or swelling) of these proteins occurs in urea solution. At certain *p*H values this is followed by aggregation.

The extent to which the aggregation reaction could be blocked by cysteine and *p*-chlormercuribenzoate was also investigated. At *p*H 6·7, 0·02 *M* cysteine had no effect on the aggregation of ovalbumin in 7 *M* urea, in accordance with expectation (cf. ref. 2, p. 5169); at *p*H 8·3 it caused considerable sharpening of the two sedimentation peaks. The effect of 0·005 *M* *p*-chlormercuribenzoate at *p*H 9·1 was similar. The molecular weight of the aggregate in the presence of the —SH reagent was estimated to be 150,000–250,000 and therefore consists of four to six molecules of ovalbumin. The behaviour of serum albumin in the presence of —SH reagent was quite different. At *p*H 9 the protein was homogeneous by sedimentation and diffusion. The molecular weight (60,000, *s* = 0·98 and *D* = 2·33) was virtually the same as the native protein.

Considering our results with the previous work[2,3], there are evidently at least two kinds of aggregation reactions possible for ovalbumin in 7 *M* urea. The exchange reaction of —SS— and —SH groups seems to be less important than the other one (probably hydrogen bonding[3]). In the case of bovine serum albumin, aggregation only occurs through the exchange reaction. Further details of the results for these and other proteins will be described elsewhere.

One of us (R. G. W.) is grateful to the Commonwealth Scientific and Industrial Research Organization for the award of a studentship. This work forms part of the food preservation investigations of this Organization.

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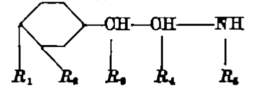
## Some Differences in the Effects of Different Sympathomimetic Amines on the Isolated Innervated Rat Diaphragm Preparation

When the electrically stimulated contractions of the isolated innervated rat diaphragm preparation are depressed by extra potassium chloride in Krebs solution, addition of adrenaline produces recovery[1,2]. Further, when mixtures of adrenaline and potassium chloride are added to preparations already depressed by extra potassium, 0·2 μgm. adrenaline antagonizes as much as 5 mgm. of the chloride[2]. The approximate amounts of twelve different sympathomimetic amines needed to antagonize in this way 5 mgm. potassium chloride have now been found; they are shown, relative to adrenaline as unity, in Table 1, together with the formulæ of the amines.

Unexpectedly, 500 μgm./50 ml. methedrine hydrochloride, or 800 μgm. amphetamine sulphate, increased rather than reduced the depression due to potassium chloride, and with larger doses (2–5 mgm.) of methedrine or benzedrine the increase was very rapid. 500 μgm. pholedrine or tyramine had no visible effect within 5 or 10 minutes. When added alone, the different doses of the different sympathomimetic amines required to antagonize 5 mgm. potassium chloride did not produce equal amounts of recovery; the amines which antagonized less potassium chloride than adrenaline generally pro-

Table 1

| Sympathomimetic amine | Relative No. of molecules needed to antagonize 5 mgm. pot. chloride | Structure  | | | | |
|---|---|---|---|---|---|---|
| | | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ |
| *iso*Prenaline sulphate | 0 2 | OH | OH | OH | H | $(CH_3)_2$ |
| 1-Adrenaline bitartrate | 1 | OH | OH | OH | H | $CH_3$ |
| Cobefrin hydrochloride* | 35 | OH | OH | OH | $CH_3$ | H |
| 1-*nor*Adrenaline bitartrate | 45 | OH | OH | OH | H | H |
| Epinine hydrochloride | 70 | OH | OH | H | H | $CH_3$ |
| 1-Phenylephrine hydrochloride | 275 | H | OH | OH | H | $CH_3$ |
| Ephedrine hydrochloride | 2,500 | H | H | OH | $CH_3$ | $CH_3$ |
| Synephrine bitartrate | 2,600 | OH | H | OH | H | $CH_3$ |
| Pholedrine sulphate | — | OH | H | H | $CH_3$ | $CH_3$ |
| Tyramine hydrochloride | — | OH | H | H | H | H |
| Amphetamine sulphate | — | H | H | H | $CH_3$ | H |
| Methedrine hydrochloride | — | H | H | H | $CH_3$ | $CH_3$ |

* I am grateful to Bayer Products, Ltd., for a gift of this compound.

duced larger recoveries than might have been expected from these antagonisms. For example, although about 2,500 times as much ephedrine as adrenaline is needed to antagonize 5 mgm. potassium chloride, about 100 times as much ephedrine as adrenaline produced equal recovery. This may be due to a slower rate of recovery produced, for example, by ephedrine.

Adsorption of adrenaline at specific receptor surfaces probably occurs prior to its effect on the contractions[3,4]. Preliminary attempts have been made to determine the amount of this adsorption: ½–2 min. after adding 1–5 μgm. adrenaline to a 50-ml. bath in which a rat diaphragm was suspended, 1–5 ml. solution was withdrawn and adrenaline estimated in the solution by the ethylene diamine method[5], without prior passage of the solution over alumina; 10 per cent of the adrenaline had disappeared from the solution. As adrenaline is not differentiated from adrenochrome when alumina is not used, the 'losses' of adrenaline may have been due to its transfer to the muscle rather than to its oxidation. If this is the case, and if the volume of the surface phase of the preparation is taken, with various assumptions[3], as $10^{-8}$ ml., the ratio of the concentrations of adrenaline in the surface and bulk phases of the solution would have averaged $10^3$–$10^4$, a figure in reasonable agreement with the minimum value $(2 \times 10^3)$, calculated from theoretical considerations by Danielli[3]. The amines with the most OH groups are the most effective in antagonizing potassium chloride and in producing recovery; this influence of polar groups is presumably related to the chemical configuration of the receptors.

Experiments carried out with the rat diaphragm preparation in normal Krebs solution and in solution containing only 0·5 m*M* calcium ions show that in these solutions the effects on the contractions due to methedrine and benzedrine are the same in direction as those of 2 μgm./50 ml. adrenaline, but are more prolonged; thus, 4–6 mgm. methedrine or benzedrine augmented the contractions in normal Krebs solution; in 400 μgm. doses they had no effect. In the solution low in calcium ions, there is partial neuromuscular block and this is temporarily increased by 2 μgm. adrenaline[6,7]; a subsequent 50-μgm. dose facilitates transmission[7]. Increased block was produced in varying amounts by other amines; for example, 4 mgm. methedrine or 6 mgm. benzedrine rapidly and completely blocked neuromuscular transmission and, also like adrenaline, slightly depressed the response to direct stimulation; unlike adrenaline, these effects were prolonged. 1 mgm. methedrine produced a slower block; no facilitation has so far been observed with these amines.

Obviously the depressant effect of 500 μgm./50 ml. methedrine in muscles depressed by extra potassium chloride, in which adrenaline produces recovery, cannot be due to prolonging of the action of adrenaline, and it is very unlikely to be due to the fairly high dosage of methedrine used: larger amounts of ephedrine augment the contractions in these circumstances, as do larger doses of methedrine in normal Krebs solution. It is even more unlikely that methedrine acts in a very different way from adrenaline on skeletal muscle. It is possible that the sometimes different effects of adrenaline and methedrine might be due to some difference in a single reaction; it is more probable, however, that redistribution of potassium[8] and of calcium[7], and other changes affecting the contractions which are produced by adrenaline, are the resultant of more than one reaction, chemical or physical, brought about by adrenaline. Further work with different sympathomimetic amines should be of interest with regard to the mechanism of action of these drugs.

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## Single-Breath Continuous Carbon Dioxide Analysis

MEASUREMENTS of inequalities in alveolar ventilation and of physiological dead space give an estimate of the under-ventilated and under-perfused volumes of diseased lungs. Comroe and Fowler[1] described the use of a nitrogen meter to detect uneven alveolar ventilation during a single expiration. Dubois *et al.*[2] showed how the physiological dead space could be assessed by measuring the carbon dioxide content of expired air with a rapid infra-red gas-analyser, and Dornhorst *et al.*[3] described the pattern produced, with similar apparatus, by emphysematous patients. This method relates the carbon dioxide content of expired air to time, and the records produced are sometimes difficult to interpret because the carbon dioxide content is also influenced by the volume of air expired. Marshall *et al.*[4] demonstrated the relation between volume and carbon dioxide content of expired air by fractional analysis and applied their method to normal and diseased subjects.

We have modified the method of Dornhorst *et al.*[3] so as to plot directly the carbon dioxide content against the volume expired. The expiratory flow-rate is also demonstrated. A single expiration is made into a Benedict spirometer which has a potentiometer attached to the pulley. The change in volume is displayed on the horizontal axis of a cathode-ray oscilloscope trace. The spot of the oscilloscope is at the same time influenced in the vertical axis by a 6-c./sec. a.c. signal from an infra-red carbon dioxide analyser. This is fed with air which is taken from just beyond the mouth, circulated through the analyser, and returned to the spirometer by a small electric pump. The graph of carbon dioxide content against volume for one expiration is photographed on a stationary film. The delay of the analyser can be reduced to one-third of a second and can be allowed for in reading the records, being represented by two strokes of the a.c. signal.[2]

The normal record (Fig. 1) consists of a horizontal line representing dead space, followed by a rapid rise to a flat plateau of alveolar air. The abnormal record, illustrated in Fig. 2, is from a patient with advanced pulmonary fibrosis and emphysema. It can be divided into three phases: the horizontal initial line; a steeply sloping portion from poorly perfused lung, the volume of which can be substantially reduced by holding the breath beforehand, and from which physiological dead space can be estimated; and finally, a gently sloping portion which is very similar to the records obtained by Comroe and Fowler[1,4] and therefore probably reflects uneven alveolar ventilation. In other patients with emphysema, the horizontal phase may be followed by a rapid rise to the final sloping phase.

It causes the subject very little discomfort or inconvenience to obtain such a record, and the apparatus is commercially available. Abnormalities are immediately recognizable and the a.c. signal provides a time-scale from which the expiratory flow-rate can be calculated.

We are comparing records so produced with other methods of estimating pulmonary function and are planning to make records from the two lungs separately through a Carlens catheter.

We are grateful to the Gateshead Hospital Management Committee for the purchase of the apparatus, to the Newcastle Regional Board Research Committee for a grant for technical assistance, and to Mr. J. T. Kennair, who gave much technical advice. The carbon dioxide analyser was supplied by the Infra-red Development Co., Ltd.

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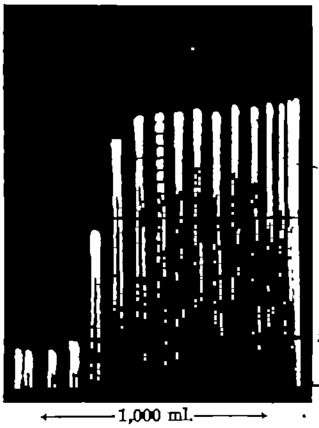
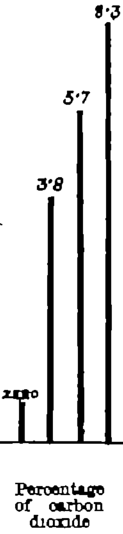


Fig. 1



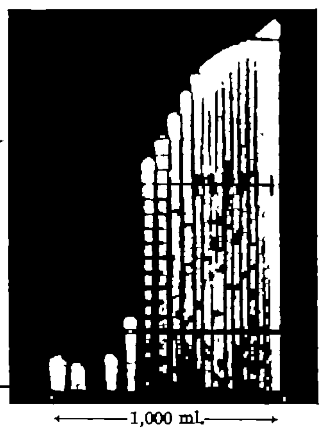


Fig. 2

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## Inhibition of the Production of Precipitating Antibodies in Young Rabbits

THE failure of rabbits to develop antibody to bovine serum albumin when injected with this antigen at an early age was recently reported by Hanan and Oyama[1]. Similar results have been reported by Buxton[2], who found there was no antibody response to killed *Salmonella pullorum* in fowls after they had been exposed to this organism as embryos and young chicks. The studies of Hanan and Oyama[1] suggest that the responses to closely related antigens may also be impaired in rabbits that exhibit inhibition. If, however, rabbits that failed to develop antibodies to one antigen were capable of producing antibodies to a closely related one, the value of such antisera in systematic serology and similar fields would be apparent. Preliminary results of pre- and post-natal exposure of rabbits to parenteral administration of whole chicken serum are reported in this communication.

Two pregnant rabbits were obtained thirty days before term, and twice weekly each was injected subcutaneously with chicken serum. The young consisted of five (litter I) and six (litter II) rabbits. The young rabbits in each of the litters were divided into three groups.

Group *A* were killed and bled the day after they were born.

Group *B* were given post-natal injections of chicken serum before they were four months old (mature). Subcutaneous doses of $\frac{1}{2}$ ml. of antigen were injected three times weekly for four weeks. The rabbits from litter I were first injected four days after they were born. The rabbits from litter II were not given the first injection until they were five weeks old.

Group *C* were given post-natal injections of chicken serum after they were mature. The schedule of injections for this group was the same as given to group *B*.

Table 1

| Litter | Group | Titre | Anaphylaxis |
|---|---|---|---|
| I | *A* | 0 | none |
| II | *A* | 0 | none |
| II | *A* | 0 | none |
| I | *B* | 0 | none |
| I | *B* | 0 | none |
| II | *B* | 1 : 1,500 | severe |
| II | *B* | 1 : 2,500 | mild |
| I | *C** | 1 : 2,500 | fatal |
| II | *C* | 1 : 12,500 | fatal |
| II | *C* | 1 : 25,000 | not attempted |

* One rabbit in this group died before post-natal injections were administered.

All the injected rabbits were bled two weeks after he first injection and again after four weeks. The serum from each blood sample was separated for nterfacial 'ring' precipitin tests with dilutions of chicken serum in neutral physiological saline. The antibody activity of the rabbit serum was also tested for ability to induce passive anaphylaxis in guinea pigs. The guinea pigs were injected intravenously with 1 ml. of undiluted young rabbit serum and after 44–48 hr. were challenged with 1 ml. of chicken serum.

The results (Table 1) indicate that, in rabbits exposed pre-natally to chicken serum antigen, antibodies are not present at birth; but, if post-natal injection of antigen is delayed for five weeks after birth, antibodies do form. Burnet[3] has recently reviewed instances in which pre-natal exposure alone was sufficient to inhibit antibody production in mice to lymphocytic choriomeningitis virus and in a human being to *A* and *O* blood groups. The inhibition may be related to the presence of gamma globulins, which have been reported not to appear in the electrophoretic pattern of rabbits until they are six weeks old[1].

When the rabbits of group *B*, litter I, were four months old, they were still incapable of antibody response to repeated injections of chicken serum. When subcutaneous injections of bronze-turkey serum were given, however, the serum of one of the rabbits reacted to a titre of 1 : 2,500 and the serum of the other to a titre of 1 : 100 with dilutions of turkey serum in physiological saline. In precipitin tests with normal antisera produced in rabbits, turkey and chicken serum antigens show strong cross-reactions; but no cross-reaction was observed when the antiserum produced with turkey serum in the pre- and post-natally injected rabbits was tested with chicken serum.

These findings suggest that antisera produced by this method may be of considerable use in specific detection of avian bloods by the precipitin test. Adaptation of the method to the serological detection of bird bloods in hæmatophagous insects is being studied.

I thank Prof. A. S. West, professor of zoology in Queen's University, Kingston, Ontario, for helpful suggestions, and Dr. J. McLintock, Entomology Division, Ontario, for advice during preparation of the manuscript.

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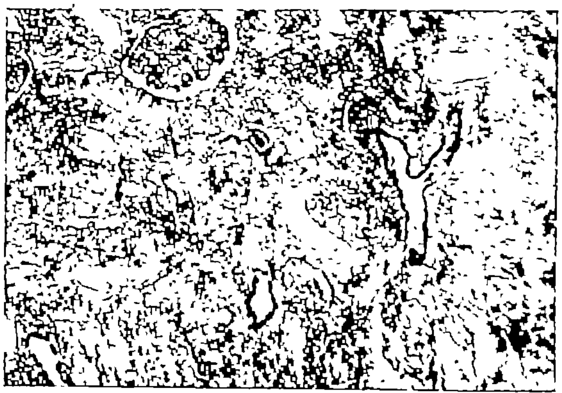
## Mucins in the Epithelium of Renal Collecting Tubules

As an incidental finding to a study of the staining of elastic tissue carried out by one of us[1], the luminal borders of the epithelium of the collecting tubule in the kidney of the guinea pig were observed to stain intensely by Gomori's aldehyde–fuchsin method[2] (Fig. 1). We have been unable to find in the literature any previous report of selective staining of the collecting system in the mammalian kidney.

Attempts have been made to interpret the significance of aldehyde–fuchsin staining[3], but little is known yet about its specificity or mode of action. Various other stains were therefore applied to characterize the reacting material. The same sites were demonstrated by a number of methods frequently used to stain mucins (Table 1), and the material is therefore presumed to be related to this general group. Krause[4] has noted the presence of mucins in the collecting system of the dove (*Columba livia domestica*) and lizard (*Lacerta agilis*).

To assess species distribution, kidneys of man, monkey (*Macaca mulatta*), dog, cat, pig, rabbit, rat, mouse, hamster, squirrel (*Sciurus carolinensis*), opossum (*Didelphis virginiana*), chicken, turtle (*Terrapine carolina*), frog (*Rana catesbiana*), toad (*Bufo marinus*), salamander (*Amblystoma maculatum*), goldfish (*Carassius auratus*), and toadfish (*Opsanus tau*) were examined. Materials stained by these various methods (Table 1) have been observed throughout the collecting tubules of the chicken



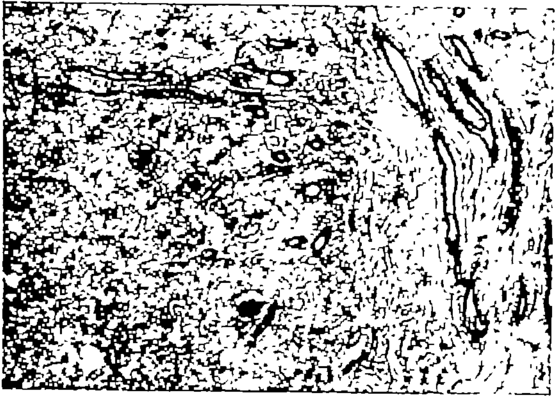


Fig. 1 (*Above*). Terminal ramifications of the collecting ducts in the kidney cortex of guinea pig. Aldehyde–fuchsin staining. × 150

Fig. 2 (*Below*). Arborization of collecting ducts in lobular papilla of kidney in chicken and dispersion into lobule proper Hale reaction. × 70

Table 1. STAINING PROPERTIES OF THE MUCINS OF COLLECTING TUBULES

| | Guinea pig | Chicken | Turtle | Goldfish | Toadfish |
|---|---|---|---|---|---|
| Aldehyde–fuchsin | 4+ | 4+ | – | 2+ | — |
| Hale | 4+ | 4+ | 4+ | 4+ | 4+ |
| Periodic–Schiff | ± | 2+ | 2+ | 3+ | 2+ |
| Mucicarmine | 1+ | 1+ | ± | 1+ | – |
| Mucihæmatin | 1+ | 1+ | 1+ | 1+ | – |
| Metachromasia (thionin) | ± | ± | – | – | – |

(Fig. 2), turtle and toadfish ; and in goldfish, numbers of mucous goblet cells have been found in some of the larger ducts.

The occurrence of such materials in the fish–reptile–bird sequence agrees with Krause's experience and is not remarkable ; but the case of the guinea pig remains a phyletic curiosity. It is of interest to note also that, despite their homologous origins, the collecting tubule mucin of each of these species is histochemically distinct.

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## A *Glossopteris* bearing Sori-like Structures

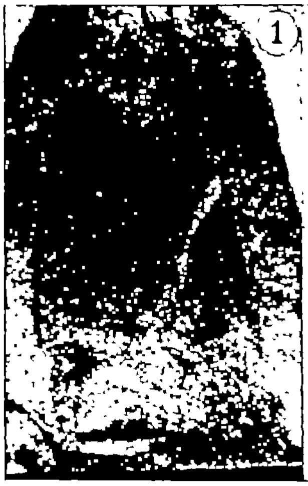
IT had been indicated by Feistmantel[1] that some species of *Glossopteris* bear sori in one of the following patterns, namely, in longitudinal rows (Indian materials), along the veins (Australian materials) and along the margin (Indian materials). Unfortunately, these structures were not well recognized in the subsequent literature on fructifications assigned to *Glossopteris*. Recently, an undetermined species of *Glossopteris*, bearing sori-like bodies (Fig. 1) as described by Feistmantel[1,2], has been collected from the Middle Permian (Barakar) in the Central Province of India. The specific determination of the specimen was not possible because its upper half only is preserved and the venation (excepting the midrib) is not always distinct. The rock bearing the fossil is a piece of soft greyish shale.

The sori-like bodies (1·2–2 mm. in diameter, Figs. 1 and 2) are usually round, slightly thickened spots, sometimes oval, and often coalesced and compressed laterally into irregularly linear structures along the margin of the frond. A number of individually recognizable sor like structures are also present on the margi These sori-like spots are mostly concentrated on th upper portion of the fossil, the lowermost portio being almost sterile. The supposedly fertile bodies a arranged (1) more or less along the main divergin lateral veins, and (2) also along the margin of th frond. They are not usually equidistant from on another. Those near the margin of the frond a bigger than those near the midrib. A few of the were examined, but unfortunately they did not yiel any spore or spore case.

It is very striking that in the present specimen th arrangement of sori-like bodies follows two distinc patterns of distribution (both along the veins an the margin), which have not been found hithert to occur in the same frond or fronds belonging t the same species[1] as in the present case. So the are at least four types of sorus arrangement in th genus *Glossopteris*, including the three types pre viously described by Feistmantel[1,2], "which b analogy with living ferns would represent as man different genera, belonging even to quite differen families"[1]. The fern-like arrangement of the sori(-lik bodies) on the *Glossopteris* fronds as described i this communication and by Feistmantel[1,2] is undoubtedly one of the most primitive types so fa known among the seed plants. Feistmantel[1] suggested the need for a generic separation o *Glossopteris*, and I formed the same opinion whe describing[3] several types of isolated cutinized micro sporangia (from macerated Indian Lower Gondwan coal) referable to *Glossopteris*. These microsporangi are of different shapes and sizes, and there may b at least two types of dehiscing mechanism. It i however, premature to suggest any generic separatio of the *Glossopteris* unless more data are available.

Whether the sori-like bodies described by Feist mantel[1,2] and by me here, and the isolated micro sporangia previously described by me[3], are the sam structures has yet to be established. However, th size and shape of the latter indicate that they ca be accommodated in the sori-like structures describe in this communication.

The manner in which the sori-like structures ar borne on the *Glossopteris* frond indicates that th



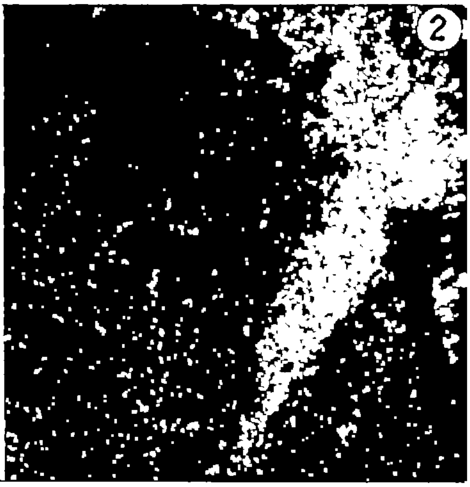


Fig. 1. *Glossopteris* frond showing sori-like structures along the margin and also more or less along the main lateral veins diverging from the midrib. Less than ½ nat. size
Fig. 2. Part of the *Glossopteris* frond showing magnified view of solitary and coalescent sori-like structures. × 3

mus probably belongs to the primitive Pteridosperms, and should be regarded as closely related to ie ferns. But on the basis of the new interpretation[4] f the recently discovered ovulate organs of *lossopteris*, it has been suggested that the genus elongs to an unknown or imperfectly known ymnosperm rather than to the Pteridosperms. discussion of the problem will be published elsehere.

I am indebted to Mr. S. K. Ghosh, geologist in ne Sohagpur coalfield, for the material, and to Mr. . C. Bhattacharya, of the Zoology Department of his University, for photographing it.

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## Significance of the Subdermal Space in Pelagic Fish Embryos and Larvæ

Fish eggs can be divided into two main groups, lemersal and pelagic, according to their buoyancy. Most freshwater and some marine eggs fall into the first category; truly pelagic eggs, on the other hand, are mainly marine. Certain freshwater fish, the 'bubble blowers', contrive to float off their eggs with an extrinsic mechanism; the egg itself is denser than water.

Between pelagic and demersal fish embryos there is a noticeable and consistent difference in the size of the marginal fin during early life (Fig. 1). The large fin of the pelagic embryo is formed late in egg development by the separation of the thin integument from the underlying mesoderm of the larval axis. There are no supporting structures in the walls of the fin, which must therefore be extended, in life, by turgor within the lumen. The lumen is a subdermal space, filled according to McIntosh and Prince, with "a jelly-like lymph"[1].

The development of voluminous subdermal spaces in fish embryos is clearly related to the pelagic habit. The immature egg of the plaice sinks in sea water. At maturation within the ovary, the egg is distended by a gross intake of ovarian fluid which dissolves the yolk spherules and gives the egg its buoyancy. The ionic composition of this yolk diluent resembles that of adult blood, as indicated by the observations of Milroy[2] and Dakin[3]. It follows that a pelagic marine egg, like the parent, is in constant danger of desiccation under the osmotic gradient; loss of buoyancy is a sure sign of unhealthiness.

If McIntosh and others were correct in describing the egg capsule as porous and freely permeable to salts and water, then osmotic work must be done by the integument of the embryo to prevent an increase in body chloride and a decrease in water content. If enough water is lost, the egg will sink, irrespective of whether it has an oil globule or not. It is a fact that healthy plaice and cod eggs remain buoyant throughout embryonic life in aquaria, even though their degree of reserve buoyancy is not excessive. In 1954, for example, a batch of floating plaice eggs, fertilized in 35 parts per mille sea water, were not buoyant in 32 parts per mille sea water.

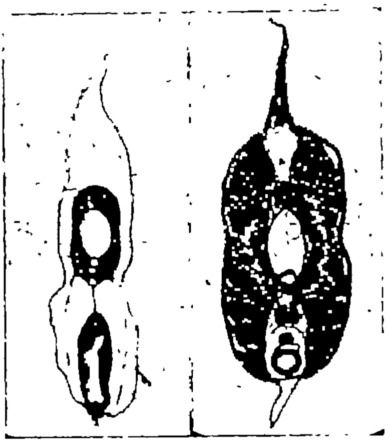

Fig. 1. Transverse sections through the trunk of a 2-day old pelagic plaice larva, × 55 (left), and a 4-day old demersal trout larva, × 30 (right), to indicate a major difference in the extent of the subdermal space

There is no known mechanism for water acceptance by the plaice embryo, from the time of liberation to the point when the mouth and anus open at hatching. One can assume, therefore, that sufficient water to preserve buoyancy must be retained within the embryo; in other words, the overall volume enclosed by the embryonal integument can only decrease within the limit laid down by the initial reserve buoyancy. As soluble nutrients from the fluid yolk are used in tissue synthesis and respiration, the remaining yolk diluent accumulates beneath the integument, separates it from the compact axial structures, and thus forms the subdermal space. The problem of water conservation does not arise in a demersal freshwater fish embryo. One can therefore readily understand the lack of subdermal space in this group and, hence, the ill-developed marginal fin.

The lumen of the marginal fin is not the only subintegumental space in the pelagic embryo and larva. It is not generally known that pelagic marine eggs, unlike demersal freshwater forms, have no circulatory system of capillaries around the yolk. These capillaries develop in the extra-embryonal mesoderm between the periblast layer of the yolk-sac proper and the extra-embryonal ectoderm. Meek[4] observed, during gastrulation in the pelagic egg of the cod,

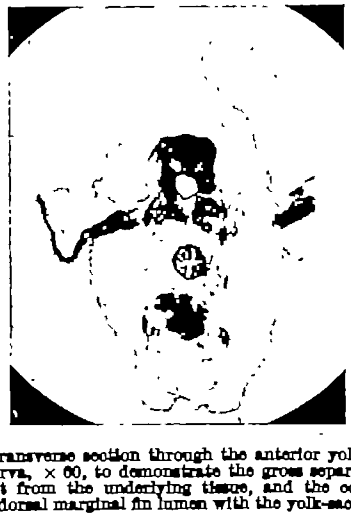

Fig. 2. Transverse section through the anterior yolk-sac region of a cod larva, × 60, to demonstrate the gross separation of the integument from the underlying tissue, and the continuity of the dorsal marginal fin lumen with the yolk-sac sinus

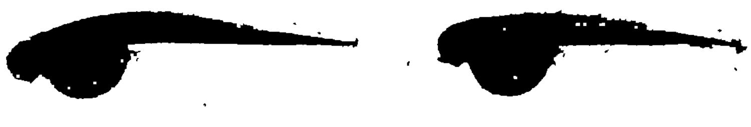

Fig. 3 Newly hatched plaice larvæ, × 7, with heavy coagulation of plasma proteins in the dorsal and ventral spaces of the marginal fin, after fixation in Heidenhain's Susa

that the extra-embryonal mesoderm rapidly breaks down into isolated mesenchyme cells, to form another sub-integumental space, the yolk-sac sinus, into which the sinus venosus of the heart opens directly. At some stage in embryonic development, the yolk-sac sinus is put in lateral communication with the lumen of the growing marginal fin. The connexion persists well into the larval stage (Fig. 2), until most of the yolk is lost. Nutrient yolk derivatives thus have easy access to embryonic and larval tissues via the subdermal spaces (Fig. 3).

There is therefore, in pelagic fish eggs and larvæ, an unorthodox extension of the primary method of direct yolk appropriation, independent of a blood vascular system. This is, undoubtedly, a result of the formation of subdermal spaces, dictated by the requirements of buoyancy and water conservation. A full account of this work will shortly be published elsewhere.

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## Preparation of Cell Suspensions from Plant Roots for Cytological Studies

A CONSIDERABLE amount of microscope work involved in cytological studies of plant roots can be obviated by the preparation of a c suspension from a number of root the cell suspension can then be e ammed instead of a large number sections or squashes of individu roots. This is of particular advan age in studies in which the examin tion of a large cell population required for the evaluation of t cytological effects of a particul experimental treatment, such as X-radiation. number of techniques have been described for makin cell suspensions from plant roots[1–3], all of whic either produce a large number of broken cells or r quire the use of enzymes. The following simplifie method without the use of enzymes has given sati factory results with *Vicia faba* root-tips, the numb of cells broken being negligible.

The root tips are fixed overnight in a mixture acetic acid and ethanol (1 : 3 v/v), washed for on hour in several changes of tap water and distille water, and hydrolysed in *N* hydrochloric acid a 60–63° C. for ten minutes. This hydrolysis soften the intercellular matrix sufficiently to allow th subsequent mechanical separation of the cells; i also serves as the essential preliminary step for stain ing the nuclei by Feulgen's method. The temperatur used in this procedure, slightly higher than is usuall employed in the Feulgen technique (60° C.), does no impair the staining of nuclei as judged by eye wit the microscope. After hydrolysis the roots ar stained by the usual Feulgen procedure. The tip are then transferred to 45 per cent acetic acid (1 ml acid/10 roots) and broken up into a cell suspensio by being drawn into and out of a 5-ml. syring through a serum needle (gauge 0·8 mm.). After thre minutes of such treatment, 70 per cent of the cell are in groups of 1–4 cells, 80 per cent in groups o 1–8 cells. The number of broken cells, shown by free nuclei and empty cell walls, is less than 4 per cent. Maceration even for a further two minutes doe not increase the number of broken cells.

Groups of beans macerated by this method giv the same value for the number of cells per root tip a

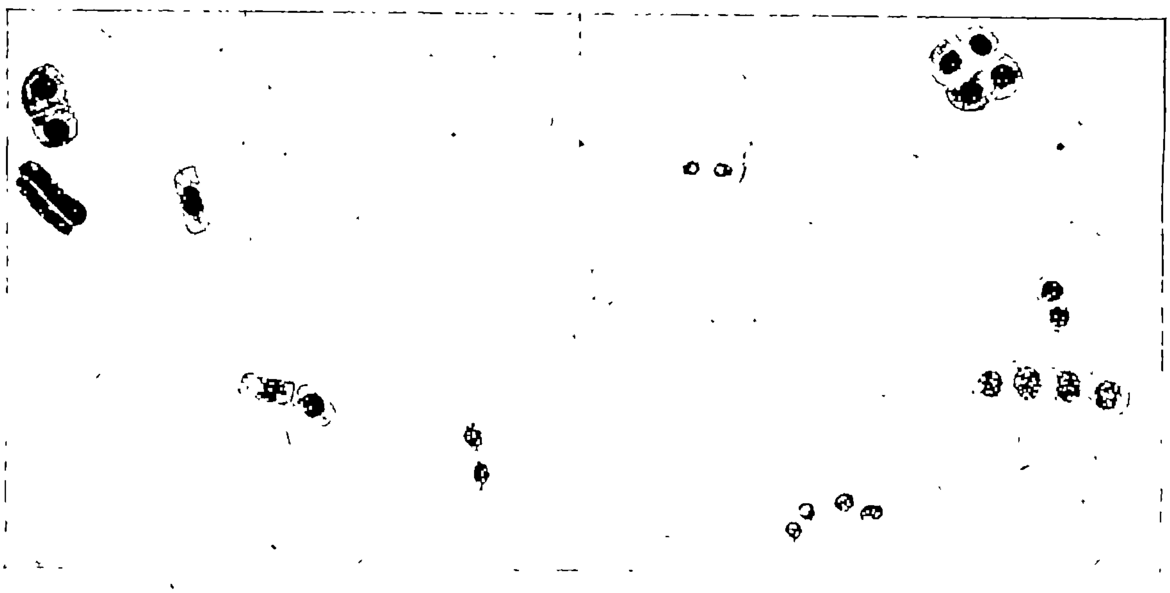

Fig. 1. Meristematic cells of *Vicia faba* roots macerated by the method described, stained by Feulgen's method and counter-stained with light green (× 160)

en they are macerated by the chromic acid tech- que of Brown and Richless[4]. Maceration is not so mplete in the fully differentiated region of the root it is in the meristem, because in that region, rticularly in the case of epidermal cells, the root nds to break into sheets of cells.

The technique has been used successfully in studies cytological abnormalities caused by X-irradiation *Vicia faba* roots, the results of which will be ported elsewhere.

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## Stoichiometry of Inclusion Compounds

A RECENT study[1] of the formation of a variety of clusion compounds by potassium benzene sulphon- e led to the conclusion that it could form zeolitic ructures in the interstices of which various species uld be intercalated. Such structures would give angmuir-type intercalation isotherms[2,3], but the hole isotherm course would not necessarily be alizable because, when the content of included olecules fell below a certain limit, the zeolitic ructure may become metastable and collapse into sorbate-free but more compact crystal lattice of otassium benzene sulphonate.

While most aspects of the behaviour could be plained in terms of the above view, and of current eatments of nucleation and crystal growth, one ature remained not fully accounted for. All the clusion compounds were formed by bathing crystals f outgassed potassium benzene sulphonate in vapours f various organic species. Usually, at a critical lative pressure, nucleation of crystal growth of the clusion compound occurred, and reaction rapidly ent to completion at this pressure. Thereafter rther increases in pressure produced little or no rther change in the content of the intercalated ecies. Moreover, the amount of the intercalated ecies was often very sensitive to the temperature, ut non-stoichiometric in quantity (Fig. 1). We will

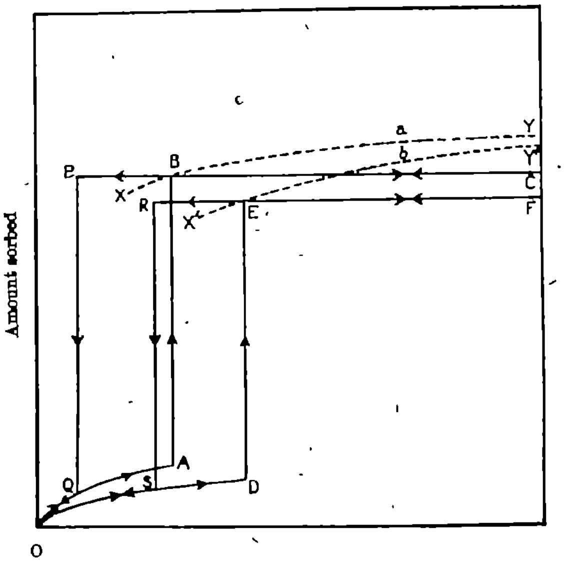

Fig. 2. Expected course of isotherms for the formation of clathrate-type inclusion compounds at temperatures $T_1$ and $T_2$ (full lines), compared with true equilibrium course (dotted lines)

consider these pressure-independent, temperature-sensitive, non-stoichiometric phases.

We may call the open lattice of the framework-forming constituent in the complex the 'host lattice'. We need for our purpose to distinguish at least two categories of inclusion compound: (1) in one group the host lattice is stable whether or not it contains included molecules (for example, tectosilicates such as certain of the crystalline zeolites); (2) in a second group the host lattice becomes metastable when the included molecules are at too low a concentration, and tends to collapse into a new phase, as with urea-hydrocarbon adducts, quinol clathrates, and complexes formed by potassium benzene sulphonate.

In both classes of inclusion compound, the true equilibrium content of intercalated molecules varies continuously with the ambient concentration of these[2,3], so that the phases are in general non-stoichiometric over the observable ranges of formation (Fig. 2, curves *a* and *b*). In the second group of inclusion compounds, however, the included molecules may be, and often are, quite immobile. Once the compound has formed, their number cannot then be increased or decreased, because the interstices containing included molecules have no exits wide enough. This circumstance will explain as follows the situation referred to earlier in connexion with the inclusion complexes of potassium benzene sulphonate.

In Fig. 2, $XY$, $X'Y'$ represent the only parts of the true equilibrium occlusion isotherms of an intercalated species at temperatures $T_1$ and $T_2$ respectively ($T_1 < T_2$), which are at least theoretically realizable without instability of the host lattice. When outgassed potassium benzene sulphonate is bathed in vapour of, say, naphthalene, the inclusion complex cannot form until the pressure at $T_1$ exceeds the value corresponding to the point $X$. Even here it will not normally

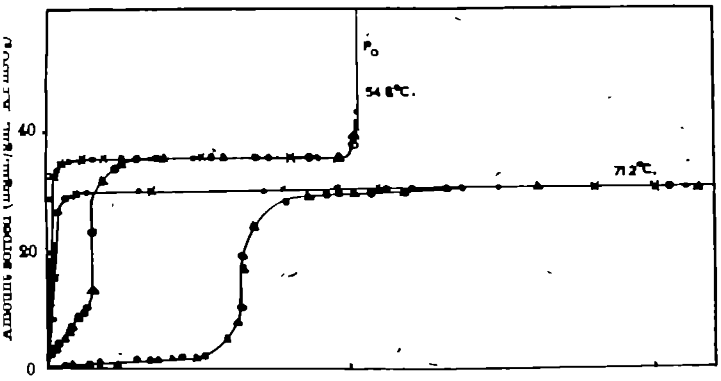

Fig. 1. Sorption isotherms for naphthalene in potassium benzene sulphonate: ○—⊙—, first sorption; ●—●—, first desorption; Δ—Δ—, second sorption; ×—×—, second desorption

form until nucleation has set in at some higher pressure, owing to difficulties in nucleation of the new zeolitic phase on or in a matrix of the naphthalene-free phase. For similar reasons, the ideally vertical section such as in Fig. 2 may also be replaced by a curve (Fig. 1)[1]. The isotherm path followed is initially *OA*, corresponding to a limited physical sorption upon external crystallite surfaces. At *A*, nucleation occurs, and a host lattice with an amount of intercalated naphthalene corresponding to point *B* is formed—a point on the true equilibrium isotherm *XY*. At *B* reaction is complete. As noted in the previous paragraph, it is assumed that no more naphthalene can now enter or leave the complex, which thus remains of fixed composition however the pressure afterwards changes over the entire range of existence of the complex. On lowering the pressure, the range of existence persists to the metastable point *P* again owing to difficulties in nucleation of crystals of the original outgassed potassium benzene sulphonate on or in a matrix of complex. At point *P* nucleation occurs, and the path *PQO* is followed. Thus, at $T_1$ the isotherm realized is *OABO* on the increasing pressure run and *OBPQO* on the decreasing pressure run.

At temperature $T_2$ ($> T_1$) exactly similar considerations apply and the isotherm realized is *ODEF* with increasing pressures and *FERSO* with decreasing pressures. Clearly, then, *PBO* and *REF* represent two non-stoichiometric phases, metastable except at *B* and *E* respectively, of composition independent (within the existence limits) of pressure, but for normal isotherms *XY*, *X'Y'*, sensitive to temperature. This behaviour was observed with the benzene, toluene, *o*-, *m*-, and *p*-xylene and naphthalene inclusion complexes in which potassium benzene sulphonate formed the host lattice[1].

In the paper[1] referred to, not all the results fall into the above pattern. X-ray data indicated more than one crystallographic structure among the complexes, and sometimes Langmuir isotherms were indeed realized, apparently without hysteresis (for example, ethanol, pyridine and ethylamine complexes).

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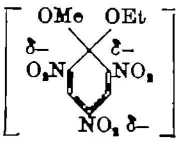
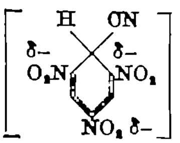
## Visible Spectrum of Potassium Ethyl 1-Methoxypicrate and of Related Compounds

The structure of the product obtained by Meisenheimer[1] from potassium methoxide and *s*-trinitroanisole and from potassium ethoxide and *s*-trinitrophenetole which depended on these two products being identical has been confirmed by infra-red spectroscopy[2]. The product appears to be the ion (I). The visible spectra of the products obtained from these two reactions have now been measured. The spectra are identical. There are three maxima in the region 390–600 mμ, namely, at 420 mμ ($\varepsilon = 27,000$); at 478 mμ ($\varepsilon = 16,500$); and at 494 mμ ($\varepsilon = 17,000$).



(I)



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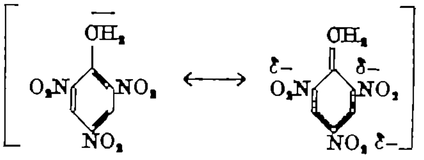

(III)

Hantzsch and Kissel[3] obtained a solid from th interaction of a concentrated aqueous solution o potassium cyanide and a concentrated alcoholic solution of *s*-trinitrobenzene. To this solid Meisenheimer assigned a structure corresponding in more moder terms to (II). This solid has been re-prepared an its spectrum in acetone has been found to be featureless; in no way does it correspond to the spectrur of (I). *s*-Trinitrobenzene gives a red colour wit potassium cyanide in damp acetone solution, and i ethyl alcohol solution. The spectrum of this mixtur in the region 390–600 mμ is very similar to that o potassium ethyl 1-methoxypicrate (I). This suggest that with *s*-trinitrobenzene and potassium cyanide a compound of structure (III) is at first formed i solution. Solutions are stable for at least 48 hr. if kept away from light. However, when expose to light, the spectrum changes to a featureles spectrum more closely resembling the spectrum o

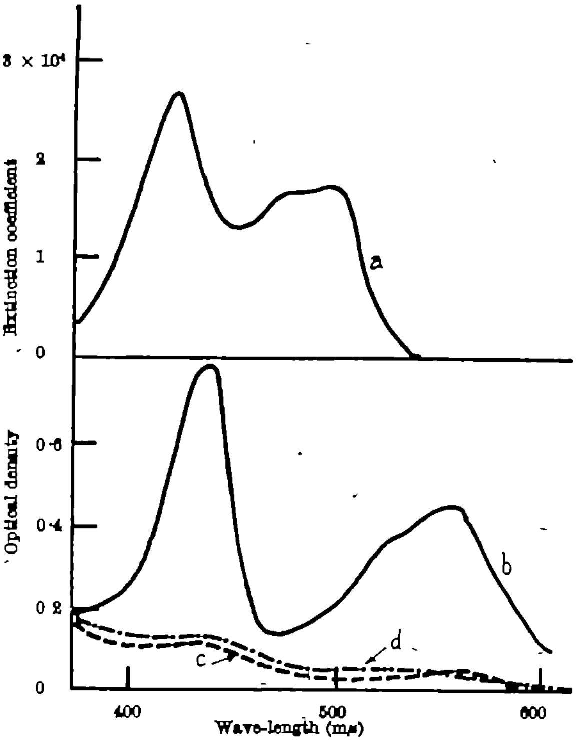

Fig. 1. *a*, Potassium ethyl 1-methoxypicrate; *b*, potassium cyanide and *s*-trinitrobenzene immediately after mixing; *c*, potassium cyanide and *s*-trinitrobenzene after 7 min. exposure to diffuse daylight; *d*, product obtained by Hantzsch and Kissel (all solutions are in acetone)

ne solid product obtained by Hantzsch and Kissel. ompound (II) may therefore have a more transient istence than has hitherto been supposed. Similar ectra are obtained in ethyl alcohol solution. This iminates the possibility that an acetone molecule involved in the complex ion, as is thought to be he case in some *m*-dinitrobenzene complexes[4].

It is interesting to note in this connexion that the pectrum of potassium ethyl 1-methoxypicrate does ot resemble the spectra of either the product of nteraction of *s*-trinitrobenzene and potassium thoxide (or methoxide) or of *s*-trinitrotoluene and otassium ethoxide (or methoxide); neither do the pectra of these two latter products closely resemble ne another. It has been suggested that in the case f *s*-trinitrotoluene + methoxide the product is an on of the type (III)[5]. The fact that the spectrum f this product has a maximum at 370 mμ which is lose to that of the picrate ion (356 mμ) may be urther evidence in support of structure (III) in this ase, as the ion (III) is *iso*-electronic with the picrate on.

R. FOSTER*

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May 27.

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Meisenheimer, J., *Annalen*, 323, 205 (1902).
Foster, R., and Hammick, D. Ll., *J. Chem. Soc.*, 2153 (1954).
Hantzsch, A., and Kissel, H., *Ber. deutsch. chem. Ges.*, 32, 3144 (1899).
Canbäck, T., *Farm. Revy*, 48, 153, 217, 234 (1949).
Caldin, E. F., and Long, G., *Proc. Roy. Soc.*, A, 228, 263 (1955).

# The Solid-Liquid Equilibrium Diagram of Argon and Krypton

MEASUREMENTS of the properties of condensed solutions of the inert gases should prove important in the development of the theory of solutions because of the comparatively simple nature of the interatomic forces. While, from the theoretical point of view, equilibrium diagrams are complicated in that they necessarily contain information concerning two or more forms of solution, their determination is a most useful initial step in the examination of any system.

Argon and krypton were chosen for the present investigation because they are inexpensive and because they can be condensed at liquid oxygen temperatures. The solid–liquid equilibrium diagram of this system has been previously measured by the method of thermal analysis[1]. Time/temperature curves were obtained for five different mixtures of known composition as they were heated or cooled through the transition points. The discontinuities in the slopes of these curves did not occur at a definite temperature, and the melting points and freezing points were determined by a method of extrapolation which, it was claimed, gave an accuracy in the transition temperature of 0·1 deg. The composition of the mixtures was known to approximately 0·05 per cent. These results are shown in Fig. 1, in which the mole fraction of krypton ($x$) of solutions in equilibrium is plotted against temperature.

In the present investigation this same method was tried; but it proved unsatisfactory because of the difficulty of locating the melting point for any composition and the freezing point for mixtures of about equimolar proportions. To overcome this difficulty a new method has been developed. The total vapour pressure ($P$) of mixtures of known composition has been measured as a function of temperature ($T$). Graphs of $\log P\Big/\left(\frac{1}{T}\right)$ have been drawn and although the discontinuities in slope are not 'sharp', a small extrapolation of one straight or nearly straight line enables each transition point to be determined. The results of measurements of twenty-two different mixtures are shown in Fig. 1. Temperature was measured with a copper–constantan thermocouple with an accuracy of 0·1 deg. K. and the compositions were determined to 0·5–1 per cent. Both gases were obtained commercially. The purity of the argon was such that the temperature range of melting was not more than 0·05 deg. The krypton contained 0·5 per cent xenon, which was also the case in the earlier determination[1].

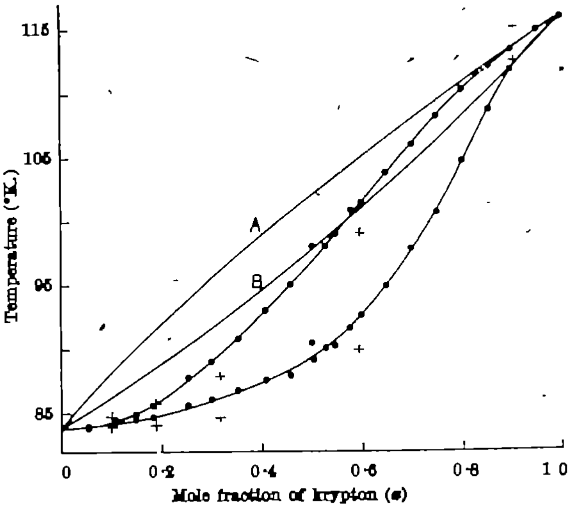

Fig. 1. Equilibrium diagram of argon and krypton: *A* and *B*, ideal solutions; +, Veith and Schröder (ref. 1); ○—○—, present investigation

Fig. 1 shows that argon and krypton are soluble in all proportions in the solid and liquid states. The equilibrium diagram that would result if both solutions were ideal is drawn on the figure. It may be seen that when $x$ approaches 1 the measured solidus and liquidus approximate to those of the ideal solutions. For all other values of $x$ the concentration of krypton in both solid and liquid solutions in equilibrium exceeds that in the ideal solutions at the same temperature. A preliminary examination of the vapour-pressure measurements indicates that, for $x \simeq \frac{1}{2}$, $\frac{P}{P_i}$ (where $P_i$ is the total vapour pressure of the ideal solution) for the solid solution at the melting point is greater than for the liquid solution at the freezing point. In both cases $P/P_i$ is greater than 1. These facts suggest that for $x \simeq \frac{1}{2}$ the deviations from ideality in the solid are more positive than in the liquid solution, and that both solutions exhibit positive deviations.

The measurements have extended down to about 62° K. for argon-rich mixtures and to 70° K. for krypton-rich mixtures, and no evidence of any phase change between these temperatures and that of the solidus has been found. If the solid solutions show positive deviations from ideality, it would be expected that at low temperatures the two substances would be insoluble. A calculation (reported in an account[2] of a meeting of the Physical Society Low Temperature Group), assuming that the intermolecular force of attraction is of the van der Waals type, shows that the separation into two phases would not occur in the temperature-range used in this investigation.

The experimental details and the results of the vapour pressure measurements will be discussed in a later publication.

I thank Prof. G. O. Jones, who suggested this investigation, for his continued help and advice.

R. Heastie

Department of Physics,
Queen Mary College,
London, E.1.
June 6.

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[1] Veith, H., and Schroder, E., *Z. phys. Chem.*, A, 179, 16 (1937).

[2] Domb, C., *Nature*, 176, 661 (1955).

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## Serially Balanced Sequences

Williams[1] has devised experimental designs for use when several subjects are to be tested on successive occasions, and the response to the treatments on any one occasion may be modified by residual influences of the one or two previous treatments. We have recently considered the possibility of analogous designs that, under certain assumptions about the mathematical model, could be used for an experimental comparison of treatments on many occasions with one subject only. The practical importance of these designs is probably not great, but they are of interest as introducing new combinatorial problems.

Suppose that four treatments are represented by the letters $A$, $B$, $C$, $D$. Consider the sequence

$$A\,;\ B, C, A, D\,;\ A, C, B, D\,;\ C, D, B, A.$$

This is an example of a serially balanced sequence for four treatments. More generally, for $t$ treatments, a serially balanced sequence is defined as follows: (i) each treatment follows each other treatment once (hence the whole sequence has $(t^2 - t + 1)$ members, one letter being repeated $t$ times and the others $(t - 1)$ times each); (ii) after the first treatment, each block of $t$ successive treatments contains one complete replicate. The first and last treatments must be the same. From any sequence, $(t - 2)$ new ones can be generated by cyclic permutation of whole blocks of four and alteration of the first letter to the new last letter. From each of these, a further $(t - 1)$ can be generated by discarding the first letter, reversing the order of the remaining $t(t - 1)$, and inserting a new first letter. For $t = 4$, sequences can be classified into three transformation sets, all members of a set being related by block permutation, reversal and letter permutation.

Statistical analysis according to the standard additive model is practicable if the time trend can be adequately represented by $(t - 2)$ parameters for differences between the $(t - 1)$ blocks; the first treatment is regarded purely as a conditioning of the subject, and no use is made of observations on it. The immediate effects of treatments and their residuals at the time of the next treatment each require $(t - 1)$ parameters, leaving $(t - 1)(t - 3)$ degrees of freedom for the estimation of the error variance. If a longe experiment is required, so as to increase replication and to improve the estimate of error, two or mor sequences can be used consecutively provided tha all begin with the same letter: for each one afte the first, this initial letter is telescoped with the last letter of the previous sequence.

Despite the balance, non-orthogonality makes th analysis awkward. For some values of $t$ (but not for $t = 4$), additional balance can be achieved by having each block also contain one residual from each treatment. For example, with $t = 5$, the sequence

$$A\,;\ B, D, E, C, A\,;\ E, B, C, D, A\,;$$
$$C, E, D, B, A\,;\ D, C, B, E, A$$

is such that both the first $t(t - 1)$ and the last $t(t - 1)$ letters form $(t - 1)$ successive replicates.

For most experimental purposes, a more complete form of serial balance, in which every letter follows every letter including itself once, and which therefore requires a sequence of $(t^2 + 1)$ letters, is obviously preferable. However, such sequences appear to be much rarer. None exists for $t = 3, 4, 5$; for $t = 6$ there are plenty, one such being

$$A\,;\ A, B, C, D, E, F\,;\ F, C, E, A, D, B\,;$$
$$B, A, F, E, D, C\,;\ C, A, E, B, F, D\,;$$
$$D, F, A, C, B, E\,;\ E, C, F, B, D, A.$$

Cyclic permutation of blocks and reversal again generate new sequences.

Further study of these sequences is in progress, and a paper describing their application in bioassay is in preparation.

This communication was prepared without knowledge of a paper by R. M. Williams[2] in which analogous designs were discussed; Williams, however, used a less severe constraint by balancing treatments in respect of adjacent treatments on either side instead of the preceding treatment only.

D. J. Finney
Anne D. Outhwaite

Department of Statistics,
University of Aberdeen.
June 6.

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[1] Williams, E. J., *Australian Journal of Scientific Research*, A, 2, 149 (1949); A, 3, 351 (1950).

[2] Williams, R. M., *Biometrika*, 39, 151 (1952).

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## Corrosion and Meteorology

In studies of corrosion under tropical conditions, it has for a long time been the practice to quote average yearly conditions of temperature and humidity. Although laboratory or simulated tropical testing is often carried out under cyclic conditions, these cannot be truly representative of the climatic conditions unless a complete examination of the climatic conditions is first made. This is particularly important in view of the principle of critical humidity developed by Vernon, Hudson, Patterson and Hebbs, and others[1], and also the work of Clarke[2] on fluctuating humidity.

An analysis of the climatic conditions in Singapore during 1953[3] gave the following information on the percentage relative humidity per day during each month:

| Month | Hr. per day at each range of relative humidity | | |
|---|---|---|---|
| | 65–80 per cent | 80–90 per cent | More than 90 per cent |
| January | 9 | 4 | 11 |
| February | 8 | 5 | 11 |
| March | 8 | 5 | 11 |
| April | 7 | 5 | 12 |
| May | 9 | 6 | 9 |
| June | 9 | 13 | 2 |
| July | 9 | 9 | 4 |
| August | 10 | 11 | 3 |
| September | 9 | 9 | 6 |
| October | 10 | 7 | 7 |
| November | 9 | 6 | 9 |
| December | 9 | 5 | 10 |

From these figures it may be generalized that an 'average' day in Singapore has the following hours of humidity :

65–80 per cent relative humidity, 9 hr./day.
80–90 ,, ,, ,, ,, 7 ,,
More than 90 ,, ,, ,, ,, 8 ,,

These values bear a general resemblance to the average figures and ranges often quoted for Singapore : average maximum humidity, 95 per cent ; average minimum humidity, 69 per cent ; average humidity, 80 per cent. But these latter figures do not take into account the time of exposure to the maximum and minimum conditions. Time is just as important as the level of humidity in corrosion processes.

From the point of view of the deterioration of paint films on metal surfaces exposed to the direct rays of the sun, the sun temperature is of great importance, and work in Singapore has shown that sun temperatures of 130–150° F. are quite normal. A full investigation of these factors is being carried out and will be published elsewhere.

P. A. Cartwright

Operational Research Unit, Far East,
G.H.Q., FARELF. March 21.

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[1] Vernon, *Trans. Farad. Soc.*, 23, 162 (1927) ; 27, 264 (1931) ; *Trans. Electrochem. Soc.*, 64, 31 (1933). Hudson, *Trans. Farad. Soc.*, 25, 205 (1929). Patterson and Hebbs, *Trans. Farad. Soc.*, 27, 277 (1931). Patterson and Wilkinson, *J. Soc. Chem. Indust.*, 57, 445 (1938) ; 60, 42 (1941). Bengough and Whitby, *Trans. Inst. Chem. Eng.*, 11, 176 (1933).

[2] Clarke, *J. Electrodep. Soc.*, 15, 158 (1939).

[3] John, Malayan Meteor. Service, Summary of Observations 1953 (Gov. Printing Office, Singapore).

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I should like to make two comments on Major P. A. Cartwright's letter printed above.

(1) Major Cartwright is right in stressing the important bearing of climatic conditions on atmospheric corrosion, and his view that the variation in the relative atmospheric humidity throughout the exposure period is much more important than the overall average value will meet with general approval. I am particularly interested in this aspect of the matter and have from time to time published diagrams such as Fig. 1, one of which relates to Singapore.

According to the classical researches of Vernon, the critical humidity for the atmospheric rusting of iron lies somewhere between 70 and 80 per cent relative humidity. In the diagrams I have, therefore, shown the periods of the day, averaged for each month of the year, during which the relative humidity of the atmosphere at the places concerned lies below, between, or above, these limits. We do not know whether or not the critical relative humidity varies with the atmospheric temperature ; but, if we assume a value of 70 per cent everywhere, the diagrams show that the conditions are propitious for rusting at Singapore during no less than 99 per cent of the year ; the corresponding figures for Kew and Pittsburgh are 80 and 49 per cent, respectively. Incidentally, the Pittsburgh figure and corresponding data for other American observatories suggest that on the whole the corrosion hazard due to humidity alone is rather less in the United States than in Great Britain.

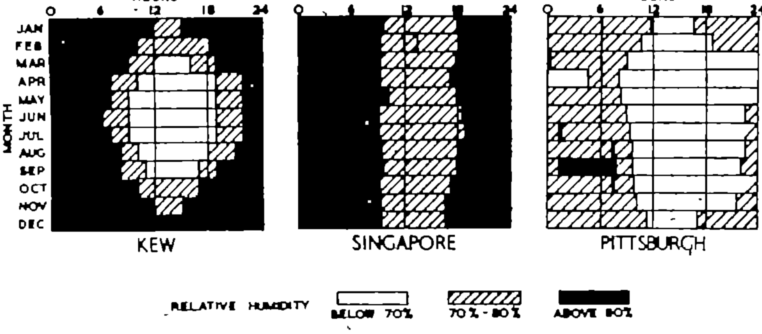

Fig. 1. Variation in the relative humidity at Kew, Singapore and Pittsburgh throughout the day

(2) It does not follow that serious corrosion will take place whenever the humidity is favourable. As Vernon showed, it is also necessary that the atmosphere should be polluted. The most damaging type of pollution is sulphur in the form of combustion products. Joint investigations by the British Iron and Steel Research Association and the Fuel Research Station have shown that in Great Britain, where the relative humidity does not vary much over the whole country, the corrosion of iron at different sites is directly proportional to the sulphur pollution of the atmosphere. Where the sulphur pollution is inappreciable, the rate of rusting is small. In conformity with this, in earlier tests made at Singapore itself, on mild steel plates freely exposed in the open at Seletar Aerodrome, the average rate of rusting observed was only 0·6 mil (0·0006 in.) per year. This figure is comparable with the rates for rural atmospheres in Great Britain—for example, 1·2 mils per year at Llanwrtyd Wells—and is much smaller than those observed in industrial atmospheres, such as Sheffield, where figures of 4 mils or more per year are not uncommon.

This does not contradict the fact that very severe corrosion may often occur in the tropics. Humid atmospheres heavily charged with salt spray, such as are found on surf beaches, are extremely corrosive, and rates of 40–50 mils per year have been recorded at sites of this type. Although the corrosion-rate falls off rapidly with increasing distance from the sea, heavy condensation may play a decisive part at inland tropical sites, since it is clear that the ease with which condensed moisture evaporates from the metal is very important. It is difficult to reproduce the full effects of this factor in small-scale experiments, and it may well be that, for practical purposes, observations made on actual articles and components will provide a better guide to the severity of the corrosive attack that is to be expected in jungles and similar places.

J. C. Hudson

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## Reactivity of Freshly Formed Steel Surfaces

Prince[1] has observed that a freshly sheared steel surface rusts far quicker than would be expected at ordinary temperatures. Whether or not it is always legitimate, in statistically distributed events, to draw conclusions from isolated observations, recorded facts support his statement in the present case. The corrosion probability of a freshly scraped surface is higher than that of a surface exposed to air; statistical studies by Mears[2] have shown that the probability number for rusting at scratch lines traced on iron, and, after exposure to air, covered with 0·07 *M* sodium bicarbonate, declines steadily with the duration of exposure.

Prince tentatively suggests that hydrogen peroxide plays a part in the rusting, apparently by converting ferrous to ferric hydroxide; under ordinary conditions, however, ferrous hydroxide would be oxidized by atmospheric oxygen, and there is no need to postulate hydrogen peroxide as the oxidizing agent. Incidentally, Pietsch and his colleagues[3] showed that the addition of pure (unstabilized) hydrogen peroxide to water prevented or postponed the rusting of homogeneous iron, which occurred rather quickly in water free from peroxide; possibly this passivation might not occur on steel—nor with hydrogen peroxide as found in the reagent bottle.

U. R. Evans

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[1] Prince, A., *Nature*, 176, [illegible] (1955).

[2] Mears, R. B., and Evans, U. R., *Trans. Farad. Soc.*, 31, 527 (1935).

[3] Pietsch, E., Grosse-Eggebrecht, B., and Roman, W., *Z. phys. Chem.*, A, 157, 363 (1931).

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## An Epidemic of Words

Epidemiology is a fascinating subject. Much the same interest is aroused and the same scientific principles involved whether, with Lodge in 1603, we discuss an "epidemick [of plague] . . . common unto all people or most of them"; or with Morgan in 1728 we discover that the mange is the "epidemical distemper" of the camels of the Algerians; or we realize with Berkeley (1857) that it was an epidemic of Irish blight which sent the Irish to New York and New Holland during the 'forties of the last century; or (more metaphorically as we nowadays think) we may disagree with John Milton (1643) that divorce is a "toleration of epidemick whordom". Thus 'epidemic', soon after the word was coined, came to have a wider and a narrower meaning than the original Greek ἐπιδήμιος. Epidemiology has apparently retained this wide meaning. It is correct to discuss the epidemiology of myxomatosis in the rabbit, and when we discuss the epidemiology of Irish blight we know we are not discussing a direct attack of *Phytophthora infestans* on the unfortunate Irish, although perhaps there may have been an indirect attack on them by way of the potato murrain.

Epidemics are, of course, dangerous things. Although I could see no scientific reason for the recent re-introduction and popularization of the word 'epizootic' to discuss myxomatosis, there may have been some political reasons. I now find that I have been in error in referring to an epidemic of Irish blight, Hayes and Immer in 1942 referring to the artificial production of epiphytotics on plants. In future, epidemics on plants should be referred to, not as epiphytics (Lindley in 1830 having defined this word correctly and according to the original Greek), but as 'epiphytotics', to rhyme, one supposes with epizootics, which, of course, except for Todd's pre-emption in 1836, might have been epizoics.

This is a small epidemic of words. Epidemics are infectious diseases. Unless strong antiseptics are used we may soon find ourselves with a new science of epibiology (or should it be epibioticology ?), with the three subsciences of epidemiology, epizoology (or epizooticology ?) and epiphytology (or epiphytoticology ?). The related word 'endemic' has travelled a long way in meaning since Stanley's description in 165 of "Those endemical malignant vapours, which infect the air". Its modern scientific use was carefully defined by Charles Darwin in the first edition of "On the Origin of Species" (1859), when he wrote "in oceanic islands . . ., the proportion of endemic species (i.e. those found nowhere else in the world) is often extremely large". Cannot our epidemiologists define an epidemic to include epidemics on populations of all living organisms, whether man, potato, rabbit or bacterium ?

Since writing the above, I have found that the epidemic of words has already started, Large, in 1940, referring to the new American science of 'epiphytotiology' or the use of meteorology in the prediction of epidemics on plants.

H. N. Barber

University of Tasmania.
July 6.

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## "Educational Problems of the Colonial Territories"

In the leading article in *Nature* of August 20 on "Educational Problems of the Colonial Territories", it is stated that "only some 450 scientists are at present engaged in Colonial research", and that "any expansion in research must draw largely on the limited supplies of scientific and technical man-power in Britain itself". Most British scientific workers are superannuated at the age of approximately sixty-five. Many of them are capable of another ten years of research, and a moderate amount of teaching. Some, at least, would be happy to work in a Colonial university or research institute. The necessary qualifications are the capacities to work in a tropical or subtropical climate, and to form friendships with non-Europeans.

Many branches of biology and geology, not to mention mathematics, require little expensive apparatus; and a salary less than that of a junior lecturer would be a welcome supplement to a pension. The research carried out would not often be of immediate economic applicability, but it would, I think, be of cultural value.

I may have over-estimated the number of suitably qualified British scientists available, but I think that the presence in a Colonial university of even two or three Fellows of the Royal Society carrying out fundamental research with African or Asian colleagues would help the local population to generate its own scientific culture.

Until it has been proved that elderly British scientists will not accept such offers, I doubt whether those interested in the intellectual development of the Colonies are justified in complaining of lack of man-power.

J. B. S. Haldane

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# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, October 17

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5 p.m.—Madame Alva Myrdal: "The Interplay of Factors in the Development Process". First of five Heath Clark Lectures on "The Role of Health and Education in the Process of Social Development". Further Lectures on October 18, 19, 20 and 21.)*

University College London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. F. Danielli: "Nuclear and Cytoplasmic Sites of Drug Action"*.

University of London (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Sir Charles Morris: "The Perennial Appeal of Plato". (First of nine Lectures by various speakers, on "Intellectual Currents and Their Educational Message", to be given on each Monday until December 12.)*

Institute of Metal Finishing (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr F. C. Reid: "Some Experimental and Practical Aspects of Heavy Rhodium Plating".

## Tuesday, October 18

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. R. H. Garstang: "Palomar Explores the Universe".*

Physical Society (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. R. Kompfner: "Travelling Wave Tubes" (Duddell Lecture); Dr. J. W. Mitchell: Charles Vernon Boys Lecture.

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. C. S. de Whalley: "The Decolorization of Sugar Liquor by Solid Absorbents".

University of London (at Senate House, London, W.C.1), at 5.45 p.m.—Prof. S. W. Wooldridge: "Geography and the Physical Sciences". (First of three Lectures on "The Teaching of Geography". Further Lectures on October 19 and 20.)*

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Analogues and Equivalent Circuits".

Scientific Film Association (in the Mezzanine Cinema, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Sir Arthur Elton, Bart.—Presidential Address.

## Wednesday, October 19

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. J. D. N Nabarro: "Diabetes and Carbohydrate Metabolism". (Further Lecture on November 2.)*

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 2.45 p.m.—Annual General Meeting. Presidential Address: "The Place of Astronomy in Navigation".

Institution of Post Office Electrical Engineers (in the Conference Room, 4th Floor, Waterloo Bridge House, London, S.E.1), at 5 p.m.—Discussion on "What Makes an Engineer?" opened by Mr. J. G. Straw.

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. W. A. Lewis and Mr. L. H. Watkins: "Investigation into the Accuracy of Four Types of Rainfall Recorder"; Mr. J. S. Turner: "The Salinity of Rainfall as a Function of a Drop Size"; Mr. E. M. Fournier D'Albe, Mr. A. M. A. Lateef, Mr. S. I. Rasool and Mr. I. H. Zaide: "The Cloud-Seeding Trials in the Central Punjab, June–September, 1954".*

British Coal Utilisation Research Association (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Prof. Sir Cyril Hinshelwood, F.R.S.: "The Carbon of Coal" (Fourth Coal Science Lecture).

Eugenics Society (at the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. F. Loutit: "Biological Hazards of Nuclear Fission".*

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.45 p.m.—Dr. James V. Neel (Michigan): "The Genetic Control of Hæmoglobin Synthesis" (Galton Lecture).*

Institute of Physics, London and Home Counties Branch (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. M. V. Wilkes: "Present Status of Digital Computors in Physical Research".

Royal Institute of Chemistry, London Section (at King's College, Strand, London, W.C.2), at 6.30 p.m.—Prof. H. C. Longuet-Higgins: "Some Recent Advances in Physical Organic Chemistry".

Oil and Colour Chemists' Association, London Section (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. L. O. Freeman: "Particle Size Assessment".

## Thursday, October 20

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. H. Chapman: "Research as a Business Enterprise"; Mr. J. F. G. R. Haywood: "Pressure Manifestations at Great Mining Depths on the Witwatersrand".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. E. J. H. Corner, F.R.S: "Taxonomy and Tropical Plants"; Mr. A. W. Exell: "The Projected Flora Zambesiaca".

University of London (in the Metallurgy Lecture Theatre, Imperial College of Science and Technology (Royal School of Mines), London, S.W.7), at 5 p.m.—Dr. R. F. Mehl (Pittsburgh): "Diffusion". (First of four Special University Lectures on "Kinetics and Mechanisms in Metal Systems". Further Lectures on October 21, 24 and 25.)*

Physical Society, Acoustics Group (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Mr. G. Mackworth-Young: "The Mechanics and Acoustics of Singing".

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall of the Junior Institution of Engineers, Pepys House, 14, Rochester Row, London, S.W.1), at 6 p.m.—Dr. S. J. Gregg: "Some Observations on Dead Burning, especially of Lime and Magnesia".

Chemical Society (in the Lecture Theatre of the Institution of Civil Engineers, Great George Street, London, S.W.1), at 7.30 p.m.—Prof. M. Calvin (University of California): "The Photosynthetic Carbon Cycle" (Centenary Lecture).

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. R. M. Gordon: "The Host-parasite Relationship in Filariasis" (Presidential Address).

## Friday, October 21

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Dr. R. W. Sperry (California): "Some Neural Mechanisms Underlying Perception".*

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. P. L. Jones: Presidential Address.

Aslib (at the Library Association, Malet Place, London, W.C.1), at 6 p.m.—Meeting on "The Case for a New Public Technical Library and Information Service". Speaker: Dr. D. J. Urquhart.

## Saturday, October 22

Biochemical Society (in the Department of Physiology, Bedford College, Regent's Park, London, N.W.1), at 2 p.m.—Scientific Papers.

British Psychological Society, Education Section (at the Institute of Education, Malet Street, London, W.C.1), at 2.30 p.m.—Dr. K. Lovell: "A Study of the Problems of Intellectual Deterioration in Adolescents and Young Adults".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. K. C. Rosser: "A 'Hermit' Village in the Himalayas".*

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Master (with a degree or recognized teaching qualification) to teach Mathematics at the General Wingate School, Addis Ababa, Ethiopia—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Wingate School" (October 21).

Lecturer or Research Assistant in Bacteriology and Virus Diseases—The Registrar, The University, Sheffield (October 22).

Senior Lecturer or Lecturer in Civil Engineering and a Senior Lecturer or Lecturer in Mechanical Engineering—Registrar, The University, Manchester 13 (October 24).

Electronics Engineer or Physicist (with recognized professional qualifications in electronics, and an interest in computing machines) in the Computational Laboratory, to work on problems of character recognition in connexion with mechanical translation—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (October 29).

Assistant Lecturer in Physiology—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (October 31).

Assistant Lecturer or Lecturer in Vertebrate Zoology—The Registrar, King's College, Strand, London, W.C.2 (October 31)

Chair of Industrial Metallurgy—The Registrar, The University, Birmingham (October 31).

Lecturer or Senior Lecturer in Pure Mathematics at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31).

Lecturers (2) or Senior Lecturers in Pure Mathematics; Lecturer in the School of Chemistry; Chair of Medicine, and a Senior Lecturer in Physiology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, October 31)

Tutorial Student (graduate) in Biochemistry—The Registrar, King's College, Strand, London, W.C.2 (October 31).

Mycologist (with a first- or second-class honours degree) for research on freshwater fungi at Windermere Laboratory—The Director, Freshwater Biological Association, The Ferry House, Ambleside (November 1).

Research Assistant (with a degree in physics and preferably some research experience) in Physics, to undertake measurements of high precision, using a reflecting echelon interferometer—The Registrar, King's College, Newcastle-upon-Tyne (November 1).

Senior Lecturer or Lecturer in Philosophy at Canberra University College, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 1).

Lecturer or Assistant Lecturer in Anatomy—The Registrar, The University, Manchester 13 (November 7).

Lecturer in Geography at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 7).

Lecturer (with special qualifications in inorganic or physical chemistry) in the Department of Chemistry—The Secretary, The University, Edinburgh (November 7).

Chair of Nuclear Engineering at Queen Mary College—Academic Registrar, University of London, Senate House, London, W.C.1 (November 9).

Chair of Zoology—The Registrar, University College, Singleton Park, Swansea (November 12).

Lecturer or Assistant Lecturer in Geography at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 15).

Lecturer in the Department of Education at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 15).

Senior Lecturer in Physics at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 21).

Fellow, and a Senior Research Fellow, in the Department of Statistics, Australian National University, to undertake research in mathematical statistics or its applications, including mathematical genetics—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, November 30).

Reader in Geology—The Registrar, University of Dacca, Ramna, Dacca, East Bengal, Pakistan (November 30).

Professor of Chemical Engineering; Professor of Soil Mechanics, and a Professor of Physics—The Dean, Faculty of Engineering, Giza, Egypt (December 1).

Guinness Research Fellow in Microbiological Biochemistry—The Administrative Officer, Department of Biochemistry, The University, South Parks Road, Oxford.

Lecturer (graduate of a British University, with industrial experience) in Power Engineering—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

Physical Chemist, Scientific Officer grade (with a first- or second-class honours degree or equivalent in chemistry, and preferably with research experience in surface chemistry with special reference to wetting of solids by liquids; friction and lubrication; adhesion; capillarity; or related phenomena), at the Ministry of Supply Royal Aircraft Establishment, Farnborough, Hants, for work directed towards the solution of lubrication and fluid problems associated with aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.711/5A.

Senior Experimental Officer or Experimental Officer (preferably with a degree in physics, electrical engineering or electronics or at least H.S.C. in science subjects or equivalent qualifications) in the General Physics Division, to assist in the experimental work and maintenance of the cyclotron, and in the design, construction and maintenance of the auxiliary apparatus—The Establishment Officer, U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/410.

Senior Research Assistants (with a good honours degree in engineering, practical experience and/or research training) in the Departments of Civil and Mechanical Engineering, for work in the fields of photo-elasticity, fatigue of metals and the creep and deformation of metals at high temperatures—The Registrar, The University, Nottingham.

Technical Author (with a first- or second-class honours degree in either chemistry, engineering or physics and with appropriate experience, and preferably with knowledge of the technical aspects of atomic energy) in the Public Relations Branch, for duties which include the preparation in non-technical or semi-technical terms for general or limited publication of news items, booklets and exhibition scripts on technical and scientific subjects—United Kingdom Atomic Energy Authority, H.1B, 14 Ormond Yard, London, S.W.1.

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# REPORTS and other PUBLICATIONS

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Rowett Research Institute. Collected Papers: Summary and Subject Reviews. Vol. 11. Pp. iv+44+76 papers. (Bucksburn: Rowett Research Institute, 1955.) [67

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London and Home Counties Regional Advisory Council for Higher Technological Education. Bulletin of Special Courses in Higher Technology (including Management Studies and Commerce), 1955–56. Part 1—Autumn Term 1955. Pp. ii+70. (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1955.) 1s. 6d. [157

Institute of Personnel Management. Occasional Paper No. 7: Revising a Merit-Rating Scheme. By A. G. P. Elliot. Pp. 23. (London: Institute of Personnel Management, 1955.) 3s. [157

Air Ministry: Meteorological Office. Professional Notes. No. 113: Depressions Crossing Labrador and the St. Lawrence Basin. By Dr. A. G. Forsdyke. Pp. 44. (M.O. 534m.) (London: H.M. Stationery Office, 1955.) 1s. 6d. net. [157

Department of Scientific and Industrial Research. Building Research Station. Analysis of Symmetric Cylindrical Shells: Its Application to Civil Engineering Design. By Dr. John McNamee. Pp. v+85. (London: H.M. Stationery Office, 1955.) 12s. 6d. net. [157

## Other Countries

Institut pour l'Encouragement de la Recherche scientifique dans l'Industrie et l'Agriculture (I.R.S.I.A.). Rapport Annuel, Exercice 1954. Pp. 205. (Bruxelles: Institut pour l'Encouragement de la Recherche scientifique dans l'Industrie et l'Agriculture, 1955.) [127

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Hypothèses sur l'Homme. Par Boris Rybak. Pp. 12. (Poitiers: Imprimerie Victor-Hugo, 1955.) [157

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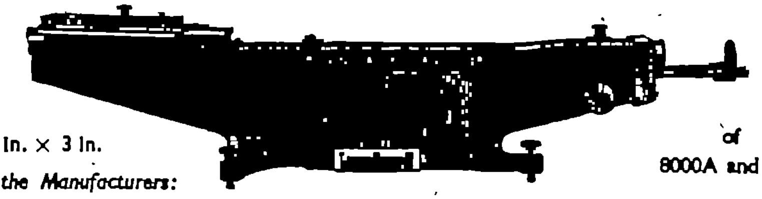

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# INTERPRETATION OF SCIENCE

ALMOST simultaneously with the opening of the meeting of the British Association at Bristol, the September issue of *The Twentieth Century* appeared ontaining contributions from some leading scientists addressed not to the specialist but to the average, ducated non-scientist who is anxious to comprehend ome of the problems presented by scientific advance not merely in nuclear physics but also in other fields. It includes contributions from Prof. R. E. Peierls on the frontier of physics, from Prof. A. R. J. P. Ubbelohde on our increasing dependence on supplies of energy, from Prof. P. B. Medawar on the biological imperfections of man, from Sir F. Macfarlane Burnet on cell and tissue replacement in modern medicine, from Sir Frederic Bartlett on the contact of cultures and from Prof. M. Polanyi on words, conceptions and science; Mr. C. F. Hudson contributes a layman's plea for independence in the pursuit of science, and provides an excellent statement of the reason freedom for science is an interest of society as well as of he scientist. An appreciation of the implications of automation comes from Mr. Austen Albu, and the issue concludes with a discussion of science-fiction by Mr. P. Fison. The journal thus ranges over all the main fields covered in the discussions at Bristol, and he two articles in particular that discuss the formulation and communication of our ideas to one another and of our culture to other societies deal with a subject around which the main criticism of the British Association has centred in recent years.

It is in the light of this fresh discussion as to what should be the main function of the British Association and how the task of interpreting science to the community is best effected that this admirable effort of *The Twentieth Century* is appropriately considered. Clearly its success depends as much on the skilled exposition of its contributors as on the level of education and interest in the community. For that reason alone, consideration of the functions and organization of the British Association is closely related to the question of education—of the general education of the scientist himself and of the teaching of science in schools and universities generally—to which the Association devoted much attention at Bristol. The extent to which the purpose and function of the British Association require modification and the organization of its annual meeting can be improved cannot usefully be determined without regard not merely to the general climate of opinion and state of public understanding of science, but equally to the work and responsibilities of other bodies such as the universities, the learned societies and the professional nstitutions. The shortcomings of any or all of these bodies should not be visited solely on the British Association.

The discussion as to what the British Association ould do to increase the public understanding of cience and how it should do so seems inclined to lose ight of this, and one welcome feature of Mr. Ritchie Calder's presidential address to the Assembly of Corresponding Societies was that, in pressing for a renewed attempt to overcome the fragmentation of science, he indicated that other bodies besides the British Association have responsibilities here. This special number of *The Twentieth Century* is likewise a reminder that the Press itself has certain responsibilities, and also suggests that those responsibilities are by no means as narrowly limited by the shortcomings of scientists themselves as Mr. Calder suggested. Whatever criticism may be levelled against the exposition of particular contributions to this symposium, they do not support his charge that scientists by and large are illiterate, inarticulate and irresponsible. On the contrary, they demonstrate that, as he admitted, some scientists are at pains to be comprehensible, to be explanatory and to recognize their responsibilities.

One dominant impression, indeed, left not only by the British Association meeting but equally by the conferences on the application of nuclear energy and by other recent events, is the extent to which scientists are recognizing these responsibilities. Further, whatever criticism is made of particular proceedings at the Bristol meeting, a second impression left by that meeting is that scientists are no less concerned about this problem of fragmentation and communication, and are determined both to improve their own capacity to communicate their ideas and also the means by which the community is informed of what they are doing and how and why they are doing it. The situation is not entirely the fault of the scientists themselves, for all the truth that there is in much of Mr. Calder's criticism: it is equally a failure of our educational system and our newspapers and broadcasting system—they have their own share of responsibility for the ignorance on the part of the average person of the nature of science and its limitations, as well as its potentialities for human welfare if used wisely.

These factors must be borne in mind in considering what scientists themselves can do to repair the situation and how far any one institution like the British Association can itself correct the fragmentation of science by organizing its annual meeting so as to provide an effective scientific stocktaking and encourage the re-definition of the frontiers of knowledge in each specialized field, relating one to the others and providing scientist and layman alike with a clearer sense of perspective. Those possibilities would, of course, be improved by educational reform, both in the training of the scientist and in the training of the ordinary citizen, just as they would be assisted by more adequate press reporting, as well as possibly by symposia such as *The Twentieth Century* has published.

Leaving educational reform on one side, disregarding the Press, save to observe that the newsprint situation is at least partly responsible for the poor reports that the British Association meetings receive to-day, compared with twenty years ago, and limiting our attention to action which scientists themselves might initiate to meet Mr. Calder's criticisms, it is only fair to point out that the Bristol meeting itself produced examples of a new outlook, and a readiness to consider what new methods and practices could be brought to assist the interpretation of science across disciplinary frontiers in an age of broadcasting and television. Scientific films, for example, are clearly coming into their own, and a new attitude towards the reading of papers indicates something much more fundamental than an attempt to raise the general standard of presentation and delivery. Besides the self-denial which will be demanded if the number of papers is to be brought down to a figure more in keeping with the supply of first-rate expositors, the president of the Physics Section, Prof. N. F. Mott, has indicated that the aim in his Section is to deal with subjects at about 'Third Programme' level. There were some notable examples of lucid description of advanced scientific work and of taking printed papers as read so that the whole of the allotted time could be given to a discussion.

Such practices, it should be remembered, may involve a break with the tradition of learned societies generally and not specifically of scientists, and it must also be recognized that changes in technique of this order require a good deal of creative and constructive thought and experiment before they can be adopted as standard practice by scholarly bodies. It is encouraging to find evidence that this is proceeding—and probably a good deal faster than some external critics realize or allow. Apart from this, the steadily growing practice for the various sections of the British Association to arrange joint sessions at which topics of common interest are discussed not merely across disciplinary frontiers but also at a level well within the level of a determined layman, shows that the Association is already attempting to deal with this problem of fragmentation. It can no longer be said without some qualification that the Association's programme consists entirely of unrelated papers or unco-ordinated themes: some specialists at least are dealing with their subjects in terms comprehensible to specialists in other fields or to an educated layman.

If we are to correct the fragmentation of science and solve this problem of exposition, the key-word is 'education'. The scientist may have far to go to remove entirely the reproach of ineffective exposition, but the limits of exposition are ultimately set by the standard of education of his public. The problem will not be solved merely by removal of the scientist's own inhibition about exposition or interpretation to a non-specialist, by improving his capacity to express himself clearly and concisely to those working outside his own field or by ensuring that his general education makes him aware of the human and cultural elements in the world in which he is working. It depends equally, as Mr. J. F. Wolfenden and Dr. J. Bronowski insisted so emphatically at Bristol, on our making sure that the education of the ordinary citizen is such that he can understand what the scientist says to him.

That point is fundamental in considering, for example, such object lessons as the Lunar Society cited by Mr. Calder. It was the absence of any gulf in education and terminology between the scient and the layman, quite as much as the mark amateur element among the scientists of the tim that facilitated the exchange of ideas and free flow discussion between the scientist, amateur or pr fessional, and the industrialist and practical man affairs in that body. The contribution to the develo ment of physical science and of industrial chemistr for example, which flowed during the latter part the eighteenth and the first half of the nineteen centuries from the meetings of the Lunar Societ the Manchester or the Newcastle Literary a Philosophical Society or the Whalley meetin started by Dr. Lyon Playfair, is only now becomi appreciated, and perhaps its full extent remains yet be demonstrated.

What Mr. Calder did well to remind the Assembl of Corresponding Societies, which is perhaps pa ticularly suited to deal with some aspects of adu education, was the danger of allowing the spirit universal inquiry to be choked by the growth barriers, not simply between the humanities a science but also between the sciences themselve which hinder or prohibit discussion except withi narrow fields. Semantics is indeed a large factor the fragmentation of science, and scientists themselves must take this question of language muc more seriously if the fragmentation of science is be checked and overcome; without some commo understanding, if it is too much to say that a scienti does not know what he is doing, it is certainly tru that he is wasting his time. Clarity and accuracy explaining and describing his results are as an essenti and intrinsic a part of his work as precision in makin and recording his experimental observations rigorous reasoning in drawing his conclusions.

Mr. Calder's clear statement of the dangers of th present situation deserves to be pondered by layma and scientist alike. Much that he said had been sai before on different occasions and in different wa by scientists to scientists; for the danger, f example, of an unhealthy and mistrustful popul attitude to science has been realized by man scientists in Great Britain as well as in the Unite States since the Oppenheimer case last year. S too, the shortcomings of the educational system Great Britain which he noted are generally reco nized in current discussions of higher technologic education, of university education, and of general further education; though not perhaps as yet wit the sense of urgency necessary to make fundament changes. Mr. Calder, for example, directed attentio to suggestions made more than ten years ago in th report of the British Association Committee on Post War University Education which have never bee implemented.

One at least of the joint discussions at Bristol di something to stimulate the re-examination of th and other proposals for facilitating the study natural science on lines wider than those of any the specialized science schools; and there is som reason for hoping that in ways such as this th British Association may steadily grow more influenti in stimulating the changes needed in the education system and practice of Britain. So, too, the closer planning of its annual meeting could contribute to the more effective interpretation to the general public nd to the specialist in other fields of scientific advances, as well as to inter-disciplinary discussions. uch planning and reorganization of the Association's rogramme demands, however, in the first place a clear conception of the functions and work of the Association in the world to-day. It demands no less clear ideas as to the part which the learned societies and professional institutions have to play in inter-isciplinary discussion, and in the education of the public as to the significance of particular scientific advances or the importance of the scientific and technical factors in matters of public concern. Equally it calls for the support and full co-operation of such bodies.

Full account must be taken of all such potentialities in order that waste of effort may be avoided and the best use made of our limited resources, just as the fullest possible use should be made of all supplementary methods of educating the public mind, whether through the Press, the cinema, broadcasting and television or the public library service. We need to remember, in fact, as the Library Association was old at its recent annual conference, that the public library is the major instrument of adult education, and especially of the informal education which is an essential element in the production of a complete and well-rounded human being. It was a director of education who remarked in the Association's annual ecture: "When I am most uncertain about the virtues which education is intended to promote, and about the methods by which we try to promote them, find comfort in thinking that the money we spend on public libraries, with its result of putting books into the hands of millions of people who would otherwise not read them at all, is the only expenditure of which we can say with tolerable certainty, 'This causes education to happen' ".

That these implications are being discussed is perhaps the most hopeful sign that the dichotomy and rivalry of science and the humanities, and the fragmentation of science itself may be ending. The scientist who has come to recognize his responsibility for seeing that, so far as possible, the ordinary educated man and woman understand the social and political implications of new scientific knowledge, has taken one step towards recognizing his responsibilities as a citizen. Nor is he likely to be backward n realizing the dangers to science itself if there is nsufficient understanding of the nature of scientific work on the part of the nation as a whole, or of that small part of it which holds political power.

It is not simply that, as Dr. Eric James remarked n his lecture to the Science Masters' Association on 'Science and Citizenship", the intellectual resources of government will be gravely impoverished unless many of those now being trained in the sciences rise to positions in administration hitherto held by arts men: there is also grave danger that insufficient resources will be placed at the disposal of science and scientists. Moreover, if, as Dr. James suggests, we reach a stage in which the possible supplies of ability are insufficient for the technical needs of Britain, there is real danger, not so much that too high a proportion of the national intelligence is directed into scientific channels—though this, too, is serious—as that at some stage the limitation of human capacity will force us to select objectives for study and pursuit, and we may choose wrongly.

This is the real danger to intellectual freedom and scientific advance, and it will clearly be greater unless men of science are prepared to use their gifts and training in administration and government and not simply in research. We need more and more, in public debate, men of science, aware indeed of the limitations of their method and technique, but none the less alert and competent to detect nonsense when it is presented in public affairs no matter what support it receives from interested groups or political caucuses.

Lastly, if scientists themselves are to undertake these responsibilities of public education and to repair the fragmentation of science and its division from man's wider cultural heritage, we must remember, as Dr. James pointed out, that a major responsibility rests on those who train them to see that the education they receive fits them to be citizens and statesmen. To produce such men, understanding the dangers and opportunities that are provided by the discoveries they themselves are making, is a task to be undertaken urgently and with determination. It means infusing into the education of such men and women the essence of the older studies, so that they are, as Dr. James said, "prepared and equipped to lead mankind to resist the temptations of purely material triumphs, and to use science not as a means of enslavement but as a force for the liberation and enrichment of mankind".

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## BIOLOGY OF TSETSE FLIES

### The Natural History of Tsetse Flies

An Account of the Biology of the Genus *Glossina* (Diptera). By Prof. Patrick A. Buxton. (London School of Hygiene and Tropical Medicine Memoir No. 10.) Pp. xx+816+47 plates. (London: H. K. Lewis and Co., Ltd., 1955.) 84*s*. net.

FOR more than fifty years, the various species of tsetse fly have been studied from many aspects by entomologists, medical men and veterinarians, and as a result an immense amount of information has been collected and published. This has produced a considerable literature of varying quality, which has not been reviewed in its entirety for a very long time. The bulk of the field-studies have been by British scientists working either on the eastern or western sides of Africa, and frequently under very different conditions. Arising from the researches of these two schools of tsetse ecology are two separate masses of literature with frequently only the most tenuous of links. At last, in the person of Prof. P. A. Buxton, a builder has appeared who has bridged the gap with a firm structure, containing no doubtful planks.

Within the compass of this superbly produced volume the author has included the most important basic facts on the anatomy, systematics, distribution, metabolism, reproduction and ecology of tsetse and their relation to disease. It must not be thought that this is one of those dull encyclopædic volumes—a lumber room of facts reserved for use by the specialist. On the contrary, it is an extremely interesting book about an extremely interesting genus of insects.

Anyone who has studied the tsetse problem appreciates what fascinating fields are open to the research worker. He may legitimately study the insect in relation to climate, vegetation and game, or he may study the habits of man and cattle in relation to the fly; or if he prefers a more restricted field, he can investigate the ecology of the trypanosome within the tsetse fly. The results from these various lines of research are likely, when integrated, to aid in the discovery of improved methods of destroying the insect vector, of preventing contact between the vector and man and his animals, and of discovering the trypanosome's requirements if it is to be carried by the tsetse to new mammalian hosts.

The fascination of the subject has been well brought out by Prof. Buxton, who has avoided the dreariness produced by dealing with each species separately and has, instead, divided his subject into topics such as source of food, movement and rest, tsetse and trypanosomes; such an arrangement enables the reader to obtain an excellent picture of the habits of the tsetse fly and the problem it presents to man in tropical Africa.

Since the War, there has been a very considerable expansion in the numbers of scientists engaged in research on tsetse flies and trypanosomiasis; a new generation of such workers has come into being. The pre-war literature on the subject is scattered through many different journals, and is often inaccessible to those who are not working in one of the few central laboratories; the unavoidable result has been that some old discoveries have been re-discovered and published anew. The appearance of this book is therefore most timely, for not only does it serve as a literary bridge across the two sides of the continent, but also as a bridge between the pre-war and post-war generations of workers.

Prof. Buxton has not been content just to pick out the information from the summaries of all those papers that were appropriate to his topic; in cases where the paper appealed to his selective instinct he has incorporated digests of the actual experiments, as well as the original diagrams, or versions of the original which have been re-drawn by his colleague, H. S. Leeson, who has also contributed many original maps, and text-figures. It is this treatment of the subject which has made the book so readable. Caution should be exercised when reading the distribution maps, remembering that these are on a very small scale. For example, from Fig. 29 one would get the impression that *G. medicorum* extended along the littoral and was a denizen of the tropical forest belt; in reality its distribution lies along the northern side of this belt in the country which is transitional between forest and savannah, and only approaches the coast in one or two dry areas.

In addition to 165 text-figures, there is an excellent selection of photographs of a very high standard. Many of these illustrate the different types of vegetation favoured by the different species of *Glossina*, and special features in tsetse ecology, such as the feeding grounds, breeding sites and resting haunts. There are also some good photographs illustrating the value of aerial survey for studying the vegetation types, and detecting the presence of the plant associations most favoured by the fly. Such plates add enormously to the value of the book, as a mer list of botanical species can convey little to th reader who is unacquainted with them and the typ of vegetation which they produce.

The ten appendixes at the end of the book are o particular value to the research worker, as the provide detailed descriptions of techniques whic should lead to a standardization of the methods used the subjects range from methods relating to metabolism, techniques employed in demonstrating trypanosomes in tsetse, to the conventions used in mapping the species distribution.

The author has taken the end of 1952 as his deadline, and it can safely be said that he has omitted references to little of real value that has been done prior to that date; the book is therefore of grea value to all who are working on the tsetse problem. It is also of special interest to those working on methods of field-survey and estimates of insec populations, as the tsetse may be considered as a classical organism in this respect, much original work having been done on this aspect by the late Dr C. H. N. Jackson and others. Further, the book is o general biological interest since it brings out mos clearly the intriguing relationships that exist between the tsetse, climate, vegetation and man, his animals and the wild game; it also demonstrates how an improved understanding of these relationships has frequently revealed some key factor alterable by man which has enabled him to change the environment and so control the insect. For example, it has been found that large areas of woodland can sometimes be freed of tsetse by the removal of only certain essential types of vegetation; similarly, under certain conditions riverine tsetse can be eradicated by discriminative clearing of the vegetation, which in this case destroys an essential ecoclimate.

Prof. Buxton is to be congratulated on the production of this magnificent volume, which will be the standard work on the subject for many years.

T. A. M. Nash

# TREATISE ON ZOOLOGY

## Traité de Zoologie

Anatomie, Systématique, Biologie. Publié sous la direction de M. Pierre-P. Grassé. Tome 12: Vertébrés: Embryologie—Grands Problèmes d'Anatomie Comparée—Caractéristiques Biochimiques. Par P. Brien, R. Cordier, A. Dalcq, Ch. Devillers, M. Florkin, P. Gérard, L. Lison, R. Matthey, J. Pasteels, J. Piveteau, A. Rochon-Duvigneaud et F. Stéphan. Pp. viii+1146. (Paris: Masson et Cie., 1954.) Broché 9,800 francs; Cartonné 10,550 francs.

This volume, Tome 12 of the whole work, is the seventh of the now well-known "Traité de Zoologie" to appear (two of them are each composed of two fascicles the size of volumes). It is introductory to the study of the vertebrates and deals in a general way with the embryology, development, adult structure of the group and the various fundamental problems that arise from a consideration of its comparative anatomy. It immediately calls to mind the classical "Studies on the Structure and Development of the Vertebrates" by the late Prof. E. S. Goodrich, since many topics are common to both. It differs in that Prof. Goodrich said of his work, "It is not a complete treatise, but deals with certain subjects and problems of special interest", hereas the "Traité" attempts to cover the whole eld and has in addition a short but interesting chapr on the biochemical characteristics of vertebrates. he twenty-four years separating the two works ave been fruitful ones. The contents of the present olume are difficult to appraise because it is to be llowed by others treating of the separate classes; hat on birds has already appeared, and so what ppear to be gaps may only be postponements. Thus, 1 the excellent account of the eye, the portion ealing with birds only mentions the pecten ncidentally and very briefly, but it is adequately lealt with in the bird volume.

Perhaps too much stress has been laid on the old lassics even for a general introduction; for example, he figure of the arterial system of the salamander is aken from Bethke (1898) with no mention of the nore detailed and modern work of Francis (1934). nformation on the elasmobranchs is taken from ?arker, and the much more recent and comparative vork of Daniel and his school not considered. On he whole, the chapters dealing with the central ervous system, eye, ear, olfactory organ and teeth ppear to be the most outstanding: the last four re dealt with by members of the medical faculty out none the less in a completely comparative manner both anatomically and functionally. No ther text-book of zoology contains such a wealth of nformation on these important subjects. They are lso up to date and, in one case, include information published in the previous year, which is praiseworthy n such a large work.

The whole format of the volume, its paper, press work and illustrations carry on the very high standard of the previous volumes. The 733 text-figures, line block (467), line block with colour (23), half-tone drawings (157), half-tone photographs (47) and half-tones of macro and micro sections vary considerably in usefulness and presentability. The line-blocks Figs. 5, 6, 7, 234 and 633 are excellent, as are those with colour—for example, Fig. 44, which occupies three whole pages, and Fig. 46 on four pages—and they show the wide range of effects that can be produced by this process. In the chapter on the central nervous system considerable use has been made of photographs of actual dissections, and they are not an unqualified success. Some—for example, on pp. 239, 252, 259, etc.—are not very helpful; others with an explanatory diagram are more easily comprehended. It is not obvious why good drawings were not used throughout, since readers of this work will be familiar with the appearance of dissections, usually difficult to photograph. It is quite otherwise with the photographs of the macro and micro sections, many of which are quite as clear as a diagram, and they do represent the actual object. It is a pity that the nomenclature has not been unified and brought up to date; for example, the same animal appears as *Scyllium* and *Scylliorhinus*, and another as *Hatteria* and *Sphenodon*. Moreover, each of the pair is indexed separately without any cross-reference. It is not as if the original name had been retained, for on p. 717 *Scylliorhinus* is used in reproducing a diagram from Goodrich, who called it *Scyllium*.

In spite of these blemishes, the volume is most useful and to be highly commended. It deals with a number of topics in an up-to-date and adequate manner and is a welcome addition to the few general works on vertebrates. Doubtless it will hold its place as an important work of reference for a considerable time. C. H. O'Donoghue

# EDUCATION AND SOCIAL DEVELOPMENT IN THE COLONIES

**Education and Social Change in Tropical Areas**
By Prof. Margaret Read. Pp. ix+130. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1955.) 8s. 6d. net.

The papers collected in this volume were written over a period of nearly ten years and addressed to audiences as diverse as the subjects covered. Most of them were presented, however, during the years 1950–52, and although the common theme—the application of social anthropology to educational problems—gives the book more unity than its structure would possess, it nevertheless lacks the coherence and incisiveness that it might have had if Prof. Margaret Read had sat down to rewrite the papers and weld them into a systematic discussion of a few leading themes. As it is, too many points are raised and cursorily dismissed, problems are indicated rather than analysed, and though there is less repetition than might have been expected, the net result is less satisfactory and penetrating than some of the individual papers.

None the less, the book is to be welcomed not solely as a contribution to the clearer understanding of the fundamental conditions in which Colonial development and welfare operate. Dr. Read indicates clearly and forcefully the leading questions which have to be considered in formulating educational policy, or social policy in general, in the Colonial and similar territories: the problem of communication and the importance of studying the results of cultural contact and education in terms of the changing patterns of living and social grouping among the people of the tropical areas. But when she also depicts in so stimulating a manner the difficulties that arise—because what is educationally desirable may be socially unacceptable, or because what is socially desirable is economically unattractive, or because the economically attractive is politically impracticable—we are aware that much that is written of tropical areas has its bearing on educational policy in Great Britain.

Quite apart from its contribution to the understanding of Colonial welfare and development, Prof. Read's book is of real value for its bearing on education in Britain on two counts. First, it emphasizes the need for a similar approach to our own educational problems; it raises, for example, such leading questions as the appropriateness of our educational system to the society in which we live. Secondly, it demonstrates the value and importance of the holistic approach to educational problems, whether, for example, at the upper end in considering the expansion of higher technological education and the balance between that and university education, on one hand, and technical education, on the other; or, at the other end of the speculum, in considering the place of adult education and whether it is not desirable that some attempt should be made by such means to reshape particular group attitudes to higher education.

The book is admirably produced and reasonably priced, but once again it has to be recorded that the absence of both index and references detracts from its full value in stimulating further thought and study on problems which determine the future of Britain as much as that of her tropical dependencies.

R. Brightman

# A HUNDRED YEARS OF TECHNOLOGICAL TRAINING AND RESEARCH IN SWITZERLAND

By Prof. MAX WILDI

Swiss Federal Institute of Technology

THE twenties and thirties of this century witnessed the centennial celebrations of the earliest non-denominational university institutions, of the type of University College, London. Now, in the middle of the century, a later phase of nineteenth-century development in the domain of higher education has completed its first century: the specialized technological colleges and institutes. Thus during October 20–22, the well-known Eidgenössische Technische Hochschule of Zurich (the Swiss Federal Institute of Technology) is entertaining guests of honour from all over the industrialized world to celebrate its first centenary.

The official opening of the first courses of this school in October 1855 was preceded by half a century of idealistic projects and enthusiastic promotion by a few far-sighted men, by petty regional squabbling and rivalry, long parliamentary debates ending in what, to the first promoters, would probably have appeared a sadly truncated affair, but which has proved a wise and far-sighted solution, eminently wise in what was not attempted and equally far-sighted in what was actually done. The first promoters, men like Stapfer, Switzerland's ambassador to the First Consul in Paris, had conceived the lofty idea of a central, national university embracing all faculties plus a technological section, to be supported and administered by the central government. In a country of such cultural, religious and linguistic diversity as Switzerland, the plan, had it ever been put into practice, would have led either to a pitiably atrophied, characterless shadow of a university, or to an aggressive stronghold of centralization in a sphere where, according to Swiss political tradition, the cantons, as embodying the regional autochthonous forces, are absolutely sovereign. It was different with the new technical sciences, for example, mechanical and electrical engineering, chemistry, geodesy and geology. These were, to a very large extent, of foreign, partly British, growth. They had no connexion whatever with the historical and regional forces. None of the older Swiss universities (Basle and Geneva) or even their younger liberal sister institutions at Zurich or Berne had seriously started teaching technology or science. Thus the way was open for a central school of engineering and kindred subjects.

The Swiss Federal Institute of Technology owes its initial impulse, its generous endowment and the wide and lofty conception of its aims to the great liberal revolution of 1848. That year marks the victory, in Swiss history, of the urbanized Protestant areas with their old textile and watchmaking industries over the mainly agricultural Roman Catholic mountain valleys, among which lay the cradle of Switzerland. Zurich, the rising industrial town, terminus of the first railway and centre of important engineering plants, was chosen as the seat of the new school. It was here, on the site of the old ramparts overlooking the Limmat, that the imposing main building in classic style of the Institute arose to the design of Gottfried Semper, the first head of the school's architectural section. Originally, that is, in the half-century between its erection in 1864 and the completion of the neighbouring university buildings, it housed both the Federal Polytechnic School as it was then called after its famous prototype, the École polytechnique of Paris, and the cantonal University.

The remarkable development of the technical sciences in the course of a century is reflected in the rapid growth of this representative centre of technical study and research. Its original six sections comprising architecture, engineering (two sections), chemistry, forestry and general subjects, had to be doubled by subdivision and the inclusion of natural science, theoretical mathematics and physics, pharmaceutics, surveying and military science. The development of the Institute during recent decades from a mainly educational centre to a scientific research institution made it imperative to adapt the existing laboratories to their new purposes and to add many new ones. Among more recent additions may be mentioned institutes or laboratories for photogrammetry, geophysics, micropalæontology and applied mathematics. In the course of the past seven years alone, twelve new professorial chairs for these and other subjects have been created. The staff of the Institute comprises at present 107 professors, 68 *Privatdozenten* (assistant professors and lecturers) and 237 assistants. Professors have the same standing as holders of full university professorships. The number of full-time students varies from 2,600 to 4,000. Of these, 15–25 per cent are foreigners. Their studies cover, as a rule, a four-year course ending in a final diploma examination. A minority of approximately 25 per cent of all postgraduates go in for independent research in order to obtain the degree of a doctor of technical, mathematical or natural sciences. Many well-known scientists and leading engineers received their early training at the "ETH"; among others, Röntgen, Sir Alfred Mond, Stodola and Einstein. The latter two were members of the Institute's teaching staff as well.

One special feature of the Swiss Federal Institute of Technology has attracted the attention of educational authorities in countries where new technological colleges were being planned or actually founded, as, for example, Australia: it is the existence, side by side with the specialized sections, of a large, fully equipped general section dealing with such humanistic and non-technical subjects as philosophy, psychology, German, French, Italian and English language and literature, political and constitutional history, law and economics, art history and history of music. Most of these formed part of the original programme of 1855. From the fact that English as the only non-national language was given a half-time professorship at the newly founded school, one may gather how great was the prestige Britain enjoyed as the foremost liberal and industrial power. (The chair for English has since been made a full-time professorship.) All courses in this so-called free section are voluntary, students being only required to attend at least one hour a week in any of the various general subjects. The Institute is proud to have had among the professors of this section men like Jakob Burckhardt, Friedrich Theodor Vischer, Francesco de Sanctis and, in recent times, Carl Gustav Jung.

In the first century of its existence the Swiss Federal Institute of Technology has played a very important national and a surprisingly large international part. It has provided Switzerland with generations of first-class engineers who helped to open the magnificent but barren mountain fastnesses to international traffic by boring the Gotthard and Simplon tunnels and by harnessing the Alpine torrents to provide the country with electric energy. It has trained thousand of architects and chemists, and it has equipped the schools of Switzerland (and itself) with young teachers in mathematics, physics and natural science, who in their turn provided an élite of scholars. The latter was supplemented by eminent foreign talent, which was freely admitted and even sought after. For many generations the eastern European and Balkan countries not only sent thousands of students to Zurich, but they also gave the Swiss Federal Institute of Technology some of its brilliant scholars, men like Stodola and Ruzicka.

In a country like Switzerland, a country that is so poor in natural resources that three-quarters of its energy supply and nearly all its raw materials as well as a very large amount of foodstuffs have to be imported from abroad, a population of five millions can only be maintained at the present high standard of living if all the latent energy of the nation can be called forth and given an opportunity of profitable activity. For Switzerland this means specialized activity in the sphere of international trade and industry rendering high visible and invisible exports. It need scarcely be said that, in such an economy, the leading centre of scientific and industrial research and training holds and will continue to hold something like an intellectual key position.

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# ADVANCES IN ORGANIC CHEMISTRY

## FOURTEENTH INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY

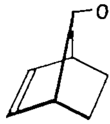
THE Fourteenth International Congress of Pure and Applied Chemistry took place in Zurich during July 21–27. It was devoted to organic chemistry and was undoubtedly the most representative gathering of organic chemists held in recent years.

Here, on the favourite meeting ground for international conferences, refreshed by the beauty of the city and its surroundings, delighted by the generous hospitality of their hosts, and encouraged by the messages of peace and political *rapprochement* emanating from Geneva, more than three thousand chemists and their ladies from nearly forty countries were assembled. The distinguished company included many leaders of the science, and the list of participants might well have been taken for the author index of a text-book of contemporary organic chemistry, with scarcely an important name omitted.

The scientific programme was arranged in three main sections, covering (i) theoretical and physical organic chemistry, (ii) natural products, and (iii) synthetic, industrial and analytical organic chemistry. It comprised fourteen lectures, delivered by invited speakers, and more than six hundred papers read in ten groups meeting simultaneously. To this were added visits to the chemical industries in Basle and to various other factories, numerous excursions and social events, including a reception at the Stadthaus and a banquet attended by more than a thousand people, as well as the committee meetings of the International Union of Pure and Applied Chemistry, which was simultaneously holding its Eighteenth Conference. Thus, the time-table was a rather crowded one, and no praise can be too high for the superb work done by the organizing committee, presided over by Prof. Paul Karrer, and for the unobtrusive efficiency with which its arrangements were put into effect.

It is, of course, quite impossible within the space of a short article to attempt even a summary of the scientific material presented at the Congress. In any event, no one Congress member could be physically present at more than about one-tenth of the proceedings. Fortunately, complete abstracts of the papers (usually with references to the journals in which they are to appear) are available in the Congress handbook, a handsomely printed volume of some 440 pages, while the lectures will be published *in extenso* before the end of the year as a special supplement to *Experientia*. Rather than to catalogue a long list of titles, better purpose might be served, therefore, by mentioning a few of what appeared to be particularly significant or memorable contributions (though such a selection must necessarily be a very personal one) and setting down some general impressions and reflexions.

Perhaps the most noteworthy feature of the programme was the emergence of physical and theoretical organic chemistry as a fully-grown branch of the subject, equal in importance and scope to the other two major branches. The papers read at the Congress were numerically divided in almost equal proportions between the three sections, and five of the fourteen lectures were devoted to a physical organic topic. C. Dufraisse discussed photoxidation, with particular reference to transannular peroxides formed by polycyclic aromatic compounds. C. K. Ingold reviewed the contributions of his school to the theory of steric hindrance. N. A. Nesmeyanov outlined a descriptive theory of conjugated systems which seeks to interpret their twin or multiple modes of reaction without recourse to the concepts of resonance or mesomerism. Recent developments in our knowledge of carbonium-ion intermediates were described by S. Winstein, who reported that the acetolysis of the anti-7-norbornenyl tosylate (I) proceeds with a rate greater by a factor of $10^{11}$ than the saturated derivative (III) owing to the intervention of the bridged ion (II). Another remarkable example of transannular interaction occurs in the acetolysis of the benzoate (IV), which yields a hydrocarbon possessing the architecturally satisfying structure (V), besides other products.



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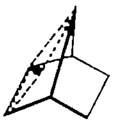

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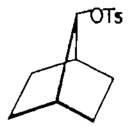

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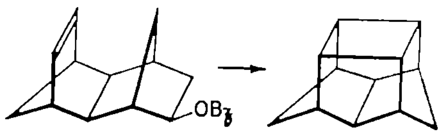
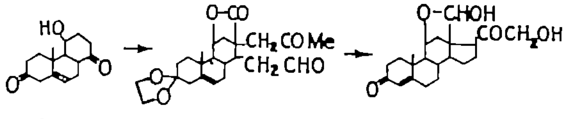


IV V

D. H. R. Barton reviewed the principles of conformational analysis, which have so revolutionized our understanding of the chemistry of alicyclic compounds. Using these principles, the conformations of molecules containing several fused *cyclo*hexane rings can usually be deduced from qualitative data; but work in this field is now moving towards still subtler and more quantitative aspects of stereochemistry. Studies on reaction-rates, such as of the formation of benzylidene derivates from triterpenoid ketones, reveal that even widely separated groups often show marked interactions, and Prof. Barton suggested that distortion due to unsaturated substituents can be transmitted through a large molecule by small contiguous alterations in valency angles and atomic co-ordinates. He coined the term ‘conformational transmission’ to describe this novel effect.

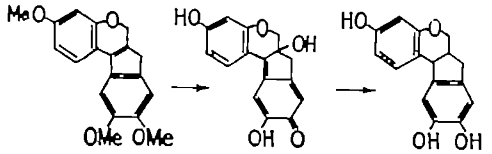
Numerous papers of great interest were read in this section, so that it would be inappropriate to single out any individual contribution for specific mention. The main lines to be followed in interpreting quantitatively the basic facts of organic chemistry now seem to be firmly laid down, and it appears that pioneering investigations will be increasingly concerned with what may be termed non-classical phenomena. It also seems quite safe to forecast a continuance of the notable activity in the field of photochemical and radiochemical organic reactions and in the application of spectroscopic and isotopic tracer methods.

In the section of natural products, many outstanding feats of synthesis were described. V. du Vigneaud outlined his recent work culminating in the complete solution of the structure of oxytocin, the principal labour-inducing and milk-ejecting hormone of the posterior pituitary gland. R. B. Woodward described the total synthesis of strychnine, an achievement which but a few years ago still seemed altogether outside the range of the attainable. Two remarkable syntheses, not previously published, were announced from Swiss industrial research laboratories. Aldosterone (VIII), the most potent hormone of the adrenal cortex, which was isolated and had its constitution determined only last year by a team led by T. Reichstein, has been synthesized through a sequence of about twenty steps starting from Sarett's tricyclic ketone (VI) through the intermediate (VII) (A. Wettstein and co-workers, Ciba Company). A highly efficient synthesis, starting from β-ionone, of β-carotene, one of the most widely distributed carotenoid plant pi ments, has been worked out and is already bein employed for commercial production on the tremendous scale of several tons per year (O. Isler an co-workers, Hoffman - La Roche Co.). The nov key-step in the synthesis is a chain-lengthening c unsaturated aldehydes by the condensation of th corresponding acetals with vinyl or propenyl ethe In addition to β-carotene, lycopene and no less tha six other carotenoid hydrocarbons have been obtaine by similar routes, and the first total syntheses of th oxygenated carotenoids, zeaxanthin and physalien have been achieved. The carotenoids are natura and harmless colouring matters for margarine an other food products, and their manufacture will n doubt rapidly bring to an end the use of aniline dye for this purpose.



VI VII VIII

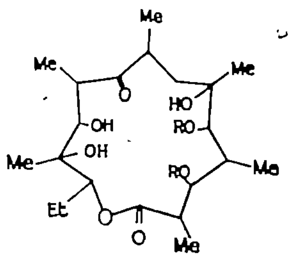
In a paper which will be remembered as much fo its historical associations as for its scientific interest Sir Robert Robinson described the final stages in th synthesis of brazilin (XI). Sir Robert recalled tha he began his studies in this field—almost his firs research topic—nearly fifty years ago with Prof W. H. Perkin, jun., at Manchester. Deoxytrimethyl brazilone (IX), which had previously been synthesized, was converted through a series of steps int *dl*-brazilein (X). Borohydride reduction, followed b resolution of the menthyloxyacetyl derivative, the gave *d*-brazilin (with F. Morsingh).



IX X XI

Besides the synthesis of substances of ever increasing complexity, the other main challenge now attracting chemists working on natural products i that of biogenetic inter-relationships. H. Erdtman reviewed the chemistry of tropolones and other constituents of conifers and demonstrated their taxonomic significance. C. Fromageot described his comparative studies on lysoenzymatic proteins which contain more than a hundred amino-acid residues. In the field of steroids and triterpenes, activity shows no signs of abating; the stereochemical connexions between the two groups have been further clarified (O. Jeger and co-workers) and several important new structures, including those for the biogenetically interesting tetracyclic triterpenes butyrospermol (T. G. Halsall and E. R. H. Jones) and α-onocerin (D. H. R. Barton and K. H. Overton), were reported.

By comparison with the very rapid expansion of well-established classes of compounds, the appearance on the horizon of structurally completely novel types show signs of slowing down, as if a rich but overworked mine were increasingly reluctant to yield new seams. Nevertheless, there were some remarkable new finds; a noteworthy example is the antibiotic erythromycin, which contains the multihydroxylated fourteen-membered lactone ring (XII) consisting of seven propionate units joined in head-to-tail fashion (K. Gerzon and co-workers). Widespread interest was also aroused by the fact (see *Nature*, August 20, p. 325) that the most complex so far of the vitamins, $B_{12}$, has yielded its secrets to the combined efforts of a team of chemists and X-ray crystallo-



XII

graphers (Sir Alexander Todd, Dorothy Crowfoot Hodgkin and co-workers); in addition to the magnitude of the molecule, the presence of a porphyrin-type nucleus containing two directly linked, partly hydrogenated pyrrole rings is unique.

In the third of the Congress sections, major synthetical methods developed in recent years were given due prominence. K. Alder reviewed advances in our knowledge of the factors controlling the occurrence and direction of diene addition, knowledge which chemists owe in large measure to the work of his school. Organometallic compounds, which seem capable of unlimited development as synthetical reagents, were represented by a particularly interesting lecture by K. Ziegler, who described his recent work on the polymerization of olefins by aluminium alkyls. This has resulted in a new process for the manufacture of polyethylene which promises to be of great technical importance; another application involves a replacement reaction yielding the anti-knock agent, lead tetraethyl, together with aluminium metal of high purity. The impact of fundamental research on quite a different field of applied chemistry, that of photographic sensitizers, was outlined by L. G. S. Brooker. The spectral properties of cyanine dyes, the most effective sensitizing agents known, are highly dependent on solvent or other physical environment, and it is now well established that the sensitizing curve is closely related to the light absorption curve of the dye–silver halide complex.

Although the dominant note of the Congress was on the pure rather than the applied side of chemistry, it thus provided many forcible reminders that civilization does not depend solely on the supply of power, an aspect which features so prominently in public discussion at the present time, but also on the harnessing of energy to the production of food, clothes, fuel and an infinite variety of other things. No one attending the Congress could have been left in doubt that organic chemistry is an immensely alive subject, and that we are only at the beginning of an era in which this branch of science will wield an ever-increasing influence on our daily lives, by substituting synthetic materials for natural products and by bringing under control biological processes which have so long sustained mankind unbridled.

Whether fired by such far-reaching thoughts, engrossed in new ideas or fresh problems, or merely stimulated by personal contact with many colleagues, members of the Congress dispersed in an elated mood, and a large proportion appeared to make for other parts of Switzerland to follow up a period of mental by another of physical recreation. The interesting encounters the writer had during a fortnight's climbing in the Grisons area certainly left him with the impression that seldom can so many organic chemists have been concentrated on so high a level.

It was announced that the next International Congress of Chemistry, covering all branches of the subject, will be held in Paris in July 1957, following the centenary celebration of the Société Chimique de France.

E. A. Braude

# DUST AND HEALTH IN INDUSTRY

A DISCUSSION on "Dust and Health in Industry" was held by Section I (Physiology) of the British Association on the morning of September 1 at Bristol. It was opened by Dr. B. M. Wright (Medical Research Council Pneumoconiosis Research Unit), who dealt with the problem of measuring dust exposure in relation to pneumoconiosis of various types. Dr. Wright pointed out that, to understand the problem, it is necessary to consider some of the physical properties of dust and some aspects of the physiological behaviour of the respiratory tract. Airborne dust consists of particles of such small size that their rate of settling in air is very low, of the order of 5 cm./min. for a particle 5μ in diameter, down to rates so low as to be negligible for particles less than about 1μ. As a consequence, the size range of airborne dust particles depends upon the atmospheric conditions; in still air they will be very fine, whereas in a well-ventilated place relatively coarse particles will remain in suspension. Particles that are large enough to be visible are of little hygienic importance, so that it is not possible to judge the likely danger to health of an environment by visual inspection, and the use of an instrument is essential.

Turning to the physiological properties of the respiratory tract, Dr. Wright pointed out that it consists essentially of two parts—the upper respiratory tract, which is covered with ciliated epithelium, and the respiratory bronchioles and alveoli, which are not. Particles that settle on the ciliated epithelium will be removed within a matter of minutes or hours, whereas particles that penetrate to the alveoli may be retained indefinitely in the lung. The low settling-rate of very fine particles enables them to penetrate deeply into the respiratory tract, and the finer they are the farther they penetrate. The main mechanism by which they are trapped in the tract is sedimentation in the smaller bronchioles, although some loss of larger particles by impingement takes place in the nasopharynx and larger bronchi. The velocity of the air in the respiratory tract decreases continuously as it approaches the alveoli, where air movement is almost negligible, so that a substantial proportion of particles penetrating into the alveoli settle out and are retained. The proportion of particles retained is not much affected by the rate of breathing, because, although the increased air velocity tends to reduce the proportion of particles captured by sedimentation, impingement becomes a more important mechanism, and also the volume of air entering the alveoli is increased. It is important to realize that the penetration of particles to the alveoli has nothing directly to do with the relative dimensions of the air vessels and the particles, since the former are never less than 200μ in diameter, whereas the largest particle ever likely to penetrate to the alveolus is only about 5μ in diameter. Particles deposited in the alveoli are removed therefrom by phagocytes and are mostly deposited in the interstitial tissue, though some probably are also carried on to the ciliated epithelium and so removed from the lungs. Particles retained in the lungs, if they are relatively insoluble, will accumulate and cause pneumoconiosis. Particles deposited on the ciliated epithelium will cause no trouble unless they are soluble and irritating. Severely poisonous substances can cause general intoxication, whereas mildly irritating materials can cause chronic conditions such as byssinosis.

Owing to the wide range of particle sizes found in airborne dust, the range to be selected for sampling must be decided by the nature of the disease under consideration. If it is thought to be mainly due to irritation of the upper respiratory tract, particles up to 10 or 15μ diameter must be considered, whereas with a true pneumoconiosis only those less than 5μ are of importance.

Two main methods of assessing the quantity of dust are available—weighing and counting. The disadvantage of the former method is that it greatly overestimates the importance of large particles outside the respirable range, whereas the latter method is liable to be indeterminate, since the number of particles counted depends largely on the efficiency of the microscope used. In theory, a measurement of the surface area of dust might be of value, but practically it is difficult to obtain a measure of the true surface, and it is still necessary to confine the measurement to particles in the respirable size range. When collecting samples for microscope counting, care has to be taken that they are not distorted by the sampling instrument, so that the actual size of the airborne particles or aggregates can be judged. Methods are now available for collecting samples for gravimetric analysis, in which the larger particles are separated while sampling by a mechanism similar to that in operation in the respiratory tract.

Prof. J. Gough and Dr. A. G. Heppleston (Department of Pathology, Welsh National School of Medicine, Cardiff) then presented a paper on "The Harmful Effects of Pneumoconiosis", with particular reference to coal-workers. In the past, a high phthisis death-rate was associated with the inhalation of highly siliceous dusts, but a low rate with exposure to coal dust. Recent evidence, however, indicates that coal-mining is not such a healthy occupation as had been supposed and that tuberculosis plays an important part in the pneumoconiosis of coal-workers. Two forms of this disease may be distinguished. Simple pneumoconiosis is characterized by numerous discrete dust foci throughout the lung and represents the effect of dust alone. Complicated pneumoconiosis is often superimposed on the simple form, appearing as one or more densely fibrous black masses, and is considered to represent the combined effect of dust and tuberculosis. James has found bacteriological or histological evidence of tuberculosis in 40 per cent of these massive lesions from 245 men. When split into age-groups, however, 88 per cent of massive lesions from men less than forty showed tuberculosis, but only 29 per cent of lesions from men of sixty and more. These findings are interpreted as pointing to the tuberculous origin of massive fibrosis and suggest that, with increasing age, the infection dies out. A tuberculous element therefore exists in the massiv fibrosis of coal-workers just as in classical silicosis but in coal-workers it is largely concealed, except i the younger men. In 1,000 consecutive autopsy cases, there were 454 with massive fibrosis and, o these, 87 died from pulmonary tuberculosis but 21 from pulmonary heart disease due to vascula obliteration and emphysema caused by massiv fibrosis. It can therefore be said that indirectly tuberculosis contributes greatly to the morbidity and mortality of coal-workers.

Simple pneumoconiosis, however, is very rarely fatal but can contribute to disability in men over the age of fifty. To establish the effect of simple pneumoconiosis on coal-workers, the pathological findings in the 1,000 autopsy cases were correlated with the disability during life. 29 cases were found in which dyspnoea could be attributed only to simple pneumoconiosis, that is, after eliminating all other possibl causes for dyspnoea. This figure, however, underestimated the contribution of simple pneumoconiosis to disability because, to prove its effect, the 454 coal-workers with massive fibrosis had to be excluded and many of these had the more severe grades of simple pneumoconiosis. Free silica is not regarded as necessary for the development of the simple dust lesion of coal-workers, which bears no pathological resemblance to the classical silicotic nodule. A woman exposed for five years to the inhalation of carbon black, a very highly purified form of carbon, developed lung lesions identical with those of simple pneumoconiosis in coal-workers, thus supporting the conclusion that the reaction to airborne coal dust is non-specific. The development of the simple dust lesion in men exposed to a dust, such as coal or hæmatite, containing little free silica, therefore depends on mechanical accumulation of sufficient dust irrespective of its nature. (The precise structure of the simple dust lesion of coal-workers was then demonstrated by means of a film prepared from serial sections.) This lesion is in effect a fairly wide cylinder of vesicular tissue consolidated by dust and a little fibrous tissue, disposed around respiratory bronchioles, which are often dilated to produce the change known as focal emphysema. The mechanics of focal emphysema are interpreted on the basis of imbalance between the forces of inspiration and expiration, in which atrophy of bronchiolar smooth muscle appears to be the main factor. Dyspnoea due to simple pneumoconiosis in coal-workers can therefore be attributed to rigidity of important segments of the bronchiolar tree and to the development of focal emphysema, which may be regarded as increasing the dead space of the lung, an effect likely to be greater as the emphysema becomes more severe.

Reference was also made by Prof. Gough and Dr. Heppleston to the pathological features of the recently recognized 'rheumatoid' nodules in the lungs of coal-workers with rheumatoid arthritis. These nodules have to be distinguished from foci of complicated pneumoconiosis. It was suggested that coal-workers with rheumatoid arthritis react abnormally to the collagen produced in infective pneumoconiosis, and the non-specific inflammatory reaction, which may occur in the absence of tubercle bacilli, is believed to be the 'rheumatoid' component of these peculiar nodules.

Mr. S. Smith (Factory Department, Ministry of Labour and National Service) dealt with protection against the risk of inhalation of industrial dust. Whereas the almost instinctive reaction to the xistence of a dust hazard is to think of providing espirators, or local exhaust ventilation, these nethods are wrong as first thoughts. The fundamental method, which has been used with success in nany processes, such as bedding of pottery, grinding nd 'sand-blasting', is to substitute a harmless dust or the dangerous one. Where this is not possible, he dangerous process ought to be totally enclosed: erhaps the most striking illustration of the success hat can be achieved in this way is the control of adioactive dusts in the Atomic Energy Research stablishments. But complete enclosure, although ften possible, is not always expedient. In such cases, s near total enclosure as is possible should be btained, and suction applied to the inside of the abinet, so that the enclosure is sealed, as far as dust s concerned, by a dust-proof wall of moving air. To e effective, the air ought to be moving into the abinet at about 150 linear feet per minute. This rrangement is none other than the common fume upboard, which is to be found in every chemical aboratory; 'industrial' fume cupboards have been uilt around such plant as 'barrels' in foundries, sbestos blending benches, asbestos stock heaps, rass melting furnaces, and luminizing benches. Of ourse, most of the fume cupboards in industry are ot the fragile glass structures commonly found in aboratories; those that enclose heavy plant have to e of steel, but the principle governing their use is he same. Obviously, very large machines can be rotected in this way for very small running-costs.

When the degree of enclosure that can be achieved s small, very large air-flows are necessary to give ven moderate control of the dust; this degenerate fume cupboard' is the familiar local exhaust hood. It s often unsatisfactory for such reasons as its high unning-costs, the poor control of dust that it someimes gives, and the fact that, if the machinery works t high speed, it is usually defeated; an example of his is the recent discovery by foundry research ssociations, in conjunction with the Factory Department of the Ministry of Labour and National Service, hat the hood of the orthodox pedestal grinder where good enclosure and high air flows are common) s ineffective because the dust moves under the nfluence of the wheel rather than of the air flow.

In the past, wetting has been relied upon to prevent he emission of dust. It has been found that this is uccessful only if gentle forces are at work, as in the tirring of a slurry; with violent forces, as in grinding, r 'dunting' in the granite industry, wetting is not ffective. Suppression of an existing dust cloud by prays is very difficult and inefficient.

If none of these methods is completely effective, ne is thrown on to the last resort—personal proection of each person at risk by the provision of espirators. The performance of dust respirators is overned by British Standard 2577, and many in se are unlikely to be able to pass its stringent tests.

Reliance is placed, sometimes, on the dilution of dust cloud to a safe concentration by general entilation. Experience has shown this to be quite rong.

A protective scheme is usually built on the basis f samples having shown the existence of dangerous onditions; therefore, it is necessary to consider nethods of sampling. Research has shown that, for eneral purposes, only the thermal precipitator and bsolute methods, such as sedimentation, are reliable. Even with these, statistical sampling errors occur; nd others appear in the evaluation of the sample, in the form of counting errors, and errors due to having to allot a given particle to one of a finite number of size groups, instead of being able to give the size distribution in a sample as a continuous function. Therefore, to express results to three, and sometimes four, significant figures, as is common in the literature, is patently absurd; and the existing tables of 'maximum allowable concentrations' (which give results to three significant figures) are of little value. All workers in this field work to two numerical values for each material, whether they realize it or not; the lower is the upper limit of concentrations that they know to be safe, and the upper is the lower limit of those that they know to be dangerous. The gap between the two limits is always wide, because there is a lack of fundamental information about which parameters make a given dust dangerous, and about the finer details of the mechanism whereby the dust causes its damage to the lung. The gap can become narrower as more fundamental information is discovered.

Dr. R. S. F. Schilling (Department of Occupational Health, University of Manchester) described the results of a recent investigation of byssinosis among Lancashire cotton workers. He gave a brief review of cotton processes and described the signs and symptoms of the disease. There were no specific X-ray changes in the lung fields, and diagnosis depended on the typical history of breathlessness and chest tightness on the first working-day of the week. Because of the lack of specific signs, the existence of byssinosis as an industrial disease has been doubted. Another masking feature is the high incidence of chronic respiratory disease in the general population of the cotton towns of Lancashire. However, by using a modified Gaensler apparatus to measure the volume of air expelled during the first 0·75 sec. of a forced expiration, the 'maximum voluntary ventilation' was calculated and gave an indication of the degree of disability caused by byssinosis. A survey made in the Oldham area against controls from two engineering factories disclosed that 60 per cent of all persons at risk were suffering from the disease. In the worst cases, the maximum voluntary ventilation was only 60 litres/min., whereas that for controls of the same age was more than 100 litres/min. Out of 190 men between forty and sixty years of age working in card and blow rooms, some 26 were seriously disabled by byssinosis. The disease principally occurred in card rooms, and its prevalence was inversely related to the distance of the workers from the carding engines. Byssinosis presents a number of problems. Is it due to a specific allergen? What is the origin of the causative agent? Is it in the cotton, or the trash, or in the concomitant moulds or bacteria? No maximum allowable concentration of cotton dust is known, or has been suggested.

Dr. C. L. Sutherland reviewed the position from the point of view of national insurance in Britain. He remarked that simple pneumoconiosis among coal miners is quite unimportant; and that statistics show that miners' wives suffer from heart disease almost to the same extent as their husbands. In reply, Dr. Heppleston emphasized that the clinicopathological correlation indicates that simple pneumoconiosis can cause disability, but the figures give no indication of frequency. Furthermore, the occurrence among miners' wives of a high mortality from heart disease and pulmonary tuberculosis does not adversely affect the arguments relating to the nature of dust disease in the coal-workers themselves.

Dr. B. Klinge queried the apparently different descriptions of the mechanism of deposition of dust in the lung as given by the different speakers, and wondered why Dr. Schilling had suggested no mechanism to explain how cotton dust attacked the lung. He regretted that Mr. Smith had limited the scope of his discourse to factories, since the principles he enunciated were plainly relevant to other dust problems, such as atmospheric pollution. Dr. Wright and Dr. Heppleston explained that the difference between the mechanisms they had described was only apparent, and was due to the fact that the latter had dealt with phenomena in the depths of the lung, whereas the former had not so limited himself. Dr Schilling said that he had not given the explanation requested, because none is known. Mr. Smith replied that the subject of dust is so vast that he had had to limit his examples to those of which he had had substantial first-hand experience.

Mr. B. W. A. Crutchlow remarked that the slide of a carding engine showed an obsolete exhaust. Dr Schilling agreed and said this showed the dusty nature of the work, but a much improved exhaust has been developed by the Shirley Institute, which with the Factory Department, is paying particula attention to methods of dust control in card rooms

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# UTILIZATION AND EVALUATION OF GRASSLAND

THE first session of Section M (Agriculture) at the meeting in Bristol of the British Association was devoted to a discussion of the utilization and evaluation of grassland. The session was opened by Mr. R. A. Hamilton, who said that increases in world population will call for increased output by agriculture. As standards of living improve, there is a tendency for people to eat less tillage crops and more meat and dairy products. This will put an ever-increasing strain on the supply of basic food nutrients, because the efficiency of conversion of plant foods to animal products is low. With about two-thirds of the agricultural land of the world under grass, it is vital that there should be efficient utilization, especially as grass that is well managed can produce greater yields of nutrients for livestock than almost any other crop and the cost of grass nutrients is low. The energy of grass has been estimated to cost, under recent British conditions, £11–14 per ton of utilized starch-equivalent, or £17 when preserved as silage and £20 as hay. By the same estimate, grazed kale costs £17, oats £28, artificially dried grass £40, and dairy cubes £54 per ton of starch-equivalent.

Where a variety of stock is consuming the grass and where other foods are sometimes given, it is difficult to measure the output of the grassland. The food requirements of the stock may, however, be estimated on the basis of their size and production together with the value of any other foods, and the contribution of the grass may then be determined by difference. This method has many shortcomings, but for comparative purposes is one of the most useful at present available, and by its means a working party of the Organization for European Economic Co-operation recently estimated that the yield of starch-equivalent per acre from grassland in various European countries was: Netherlands, 26·2 cwt.; Denmark, 22·3 cwt.; Belgium, 20·0 cwt.; Norway, 19·0 cwt.; West Germany, 17·2 cwt.; Great Britain, 16·7 cwt.; and France, 11·1 cwt. The low value for Great Britain may be partly due to an over-estimate of the value of the large amounts of concentrates used. Surveys show that, with good management, yields of 30 or even 40 cwt. can be obtained in Britain; few arable crops will produce values of this order. It has, however, been estimated that even in New Zealand, with its ideal climate and highly specialized grassland dairy industry, utilization of grassland is still only 50 per cent of the potential.

Maximum utilization will be achieved with a careful system of management which includes the longest possible grazing season and an efficient system of storing all grass produced in excess of immediate requirements. This was illustrated diagrammatically by Mr. Hamilton from the management followed in fat-lamb production in New Zealand. By this system 400–600 lb. of meat is produced annually per acre In New Zealand the fit between production and the requirements of dairy cattle is less close than for fat lambs, but grass in some form nevertheless provides for the full needs of most dairy herds. In consequence, New Zealand can provide lamb and butter at lower costs than any other country in the world

In Britain the liquid milk market requires a more even spread of milk production through the year yet the grazing season is considerably shorter than in New Zealand. Mr. Hamilton accordingly stressed the need to lengthen the grazing season and to secure efficient grass storage for winter feeding. Methods of grass conservation are, therefore, of very great importance in the British economy. With any of the recognized methods there will be losses of nutrients, and it has been estimated that average losses of starch-equivalent are of the following order: artificially dried grass, 5 per cent; silage, 22–35 per cent; hay, 40–45 per cent. These all depend somewhat on the method employed and the efficiency with which it is applied; clearly at times the losses may be much higher. At present, hay and silage account for more than 95 per cent of all grass conserved in Britain and, of this fraction, 90 per cent is still in the form of hay. Silage-making is more suited to the British climate than hay-making, and Mr. Hamilton was of the opinion that we should be making 15 million tons of silage instead of the 2½ million tons being made at present.

Before a completely efficient system of grassland utilization can be achieved, Mr. Hamilton concluded, there are many problems that have to be overcome Perhaps among the most important of these are the increased incidence of hypomagnesæmia, bloat, infertility, various allergies and parasitism that has followed more intensive methods. Unless these problems are solved, it will not be possible for grass to play its potentially important part in lowering the cost of production of ruminant products.

The question, raised by Mr. Hamilton, of the difficulty of measurement of the output of pastures has recently received considerable attention. Three types of approach have now been tried, each with some success; they are based either on a measurement of the amount of grass removed from the field, the amount consumed by the cow, or of the production of the cow. Mr. C. Line (National Institute for

Research in Dairying, Shinfield) talked about these techniques and described an experiment that has recently been carried out over three seasons at Shinfield. A field was divided into twenty-four paddocks, each 20 yd. wide and 100 yd. long, and each paddock was sown down to a ley consisting of either perennial ryegrass, or meadow fescue or cocksfoot, each with white clover. During the experiment one milking cow was allocated to each paddock, twelve paddocks being tested at any one time. Ample grazing was allowed by strip-grazing with an electric fence; they received no other food. The primary object of this experiment was to develop a satisfactory technique for measuring the output of leys with the milking cow, and, with limitations, this was achieved. Under the particular conditions at Shinfield, the meadow fescue ley proved superior to those with ryegrass or cocksfoot, probably due to a higher clover content and to superior palatability. Although this result cannot be taken as generally applicable, it is interesting to find that similar comparative values were obtained when the results were expressed as grazing days obtained or milk yield per acre. Mr. Line felt that, because of its simplicity, measurement in grazing days per acre has the greater application for experiments of this type.

In view of Mr. Hamilton's insistence on the need for increased silage production, it was logical to conclude the morning with a consideration of the nutritive value of silage. In dealing with this question, Dr. C. C. Balch (Shinfield) emphasized that, of the 2½ million tons of silage now made annually in Britain, a considerable proportion is given to cattle and that to a large extent its value to the farmer is measured by its use for milk production and the part it can play in dairy farming systems. Good silage can be made only from good herbage, but good herbage can be satisfactorily ensiled by a variety of methods. With all methods of ensiling there will be losses of nutrients due to fermentation and seepage of substances in solution. Together these may amount to 40 per cent of the dry matter. Methods using preservatives such as sodium metabisulphite will reduce the losses due to fermentation, and wilting of the crop before ensiling will reduce both losses. In a pilot experiment at Shinfield, the loss of carbohydrate was approximately halved by the use of metabisulphite; but unfortunately wilting and the metabisulphite method do not appear to be always compatible.

Provided the method of ensiling is efficient and does not lead to the development of high temperatures, the digestibility of the finished silage will not differ very markedly from that of the crop; any changes are usually towards a lowered digestibility resulting from the loss of readily soluble constituents. Excessive heating lowers the digestibility of the protein. Thus silages of similar nutritive value can be made by different methods, and the choice of method depends largely on how it fits in with the equipment and management used on a particular farm. Among advisory workers there is an urgent need for a simple means of relating the nutritive value of silage to its gross chemical composition. The evidence available at present suggests that the crude fibre content may prove to be a satisfactory guide for practical purposes.

The impression given by the speakers, and confirmed in the short discussion, was that the efficiency of utilization of grassland could be improved by management changes giving a prolonged grazing period and the making of increased amounts of good silage.

# PEACEFUL USES OF ATOMIC ENERGY

## BIOLOGY AND MEDICAL SESSIONS AT GENEVA

By Dr. L. F. LAMERTON

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THE sessions of the Geneva Conference on the Peaceful Uses of Atomic Energy devoted to applications in biology and medicine were of a rather different nature from the others. In the first place, the field was wider, covering a large number of specialities, and secondly, since relatively little material in the subject had been classified, there could be none of the disclosures of information which added so much to the significance of the other sessions. The success of the biological and medical side of the Conference had therefore to be judged by the extent to which a real understanding could be established between the workers attending from the various parts of the world. That this was achieved reflects great credit on the various governments and individual delegates, not only for the quality of the material presented, but also because there was no attempt to make political issues out of any of the subjects under discussion.

For the sessions assigned to biology and medicine, nearly three hundred papers were submitted by twenty-four governments. About a hundred and fifty of these papers were submitted by the United States of America, covering a very wide range of topics, and including both reviews and reports of special investigations. The United Kingdom submitted twenty-one papers, the majority being in the nature of reviews. The U.S.S.R. submitted eighteen papers, mainly reviews of work carried out by Soviet investigators, and therefore of special interest to Western workers, for whom coverage of Soviet scientific journals is generally very incomplete.

In the time allotted it was possible to plan for oral presentation only about one-third of the papers submitted (101 papers from nineteen countries and three specialized agencies of the United Nations), and even so the length of time allowed for presentation and for discussion was much less than ideal for a scientific meeting.

The main subject headings were as follows: "Radioactive Isotopes and Nuclear Radiations in Medicine" (therapy, one session; diagnosis and studies of disease, two sessions); "Biological Effects of Radiation" (modes of radiation injury and radiation hazards, one session; mechanisms of radiation injury, protection and recovery, one session; genetic effects—human implications, half session); "Radioactive Isotopes and Ionizing Radiations in Agriculture" (radiation-induced genetic changes and crop improvement, half session; tracer studies in agriculture, one session); "Radioactive Isotopes in Physiology and Biochemistry" (animal physiology and plant biochemistry, one session; general biochemistry, one session); "Safety Standards and Health Aspects of Large-scale Use of Atomic Energy" (radiation safety recommendations and control, hazards related to uranium mining, one session; hazards related to reactions and chemical processing, ecological problems related to reaction operation, one session).

In addition to these sessions, biological and medical subjects were included in the plenary sessions of the Conference, and certain of the evening lectures were devoted to biological topics.

In a short review it is clearly not possible to summarize each of the sessions, but only to give general impressions. One of the strongest impressions was of the progress being made in agriculture by radioactive tracer studies. Some very interesting contributions came from the U.S.S.R., where there has been a large effort put into the study of the efficiency of fertilizers, as well as into more basic problems of translocation of materials in plants. The work reported indicated real practical advantage gained from these studies, and corresponded well with work reported from the United States, the United Kingdom and other countries. This certainly represents a field of study where international collaboration can develop, with considerable mutual advantage. Much effort has also been put into studies of the method of crop improvement by the use of radiation-induced genetic changes, as shown in reports from Sweden, Norway and the United States of America.

In the session devoted to the therapeutic use of radioactive materials and nuclear energy, a number of different aspects of the subject were discussed; but progress was not so obvious as, for example, in the papers dealing with agricultural applications. Radioactive isotopes have now an established place in radiotherapy, and the large number of reports submitted showed that they are being used in an increasing number of centres throughout the world; but any spectacular advance must depend on finding means for a high degree of localization of the isotope in the desired tissue. Papers from Switzerland and France described recent clinical experience with particulate radioactive materials which permit, in certain sites and with certain limitations, a localization of irradiation. Except for radioactive iodine in the thyroid gland the problem of a high degree of localization by metabolic processes remains unsolved, although a paper from the United States, reporting some preliminary studies on the labelling of antibodies, indicated a possible approach. Another paper from the United States was read on preliminary clinical experience with brain tumours using neutron-capture therapy, a technique that may prove to have more general technical applications.

The fundamental advances that radioactive isotopes have made possible in biochemistry and physiology were described in the sessions dealing with diagnosis and studies of disease as well as in the more specialized sessions concerned with general physiology and biochemistry. Many topics were discussed. From the direct clinical point of view there was much interest in the work reported from the United States on the use of radioactive iron in the study of various types of anaemia, and also in the United Kingdom's contributions on absorption studies of vitamin $B_{12}$ labelled with radioactive cobalt. From India there was a report on autoradiographic methods being used to study the action of certain drugs in leprosy treatment.

The mechanism of photosynthesis was the subject of papers from both the U.S.S.R. and the United States of America, and nucleic acid studies from the United States of America and the United Kingdom. Papers from the United States and from Brazil dealt with the application of radioactive materials in public health problems. Much important information has already been gained on the habits of insect populations, such as range of flight, and the discussion following these papers demonstrated the wide application that these techniques could have in the future.

A number of countries contributed papers to the subject of the effects of radiation and radiation hazards. The Soviet workers put a great deal of emphasis on the neurological changes produced by radiation. They regard these changes as being among the most sensitive primary effects of radiation, and have considered them in setting up their radiation protection regulations. Difficulties of language, in spite of a very adequate simultaneous translation service, prevented a full discussion on some of these matters during the meeting, but informal contacts were made which it is hoped will continue.

In spite of some apparent difference in approach, it was encouraging to find that the maximum permissible dose recommendations of the U.S.S.R. are similar to those set out by the International Committee on Radiological Protection. The main difference was the length of time over which the exposure can be integrated. Whereas the International Committee recommends 0·3 rem per week as the maximum permissible dose, the U.S.S.R. take a value of 0·05 rem per day. Although there are other differences in the approach of the U.S.S.R. and the International Committee on Radiological Protection on the protection of radiological workers, the general basis is remarkably similar.

Two papers were read, in the plenary sessions, concerned directly with the effects on humans of large over-exposure arising in reactor accidents. From the United States a report was given on four exposed workers, the greatest dose received being about 190 r., mainly gamma radiation, and from the U.S.S.R., where two workers were reported to have received 300 r. and 450 r., respectively. Very full clinical reports were presented. None of the accidents proved fatal, though the U.S.S.R. workers became seriously ill. The number of cases of known human exposure to radiation, without other forms of injury, and with adequate clinical data, is so small that reports of such cases are of extreme value.

It was natural that there should be a great deal of interest in the problems of the genetic effects of radiation. On this subject three papers were read, two from the United States and one from the United Kingdom. In spite of large programmes of work on experimental radiation-induced mutations, the paucity of knowledge, so far as population genetics and in particular human population genetics is concerned, is very evident. There is need for a wider field of research, and one that will include studies of the genetics of human populations in various localities where the natural radiation background is abnormal. This again is an international problem, where co-operation through one of the international agencies could be of the greatest value.

In the sessions devoted to the health aspects of the large-scale use of atomic energy, it was demonstrated that in atomic energy installations the plant personnel need suffer no serious exposure to radiation. In normal operating conditions exposure can be kept down to a small fraction of the maximum permissible limit, and even in the case of reactor accidents exposure can normally be adequately controlled.

A problem of greater concern is that of the possible spread of radioactive materials over wide regions, so that large populations might be subjected to risk. The problem is not yet of a magnitude to constitute a serious hazard; but it is important that there be available as soon as possible basic data on the uptake of various radioactive substances in plant, fish and animal forms. Over the past few years much information has been obtained in the United States, but not all has been readily available. It was, however, presented in a series of papers in the last session of the biological and medical meetings, which will provide most valuable reference material.

# OBITUARY

## Prof. Wilfred Smith

Wilfred Smith, John Rankin professor of geography in the University of Liverpool, died suddenly while preparing to attend a university function on September 27 at the age of fifty-two. Prof. Smith had been closely associated with the University of Liverpool all his life. He entered as an undergraduate and remained as a postgraduate research worker, lecturer, senior lecturer, professor of geography, and since 1953 Dean of the Faculty of Arts.

Wilfred Smith belonged to that distinguished band of students that gathered around the late Prof. P. M. Roxby, the first holder of the John Rankin chair at Liverpool. The impress of the great teacher was clearly seen in everything Smith wrote about and lectured upon. He began his life-long interest in the location of industry with an important study of the iron and coal resources of China—a country in which Roxby had developed a special interest. In later years, and more particularly in view of the disturbed conditions in the Far East, Prof. Smith concentrated his attention on the homeland, and in 1949 there appeared the standard work on the location of industry in Britain under the title of "The Economic Geography of Great Britain". This work well illustrates the author's technique. It shows him to be a meticulous and painstaking worker with a passion for fact and, particularly, for pattern in fact. His references were always abundant and exact, and his writing precise and direct. This work makes, in fact, a new approach to economic geography in the Roxby tradition—the industrial landscape seen as an expression of historical as well as of physical factors.

In later years Prof. Smith directed the attention of his students more and more towards the economic geography of Merseyside, and the visit of the British Association to Liverpool in 1953 provided the opportunity for the publication of "A Scientific Study of Merseyside", edited by Prof. Smith and to which he himself made a most valuable contribution.

He was one of those modest men who gave practically all his time to academic work; he seldom rested. When not engaged in research, he was busy as an administrator, or actively engaged in teaching. At the time of his death he was president of the Institute of British Geographers, which now includes within its membership practically all teachers of geography in the British universities. In spite of physical handicaps he succeeded in travelling widely, particularly in western and southern Europe. He will be greatly missed by his professional colleagues in every university, for he never spared himself in furthering the interests of his subject; and in particular by his own university, to which he was deeply devoted and to which he had given a lifetime's distinguished service in so many capacities.

E. G. Bowen

# NEWS and VIEWS

## Embryology at the Carnegie Institution of Washington: Dr. G. W. Corner, For.Mem.R.S.

Dr. George W. Corner will retire on January 1 from his post as director of the Department of Embryology of the Carnegie Institution of Washington and will be succeeded by Prof. J. D. Ebert, professor of zoology in Indiana University, Bloomington, Indiana. Dr. Corner was elected this year a foreign member of the Royal Society, and a note was published then on his work and activities (*Nature*, May 14, p. 838).

### Prof. J. D. Ebert

Prof. James D. Ebert, who is not yet thirty-four, graduated in 1942 from Washington and Jefferson College, Washington, Penn., and then spent nearly four years on active duty as an officer in the United States Naval Reserve. During 1949–50 he held an Adam T. Bruce fellowship in biology at Johns Hopkins University, gaining his Ph.D. degree, then spent a year as an instructor in biology at the Massachusetts Institute of Technology, and in 1951 joined the Department of Zoology of Indiana University, to set up a programme of research and advanced teaching in experimental embryology. Prof. Ebert's research work has been directed toward an understanding of the mechanism of synthesis and interaction of tissue-specific proteins in development. He has employed the techniques of immunochemistry to throw light on the processes involved in the formation and localization of the contractile proteins, actin and myosin, in the developing heart, and recently he has made an analysis of the metabolism of the heart-forming regions of the early embryo, paying special attention to the mitochondria and their role in fibrogenesis. Since 1952 he has combined the classical methods of experimental embryology—transplantation, organ culture, etc.—with radiobiological techniques in an investigation of the growth-regulating mechanisms of the chick embryo, and these experiments suggest that, at the outset, growing organs can utilize specific macromolecules almost intact without breaking them down into simpler building blocks. The Department of Embryology of the Carnegie Institution of Washington is situated in Baltimore, Maryland, and is well known for its investigations of the morphology of the human embryo and the comparative physiology of the reproductive system, the morphological research being centred on the Department's superb collection of human embryos. Under Prof. Ebert's leadership it is expected that workers in the Department will pay increasing attention to the study of the basic mechanisms of differentiation, growth and morphogenesis of the early embryo, using the technical advances in such fields as immunochemistry, protein physical chemistry and virology to link up our knowledge of reactions at the cell group and tissue level with the reactions of specific molecules.

### Hunsaker Chair of Aeronautical Engineering at the Massachusetts Institute of Technology:

### Prof. W. R. Hawthorne

PROF. W. R. HAWTHORNE, Hopkinson and Imperial Chemical Industries, Ltd., professor of applied thermodynamics in the Department of Engineering, University of Cambridge, is at present on leave of absence at the Massachusetts Institute of Technology and has been appointed for the current academic year to a new chair at the Institute, the Jerome Clarke Hunsaker chair of aeronautical engineering. Prof. Hawthorne's principal interests are in the fields of aircraft propulsion and advanced fluid mechanics, and at the Institute he will divide his lecturing between the Departments of Mechanical and Aeronautical Engineering. During his tenure he will deliver the Minta Martin Aeronautical Lecture. The Hunsaker chair was established last year in honour of Prof. J. C. Hunsaker, founder and for many years head of the Aeronautical Engineering Department at the Institute and a leading figure in American aviation. He retired in 1952 but is still closely associated with the Institute. The founding of the chair has been largely due to Major Lester D. Gardner, of New York, an alumnus of the Institute and one of the founders of the Institute of the Aeronautical Sciences; more than 360,000 dollars has been raised, and it is hoped to increase this eventually to 500,000 dollars.

### L. G. Groves Memorial Prizes and Award of the Air Ministry

Two L. G. Groves Memorial Prizes and an Award are made annually by the Air Ministry from a fund established in 1946 by Major and Mrs. Keith Groves in memory of their son, Sergeant Louis Grimble Groves, R.A.F.V.R., a meteorological observer who lost his life on a weather flight in 1945. The recipients this year are as follows: *Prize for Aircraft Safety*, to Squadron-Leader J. Harvey (technical staff, Headquarters, Fighter Command) for designing an alteration to the fuel system of the Meteor night-fighter, which provides the aircraft with automatic operation of the fuel system from all tanks, in place of the original arrangement of individual tank selection by the pilot, and thereby greatly enhances its safety; *Prize for Meteorology*, to Dr. F. J. Scrase (principal scientific officer and leader of the Instrument Development Division of the Meteorological Office) for his research on turbulence in the upper atmosphere and theoretical investigation of the errors, due to radiation and lag, of radiosondes, studies which are closely related to practical problems of aviation and air navigation, and also for his work as president of a sub-commission of the World Meteorological Organization responsible for the new "Guide to International Meteorological Instrument Practice"; *Awar for Meteorological Observers*, to Flight-Lieutenant J Formby (of Short Bros. and Harland, Ltd.), for hi work since September 1952 in carrying out meteorological ascents under contract with the Air Ministry amounting to more than 450 flights in Spitfire aircraf from the R.A.F. Station, Woodvale, Lancs, and involving exceptional ability both as a pilot and as a meteorological observer.

### Central Advisory Water Committee

MEETINGS of the Central Advisory Water Committee, appointed by the Minister of Housing and Local Government, are being resumed, and the first will be held on October 31. The Minister, Mr. Duncan Sandys, is chairman of the Committee, and the vice chairman is the Parliamentary Secretary, Mr. William Deedes. The Committee was first set up in 1946, under the Water Act, 1945, and has issued a series of reports on river pollution, water softening, gathering grounds and land drainage. Its sittings were suspended in 1952, and its revival has necessitated the appointment of new members, the terms of appointment of the previous members having lapsed. The members are: Sir David Brunt, secretary and vice-president, Royal Society; Mr. John Cockram, chairman, Water Companies Association; Lieut.-Col. J. Godman, chairman, Severn River Board; Coun. A. Gorman, chairman, Metropolitan Water Board; Sir Arthur Heneage, president, River Board Association and chairman of the Lincolnshire Branch, Country Landowners Association; Dr. N. R. Hood, director, British Paper and Board Industry Research Association; Mr. H. E. Hopthrow, assistant secretary, Imperial Chemical Industries, Ltd.; Sir Reginald Kerr, chairman and general manager, British Transport Waterways; Prof. W. B. R. King, sometime professor of geology, University of Cambridge; Mr. W. O. Knill, vice-president, Association of Waterworks Officers; Mr. C. E. Lucette, manager and secretary, Manchester Ship Canal Co.; Mr. A. G. McLellan, engineer and general manager, Sunderland and South Shields Water Co.; Canon W. Marsden, chairman, Public Health Committee, Rural District Councils Association; Mr. G. S. Mason, chairman, Pollution Prevention Committee, River Boards Association; Mr. W. A. Muddell, chairman, Trent River Board; Prof. J. Proudman, sometime professor of oceanography, University of Liverpool; Lord De Ramsay, president, Association of Drainage Authorities; Mr. J. H. T. Stilgoe, engineer, Liverpool Water Undertaking; Mr. A. Titherley, director, Mid-Kent Water Co.; Ald. J. R. Wardell, past president, British Waterworks Association; Mrs. Charles Williams, chairman, Public Health Committee, Cornwall County Council; Mr. Harold Woolley, vice-president, National Farmers Union; Ald. R. O. Yates, president, British Waterworks Association; *Secretary*, Miss M. E. Petzsche, Ministry of Housing and Local Government; *Assistant Secretary*, Mr. G. D. Vaughan, Ministry of Housing and Local Government.

### Photobiology Group: Inaugural Meeting

THE inaugural meeting of the Photobiology Group was held in Bedford College, London, on October 3, and about seventy members participated. A series of review papers was presented on different aspects of the biological action of light. Dr. E. J. Bowen (Oxford) opened the meeting with an account of work on triplet states in excited molecules, in which he demonstrated some colourful experiments showing fluorescence and phosphorescence in solids, and energy transfer in solid mixtures; the possible mportance of such phenomena in biology was discussed. Dr. R. Hill (Cambridge) followed with an account of recent work on photosynthesis. He pointed out the sequence of biochemical processes in the breakdown and synthesis of carbohydrates, nvolving phosphorylated intermediates and adenosine triphosphate. His comparison of the structure and properties of chloroplasts and mitochondria led to interesting discussion of the possible influence of physical structure on the chemical processes which these regulate. During the afternoon session Dr. W. A. H. Rushton (Cambridge) gave a stimulating review of recent physiological work on visual pigments, including a recorded demonstration of the electrical response from the optic nerve of a frog on change of illumination, in contrast to the absence of signal during steady illumination. In the final paper, Mr. J. S. Preston (National Physical Laboratory, Teddington) gave an account of methods used for the absolute standardization of light meters. At the conclusion of the papers, a business meeting was held at which it was decided to establish the Photobiology Group on a permanent basis; to hold two meetings of this kind a year; and to affiliate with the Comité International de Photobiologie. Further information about future activities can be obtained from Dr. E. M. F. Roe, Chester Beatty Research Institute, Fulham Road, London, S.W.3.

## The Woodhull Lecture at the Royal Institution

The late Miss Z. M. Woodhull, of Norton Park, near Tewkesbury, who was a life-member of the Royal Institution, Albemarle Street, London, gave practical form to her interest in the improvement of racial qualities in future generations and her attachment to the Royal Institution by making a bequest to be used by the Institution for the furtherance of the study of eugenics. The managers of the Royal Institution, as a first step in carrying out Miss Woodhull's wishes, have, after consultation with the trustees of her estate, arranged for lectures to be given from time to time on aspects of eugenics. The first Woodhull Lecture will be delivered at the Royal Institution at 6 p.m. on October 27 by Prof. J. B. S. Haldane, on "The Prospects for Eugenics". He will discuss how the earlier eugenists were over-hopeful as to the possibilities of rapid racial improvement; that the fact of mutation makes the permanent 'purification' of a race impossible with our existing knowledge; how a large reduction in congenital abnormalities may eventually be achieved; and the impact of atomic nuclear reactions upon the study of genetics.

## Recent Gifts to the University of Oxford

The University of Oxford has announced the receipt of gifts and grants amounting to £100,000 for a wide variety of purposes. The largest is £52,000 from the Rockefeller Foundation towards the cost of providing research laboratory facilities and equipment for the use of the regius professor of medicine at the Radcliffe Infirmary. Arthur Guinness, Son and Co., Ltd., is increasing to £4,000 a year the sum of £2,500 a year for seven years which they previously covenanted to pay for the three research fellowships in microbiological chemistry in the Department of Biochemistry. Other sums include 2,000 dollars from the National Council to Combat Blindness, Inc., towards the purchase of apparatus for research at the Nuffield Laboratory of Ophthalmology; 10,000 dollars from the International Bank for Reconstruction and Development for a survey of British experience in the management of capital investment overseas, which is to be carried out at Nuffield College; £4,850 from the Nuffield Foundation for research work in the Department of Human Anatomy; £700 a year for seven years from Major H. W. Hall to make possible the purchase of an optical spectrograph for use in the research laboratory for archæology and the history of art; and £1,000 a year for seven years from the British Oxygen Co., Ltd., for the continuation of low-temperature research in the Clarendon Laboratory.

## Preservation of the Sheld-Duck in Germany

In the annual report for 1954 of the International Committee for Bird Preservation (pp. 66; from the British Museum (Natural History), 1955; 2*s*. 6*d*. net) a noteworthy example is given of the help afforded to bird-lovers by one of the Armed Services. When Heligoland was given up as a bombing range by the Royal Air Force in 1951, it was agreed with the Government of the German Federal Republic that the range should be transferred to the Grosse Knechtsand in the mouth of the Elbe. As a result, large numbers of sheld-duck were being destroyed, and there was a real possibility that the species would be exterminated. The matter was referred to the Secretary of State for Air, who was informed that the sheld-duck use the sand-banks of Grosse Knechtsand during their moulting season in July and August; the duck are flightless during this season, which is thus the season of danger. Almost immediately the Secretary of State announced that "new arrangements will be made for the use of the range during the next moulting season. Only practice bombs will be dropped containing only a small charge to set off a smoke marker, which will mean that there will be no blast effect. The Royal Air Force will co-operate with ornithologists under arrangements to be made with the British Section of the International Committee, to inspect the range before and after bombing has taken place to establish its effect on the Sheld-Duck. By these measures there is every hope that in the future the species will be able to moult without being seriously molested".

## Protection from Radioactive Isotopes

The increased applications of radium sources and the change in the maximum permissible dose have necessitated a revision of the radium protection code given in Handbook 23 of the United States National Bureau of Standards. Furthermore, the nuclear reactor has made available other high-energy, relatively long-lived, gamma-ray emitters—for example, cobalt-60 and cæsium-137, which are now coming into general use. The National Committee on Radiation has accordingly issued Handbook 54, "Protection against Radiations from Radium, Cobalt-60, and Cesium-137", prepared by Subcommittee 9, which supersedes the previous Handbook. The general principles outlined, though referring specifically to the three sources, are also applicable to other gamma-ray emitters and should prove useful as a preliminary guide until these other emitters are given separate treatment. Industrial applications are not considered; the medical applications discussed cover interstitial, intracavitary and surface treatments, and teletherapy (that is, therapeutic irradiation with collimated gamma-rays); and in the non-medical applications, specific consideration is given to the uses of sources in instrument calibration, research and civil defence exercises. Radiation hazards can be significantly reduced by the proper use of suitable facilities, and details of appropriate equipment for the safe handling, storage and transportation of the radioactive materials are given together with emergency measures to be taken when accidents such as spilling occur. The disposal of radioactive materials is not dealt with. The Handbook concludes with several tables and graphs giving data from which a worker can calculate, to suit his particular purpose, the correct arrangement and barrier thicknesses of concrete, iron or lead for any one of the three sources.

## Courtaulds' Scientific and Educational Trust Fund: Postgraduate Research Scholarships for 1955

THE Courtaulds' Scientific and Educational Trust Fund has recently announced the award of postgraduate research scholarships for 1955. Scholarships in a branch of science related to the textile, plastics and allied industries (maximum of £400 for one year only, but renewable for further periods) have been awarded to the following: J. D. Coombes, University of Nottingham; J. H. N. Hill, The Queen's University, Belfast (renewal); G. Holden, University of Manchester; G. R. Kotten-Kaye, Royal College of Science, Imperial College of Science and Technology, London (renewal); F. Nyman, University of Cambridge; J. H. Oxley, University College, London (renewal); M. T. Pope, University of Oxford; P. R. Sewell, University of Birmingham (renewal); R. R. Sheldon, University of Liverpool; and T. C. Stening, King's College, London (renewal). Postgraduate research scholarships in textile technology, tenable for two years (£320 the first year and £360 the second) have been awarded to the following: C. B. Chapman (third-year renewal), Miss M. M. Forrester, A. F. Greenwood (third-year renewal), D. R. Hardisty (third-year renewal), J. Hope, A. T. Peters and A. Selwood (second-year renewal). The holders of these latter scholarships have all chosen to do their research at the University of Leeds, except Mr. Hardisty, who will work at the Manchester College of Technology.

## Mond Nickel Fellowships for 1955

THE Mond Nickel fellowships for 1955 have been awarded to the following for study in the fields indicated: D. H. Butler (Phosphor Bronze Co., Ltd.), production of copper and its alloys, with particular attention to foundry methods, in Europe and in America; R. W. N. Dron (Rhoanglo Mine Services, Ltd.), organization of research and its relation to production in extraction metallurgy in the United Kingdom and North America; W. F. Duncan (British Aluminium Co., Ltd.), the design, layout and operation of continuous strip mills and, in particular, metal behaviour, properties and quality, roll lubrication and cooling, and the development of automatic controls; R. H. Hannaford (British Iron and Steel Research Association), organization and practice in the ferrous foundry industry in Europe and the United States, with particular reference to layout, mechanization and the application of management techniques; R. J. Harbord (John Lysaght's Scunthorpe Steelworks, Ltd.), the development of continuous casting in the non-ferrous industry an its application to the production of steel.

## Institute of Metal Finishing: Officers

OFFICERS of the Institute of Metal Finishing fo the session 1955–56 are as follows: *President* R. A. F. Hammond; *Immediate Past President* Prof. J. W. Cuthbertson; *Vice-Presidents*, Dr. S. G Clarke, Dr. T. P. Hoar, Dr. L. B. Hunt, R. W. Nicol H. Silman, A. Smart and A. W. Wallbank; *Honorary Treasurer*, F. L. James; *Honorary Secretary*, Dr. S Wernick.

## Announcements

MR. W. STRATH, at present serving as a Third Secretary in H.M. Treasury, has been appointed a full-time member of the Atomic Energy Authority. Sir Rowland Smith, chairman of the Ford Moto Co., and Mr. C. F. Kearton, a director of Courtaulds, Ltd., have been appointed part-time members. This brings the membership of the Authority up to the limit of ten, other than the chairman, laid down in the Atomic Energy Authority Act, 1954. Mr. Strath will be largely concerned with the Authority's relations with industry, with overseas atomic energy organizations and with raw material procurement.

A CONFERENCE on "Cloud Physics", arranged jointly by the Physical Society and the Royal Meteorological Society and organized by Prof. P. A. Sheppard, will be held in the Department of Meteorology, Imperial College of Science and Technology, Exhibition Road, London, S.W.7, during January 4–5. A number of leading workers in this field have been invited from the United States, Australia and the Continent of Europe. Further information can be obtained from the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7, marked for the attention of Miss E. Miles.

THE Worshipful Company of Glass-Sellers of London is offering up to four scholarships in glass technology, tenable at the University of Sheffield, which in suitable circumstances will be eligible for supplementation by the Ministry of Education up to the full value of State scholarships. The scholarships will be awarded by examination, for which candidates will take papers in chemistry, physics and pure mathematics (two as primary subjects and one as a secondary subject) together with an English language paper. Entry forms (to be completed by January 16) and further information can be obtained from the Registrar, University, Sheffield 10; the examination will begin at the University on April 9.

THE National Science Foundation, Washington, D.C., has appointed the following three programme directors: Dr. Helen S. Hogg, on leave of absence from the University of Toronto and the David Dunlap Observatory, to be programme director for astronomy in the Division of Mathematical, Physical and Engineering Sciences; Dr. Vernon Bryson, until recently a geneticist at the Long Island Biological Association, Cold Spring Harbor, New York, to be programme director for genetic and developmental biology in the Division of Biological and Medical Sciences; and Prof. Rogers McVaugh, on leave of absence from the University of Michigan, where he is curator of phanerogams in the University Herbarium and professor of botany, to be programme director for systematic biology in the Division of Biological and Medical Sciences.

# FLAMES AND COMBUSTION

DURING recent years the approach to combustion research has undergone a marked change from the domain of chemistry towards that of the physical sciences. This swing has been closely associated with the changing aspect of engineering requirements. The upper limit of performance of the internal combustion engine is largely set by the maximum compression ratio that can be employed without the onset of knock. Accordingly, much of the research was directed towards a better understanding of oxidation reactions in stationary systems—an essentially chemical problem. The advent of various types of jet and rocket engines, however, has emphasized the importance of heat and mass transfer in reacting flow systems, of the fundamental mechanism of flame propagation, and of the stability and structure of flame fronts. It therefore seems appropriate that, at the meeting in Bristol this year of the British Association, a series of papers on flames and combustion was included in the programme of Section A (Physics).

Dr. S. Whitehead acted as chairman of the session. The four contributions were divided equally between academic and applied research.

In general, flames can be subdivided into those which occur in the interface of the fuel and oxidant (diffusion flames), and those in which the flame front advances into a mixture of the reactants (premixed flames). In the latter case, the flame advances at a uniform velocity characteristic of the medium and can be stabilized on a burner by a suitable rate of counter-flow; in the former, the rate of burning is in general controlled by the rate of mixing. According to the flow conditions, both types of flame can be either laminar or turbulent.

The first speaker, Dr. A. G. Gaydon (Imperial College of Science and Technology, London), dealt with laminar flows in a paper entitled "The Structure of Flames". The mainly physical techniques available for the study of stabilized flames, such as measurements of temperature, spectra, ionization and others, are most effective when applied to flames of simple geometrical shape. During recent years much progress has been made in the design of special burners, and Dr. Gaydon gave a summary of the techniques now available for the stabilization of two-dimensional flame fronts both of the diffusion and of the premixed type.

The processes of heat release in the flame can be studied by the measurement of temperature distribution, by sampling and subsequent analyses, and by the study of emission and absorption spectra. The spectra, as well as indicating the presence of some short-lived chemical species, such as OH, $C_2$, CH and HCO, also give information about the energy distribution, and Dr. Gaydon discussed studies of effective translational, rotational, vibrational and electronic excitation temperatures. These are often quite abnormal in reaction zones, and similar anomalies are indicated by ionization measurements. Dr. Gaydon concluded his remarks by a brief summary of the main deductions from such measurements, with reference to the general structure of flames.

The second speaker, Dr. F. J. Weinberg (Imperial College of Science and Technology, London), discussed "The Study of Flames by Optical Means". It may perhaps seem rather incongruous that, although combustion in one of its forms was probably the first type of chemical reaction consciously put to use by man, the fundamental mechanism by which flame is propagated has still not been solved completely. The reason for this lies not only in the inherent complexity of the phenomena, but is also due, to a large extent, to the extreme conditions prevailing in combustion zones. Large temperature and composition changes occurring over extremely small intervals of space and time give rise to exceedingly large gradients of temperature and concentrations and to accelerations of the order of $10^{6}$ cm./sec.$^{-2}$. Since extrapolation of available physical and chemical data to such extreme conditions is unreliable, it is desirable to confine all studies to actual flame *in situ*, and optical methods, that is methods based on refractive index changes attendant upon combustion, constitute a most powerful tool in such studies.

After a brief outline of the underlying theory, Dr. Weinberg discussed the methods available and illustrated their use by slides. The luminous zone of a flame is not necessarily the most important nor the most informative region, and flame records using extraneous light give a more relevant, and in some cases the only reliable, account of flame events. As occasion demands, an instantaneous record or an exposure of any extended duration can be produced by photographic means, and can be used for visualization or for exact measurements. Dr. Weinberg concluded by showing examples of a complete analysis of the relevant variables across a flame front, obtained by a mathematical analysis of the distribution of deflexions produced by the flame from an initially parallel beam of light.

The more practical aspects of turbulent flames were discussed by Dr. B. P. Mullins (National Gas Turbine Establishment) in a paper entitled "Combustion and the Gas Turbine". Dr. Mullins stated that ". . . a new science, 'Combustion' has emerged in the past decade . . .". While it may perhaps seem a little premature to reject so much of the valuable earlier work, the new trend in approach, already referred to earlier in this article, has certainly become manifest during this period. Dr. Mullins, who illustrated his lecture by many spectacular demonstrations, aimed at correlating turbine combustion-chamber performance with fuel properties and other fundamental factors. The dependence of such desirable requirements as high combustion efficiency and intensity, ease of ignition and wide range of stable burning, minimum fire risk and freedom from carbon formation, on fuel properties such as calorific value, limits of inflammability, flash point, viscosity and vapour pressure, is obviously manifold and complex. Dr. Mullins outlined much valuable work aiming at making such dependence of behaviour on initial variables understood and predictable.

The last paper, by Prof. M. W. Thring and Dr. C. Hulse (University of Sheffield) and read by Dr. Hulse, dealt with "The Part played by Luminous Radiation in Furnace Heat Transfer". Luminous radiation emanates largely from soot particles which are the product of incomplete combustion in large turbulent diffusion flames. The paper dealt with parts of the work carried out by the International

Flame Radiation Committee on experimental furnaces at Ijmuiden in Holland and at Stockholm. Two types of trial are carried out. In 'performance trials' the effect of input variables on the distribution of emissivity is investigated by radiation pyrometry, while in 'combustion mechanism trials' probe methods are used to determine distributions of the more fundamental variables, such as suction pyrometer temperature, fraction of combustion, Pitot velocity and soot content. Such experiments provide much valuable information on furnace heat transfer, and general correlations are already emerging of the dependence of flame characteristics, such as flame length, temperatures and emissivities in various parts of the flame, on input variables such as nozzle design, atomizing agent, preheat temperatures and type and quantity of fuel.

Subsequent discussion reflected the diversity of the topics raised by the original contributions which may perhaps have seemed a little bewildering to the uninitiated. Such diversity, however, enables the newcomer to the field to form a balanced impression of current trends in combustion research and often gives rise to valuable cross-fertilization of ideas among workers in the various branches of the subject. In fulfilling these aims, the meeting was thoroughly successful.

F. J. WEINBERG

# ANIMAL MIGRATION

SECTION D (Zoology) of the British Association held a symposium on "Migration" in Bristol on September 2, with Mr. Peter Scott, vice-president of the Section, in the chair. A paper on "Recent Data on Movements of Desert Locust Swarms", by Dr. R. C. Rainey, Z. Waloff and H. Sayer, was read by Dr. Rainey. Recently some reasonably accurate estimates of the numbers of individuals in a locust swarm have been made by taking out samples obtained by spraying portions of the swarms with insecticides. A density of 70 locusts per square yard has been found, so that a swarm 8 square miles in area would contain some three thousand tons of locusts. These eat their own weight of food every day, and it is thus easy to understand how the recent invasion of Morocco has caused damage estimated at £4½ million.

Studies of orientation within the swarms have been made by taking photographs vertically upwards, coupled with pilot balloon observations of local wind conditions. It is found that individual locusts are orientated at random within the swarm. But this does not mean that the individual's flight is wholly independent of its neighbours'. The swarms show marked cohesion in turbulent air, and there is a strong 'edge effect' which causes locusts leaving the swarm to turn back into it. The movement of the swarm as a whole tends to be downwind, a conclusion agreeing with previous work in which the recorded tracks of locust swarms were correlated with weather charts. This downwind movement of the swarms will in the course of time inevitably lead them to the 'zones of convergence' where winds from different directions meet. The air in such zones must necessarily rise, leading to condensation, rain and moist ground conditions. The very lack of positive orientation of the swarm will thus ensure its arrival in an area which is suitable ecologically. The so-called 'intertropical fronts' are examples of such zones. Occasionally there may be a carrying-over beyond the zone in the downwind drift, as occurred last October when desert locusts appeared at several points in Britain. A film of locust swarms seen from the ground and the air was then shown.

In the discussion, Dr. Rainey said that it seems that the locusts maintain contact with one another within the swarm by visual means. Their auditory sensitivity is insufficient for this purpose. The fact that a swarm was once picked up by a ship's radar four hours after sunset cannot be cited as evidence for non-visual orientation, because the swarm was so large that there would not have been sufficient time for it to have become dispersed. While there is a possibility that the locusts appearing in England were brought by a ship, this is unlikely because of the simultaneous appearances at scattered points and the precise correlation with weather conditions. Large numbers of dead locusts were found at sea up to the latitude of Lisbon on the same day. It is impossible for locusts to keep flying actively for the thirty hours or so needed to reach England, but they can remain airborne for such periods by gliding at intervals, a habit Mr. Scott had noticed in Morocco. In 1865 substantial numbers of locusts came aboard a ship 1,200 miles off West Africa.

Mr. T. A. Stuart next spoke on "The Local Migrations of Brown Trout". He said that sea trout make local movements—the resulting concentrations being exploited by fishermen—as well as their true migrations to and from the sea. The benefit of this behaviour to the species is that far more fish can grow to maturity on the plentiful food of the sea than could if they remained in the home brook. The brown trout was originally thought to be non-migratory; but it has now been shown, by catching and marking samples of the fish, that there is a definite movement downstream to the lochs, where the fish matures. The adult fish migrates back up the streams at about the same time, though the two movements do not necessarily coincide. Occasionally precocious young males will stay and fertilize incoming females before starting on their own migration, but young females always require the extra year in the loch to lay in sufficient reserves for egg production.

The trout has a strong homing tendency, and, of many hundreds marked, none has afterwards been recovered in a stream other than that in which it was originally captured, except when the latter has been blocked. From 1952 the fry has been marked in this way, so that it is definitely known that the individual was born in a particular stream. Again strong homing tendencies have been demonstrated. Experiments have been made in which ripe fish moving up a stream are removed and released in streams on the opposite side of a large reservoir into which the streams emptied, a distance of more than a mile. No fish was recaptured in the stream to which it had been transferred; but about half those released were recovered and all save two were back in the original stream from which they had been removed. The successful homers did not only have to detect the mouth of the home stream once they were in the reservoir, but also actively to leave the foreign stream, swimming downstream against the mass of incoming fish for whom that particular stream was home. Mr. Stuart could not offer any explanation for the way in which the fish could re-orientate themselves in this manner. He thought it unlikely to be based on the detection of chemical factors, a view he maintained in the subsequent discussion when the work of Hasler was mentioned. This latter worker has claimed that fish can 'smell' the difference between streams from the difference in their organic contents.

Dr. G. V. T. Matthews then presented a review of recent work concerning "The Sun's Role in Bird Orientation". There is now plenty of evidence that birds can home from areas of which they have no previous experience. In some cases this may be due to a simple random wandering, but often the birds show initial homeward orientation followed by such swift returns that they must have flown pretty well straight home. Two types of navigation may be distinguished, the first being a limited navigation in which birds orientate themselves and fly in one direction only, fixed either by their instinctive behaviour or by a learning process. This suffices so long as the starting and finishing points always bear the same relation to one another; but the birds will be led astray if displaced in a novel direction. Secondly, there is a form of complete navigation in which the birds can orientate themselves and fly towards home no matter in which direction they were released. Many remarkable results have been obtained, culminating in the Manx shearwater that flew three thousand miles home across the Atlantic in twelve days.

The simple 'compass' navigation has been studied under laboratory conditions by making a bird indicate a certain direction. Bower birds, building their constructions with a rigidly northward orientation, provide a natural experiment, but the most important work has been done with caged migrants whose restless movements showed a strong directional component. Birds can also be trained to take up a direction by food conditioning. The prime orientating factor is undoubtedly the sun, since when it is lacking or 'displaced' by mirrors, the birds' orientation becomes random or is displaced accordingly; also, an artificial source of light is treated as if it were the true sun. The sun compass is fully developed in night migrants, and it is probable that they pick up a direction around sunset.

The complete navigation has been studied by observing the orientation behaviour of birds in the field under different conditions. Again the sun is an essential factor, only random orientation occurring in its absence. There are indications that some type of 'grid' navigation is concerned which, depending on the comparison of stimuli, becomes ineffective close to home. The main controversy is on whether the sun is still only concerned as a compass, or whether the bird can interpret the sun's position in the sky sufficiently to provide the 'grid'. This would require observation of the sun's movement along its arc, extrapolation of that movement, accurate angular measurements and an accurate internal chronometer. These are difficult to credit, but are theoretically within the capacity of the birds' sensory equipment. Some experiments aimed at confusing such a navigating mechanism have produced results supporting the hypothesis, which is the most promising one at the moment, though it cannot be finally accepted as yet. A film of the homing experiments with Manx shearwaters was then shown.

An extended discussion followed in which the required sensitivity of the bird eye, the stability of the head in flight and the accuracy of the internal chronometer received attention. Dr. Matthews said that claims of orientation within ten seconds of release could probably be referred to directional tendencies and not to position-fixing. Dr. J. Verwey, from Holland, a distinguished foreign guest at the meeting, contributed much to the discussion; he directed attention to recent work by Sauer which apparently shows that caged migrants can pick up a direction from the (unclouded) night sky, and gave an account of the orientation of sand-hoppers.

G. V. T. MATTHEWS

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# INFORMATION THEORY

## THIRD LONDON SYMPOSIUM

THE mathematical theory of information has undergone considerable broadening and clarification during the past few years, and it is being studied, and applied to the design of experiments, by people in very varied fields—in particular, communication engineering, taxonomy, linguistics and neurophysiology. Two symposia have previously been held in London, in 1950 (*Nature*, 167, 20; 1951) and in 1952 (*Nature*, 170, 1051; 1952); and, as a further experiment, another inter-disciplinary and international meeting was held at the Royal Institution during September 12–16 last. This meeting was attended by two hundred and fifty representatives from fifteen different countries, including a large body from the United States and representatives of the Academy of Sciences of the U.S.S.R. The meeting was organized by Dr. Colin Cherry, of the Electrical Engineering Department, Imperial College of Science and Technology, London.

The symposium was opened by Prof. Balth van der Pol, of Geneva. From the start, the discussions were numerous and lively, showing that, in spite of their variety of background, the participants enjoyed a considerable degree of mutual understanding through their common study of information theory. The subject is, of course, mathematical and forms a part of scientific method; it does not relate solely to telecommunications (whence it arose) but concerns all phenomena which are 'communicative' in nature, for which representations or scientific models are made, and to which true measures can be applied, precisely and numerically. The early promise offered, that information theory would provide a valuable unifying force between various specializations, is certainly being fulfilled.

The first day of the meeting was devoted to a review of the fundamental concepts and the various measures which may be applied to 'information rates'. Prof. J. L. van Soest, of the Netherlands, discussed the essentially discrete, or quantal, nature of communicable information and some of its consequences for the theory. A paper by Mr. G. Spencer Brown on the difficulties underlying definition of 'randomness' raised discussion to the level of debate —as might be expected of that thorny subject. But the concepts of 'randomness' of a stochastic source and of the degree of 'disorder' of finite sequence are of great importance to the whole theory; information theory may yet resolve some of the difficulties.

On the same day, Dr. D. Gabor, and also Dr. W. Meyer-Eppler (Germany), extended the application of the theory to physics; in particular, to optics. Finally, the relevance of 'information' in the theory of games was considered by Dr. R. Farquharson (Great Britain).

On the second day, questions of 'coding' of information-sources were discussed—the transformations of message representations from one form to another—and of the possibility of improving rates of flow of information in noisy channels. Profs. A. E. Laemmel and P. Elias (United States) considered the theoretical bases of encoding so as to reduce the probability of error in, respectively, low and high noise-levels. Their colleague, Dr. D. A. Huffman, then showed ways in which such encodings might be carried out automatically, in practice.

A related field of work was surveyed, in the afternoon, which included study of preferred ways of cataloguing, filing or classifying data in, for example, libraries—the theory of 'clerical operations'. Mr. R. A. Fairthorne (Great Britain) has worked in close association with Dr. Calvin N. Mooers, of the United States, and gave a most humorous exposition of what a layman might otherwise guess to be a dry subject.

Real-life, human, language was the topic on the third day, with accounts of some of the remarkable statistical facts about it. Prof. W. Fucks, of Aachen, disclosed statistical data relating to nine different languages, ancient and modern, Eastern and Western, showing that they have certain forms in common. Prof. Fucks is well known for his claims to establish the authenticity of certain controversial classical texts by the use of statistical discriminating-functions applied to the words. Prof. A. S. C. Ross and Dr. D. A. Bell, of Birmingham, continued their earlier work (reported in the 1952 Symposium) of computing the degree of redundancy in a written language; this time they chose written Welsh, because it is essentially a phonetic writing, and so their results bear at least some reasonable approximation to a spoken language (statistical data about spoken languages being extremely difficult to gather). Dr. B. Mandelbrot (Geneva and Grenoble) continued the discussion to the statistical laws which relate to languages. There are close relations between statistical laws of language and other biological laws, in particular those first exposed by J. C. Willis. The reasons for the similarity are by no means clear, but the suggestion was offered, by Dr. Margaret Meade, that it arises from the fact that the various descriptive categories (phonemes, say, in language, and species or genera in biology) are set up by groups of people, in society. The laws may not be so much properties of 'nature', but of ourselves who set up descriptions and classifications.

The afternoon of this same day was devoted to "Mechanical Translation", the principal contributors being Drs. A. D. Booth and J. Cleave, of Birkbeck College, London, Prof. V. H. Yngve, of the Massachusetts Institute of Technology, and Profs. S. Ceccato and E. Maretti, from Italy. Distinction between translation and transcription (or encoding) was quickly drawn, and discussion largely concentrated upon the parts played by the syntactic and semantic rules in translation. The machines, as at present constructed, operate necessarily upon syntactic rules, and it is indeed surprising the extent to which successful conversions of a text from one language to another may be accomplished, even on a word-by-word conversion basis. The speakers emphasized the practical achievements of their work, with examples of translation of scientific texts. The semantic rules may come in with the pre- and post-editing processes, using reasonably intelligent human beings. As might be expected, it is scientific texts which offer most promise, being to a large extent inter-cultural. The two Italian speakers gave a brief account of the approach of their operational school to problems of language and translation, leading to discussion of some of the philosophical difficulties and pitfalls.

During the afternoon, speakers from Britain, France and the United States outlined modern views upon the structure of physical speech signals, and upon aural and visual perception.

The final day was devoted to psychological and neurophysiological studies. 'Models' representing certain aspects of brain functioning were discussed which, in their main attributes, are nowadays far removed from the digital computer analogies which so plagued us a few years ago. The stress to-day is upon self-organizing models, in initial random connexion. A paper by W. K. Taylor (of University College, London) is likely to become a classic; Taylor considers the properties essential to the elements of a mechanism which can 'learn by association', based upon known properties of neurons in living nerve cells and sense receptors—correct firing-rates, mutual interaction, facilitation and inhibition, accommodation—which determine the whole pattern of activity when associated. His analogue mechanisms are of the self-organizing type which, experimentally, exhibit primitive learning and adaptive behaviour.

Later in the same day, some varied uses of information theory were demonstrated in human behaviour studies, especially to give quantitative measures for experiments upon learning, motor skills, visual recognition and human operator capacity.

It was a happy sign of the times to hear, finally, a short report upon information theory developments in the U.S.S.R. from Prof. V. Siforov, the leader of the Russian delegation. He brought news of a number of well-known workers in the field, including the pioneers, Profs. A. Khinchin and A. Kolmogorov.

The Proceedings of this third London Symposium on Information Theory are to be published by Butterworths Scientific Publications, London.

COLIN CHERRY

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# CHOLESTEROL AND FAT METABOLISM

A SYMPOSIUM on "Cholesterol and Fat Metabolism in Relation to Diet and Disease", arranged by the Scottish Group of the Nutrition Society jointly with the Biochemical Society, was held in Aberdeen on September 17. At an excellently attended meeting five papers were given as a basis of discussion, the speakers each making their characteristic contribution to the subject in hand. The subject-matter, covering the factors of diet and disease, proved attractive to biochemists, nutritionists and clinicians; and indeed the papers were so arranged that the more purely scientific aspects of the subject were followed by those parts of the problem of cholesterol and fat metabolism which are of more particular interest to pathologists and clinicians.

The subject, from the chemistry of the sterols to the treatment of atherosclerosis, is as full of interest as it is of difficulties, both in the investigation of the scientific problems and the interpretation of the complex of signs and symptoms which present themselves to the clinician.

Dr. R. P. Cook, of the Department of Biochemistry, Queen's College, Dundee, opened with a paper on "Chemistry and Biochemistry of the Sterols with Special Reference to Cholesterol". After a brief but interesting reference to the historical development of our knowledge of cholesterol, he reviewed the structure of the sterols. He discussed fully the biological function of the sterols and concluded with an account of sterol absorption in various types of animals.

Dr. J. A. Lovern, of the Torry Research Station, Aberdeen, followed with a paper on "Methods of Investigating Cholesterol and Associated Lipids". The paper dealt with the general principles involved in the main sequence of operations in a study of the lipids of a tissue, with particular emphasis on cholesterol and its esters. In an excellent and highly technical account, he indicated the extraction difficulties associated with lipid protein complex formation and pointed out that they are not likely to be serious with cholesterol, and that a rigorous removal of non-lipid impurities is not essential if the investigation is concerned solely with cholesterol; but it was shown that separation problems are serious if the fatty acids of the cholesterol esters are to be examined. Detailed reference was made to the well-known drawbacks of the Liebermann–Burchard colorimetric method for cholesterol, these being associated with the transient nature of the colour and its sensitivity to experimental conditions. Such difficulties as arise, however, can be avoided by the use of alternative reactions. It was shown how metabolic studies with precursors labelled with deuterium and radioactive carbon have thrown much light on cholesterol synthesis and metabolism in the animal.

Of importance to those interested in the origins of the secretion of the adrenal glands were the remarks of Dr. G. S. Boyd, of the Department of Biochemistry, University of Edinburgh, when he spoke on "Some Aspects of Cholesterol Metabolism". Isotopic studies have shown how acetate must be involved in the *total* synthesis of the cholesterol molecule. He emphasized how true it is that while the adrenal cortex and the liver, particularly the latter, play an important part in the synthesis of this sterol, nevertheless other tissues such as the lungs, kidneys and spleen may in some species enter the field of biosynthesis. That the adult brain, rich in cholesterol, seems to be a non-participant in this biosynthesis does not indicate that the central nervous system has no part to play in the maze of activities which apparently have their origin in cholesterol or its precursors. It was apparent that we have only to think of the influence of the various steroids and steroid hormones on the hormonal activity of the anterior lobe of the pituitary gland, with its close links with the hypothalamic nuclei, to realize the complexities of the problem. A stimulated pituitary has a potent action in depleting cholesterol sources, especially in the adrenal cortex, and in forcing the production of cortical steroids and concurrently removing, from the circulating blood, cholesterol and especially cholesterol esters for the purpose of the restoration of depleted reserves. The complexities of the subject were further emphasized by Dr. Boyd in his remarks concerning liver glycogen and blood-sugar levels and the influence which they exert through the hypothalamus on the energy balance within the body.

The last two papers, given by Dr. L. Rannie, of the Department of Pathology, King's College, Newcastle upon Tyne, on "Experimental Cholesterol Atherosclerosis", and by Prof. H. W. Fullerton, Department of Medicine, University of Aberdeen, on "The Relationship of Lipæmia to Thrombosis and Atheroma", presented the problem of cholesterol and fat metabolism in its relation to disease. To the biochemist and the nutritionist, this aspect of the problem is apparently not without interest; nevertheless, to the pathologist and more especially to the physician, with the care of the patient his supreme responsibility, it is of vital importance. In his references to experimental atherosclerosis Dr. Boyd, by a most illuminating series of slides, showed how lipid-bearing phagocytes or cholesterol taken up by reticulo-endothelial cells may become imbedded in the wall of the artery and, in this connexion, referred to the important part played by the permeability of the vessel endothelium and how at sites of turbulent flow macromolecular substances can stick to and damage the endothelial lining of the vessel. It was further made abundantly clear that the problem is made the more difficult because of species differences, and that as a result of this, one has to be extremely careful in arriving at conclusions to note the type of animal from which results have been gleaned.

Prof. Fullerton, in discussing the more clinical aspects of the problem, gave it as his opinion that while a thrombosis or fibrin deposit is situated within the wall covered by endothelium, the initial abnormalities, at least in man, are to be found in the plasma and not in the wall of the artery. Prof. Fullerton corroborated the suggestion first put forward by Prof. Duguid that the factor responsible for intermittent fibrin formation is the ingestion of meals rich in fat. As a result of his own work, he showed that the amount of fat ingested at a meal may on many occasions exceed the critical level at which an increase in the coagulability of the blood occurs.

A matter which received a certain amount of attention was the relation of plasma cholesterol to the nature of the plasma lipoproteins, and the distribution of cholesterol between the α- and the larger β-lipoproteins. As a result of discussion, it became clear that an increase in plasma cholesterol, while it may lead to an accumulation in the plasma of abnormal lipoproteins of macro-molecular structure, does not provide an explanation of the processes upon which the development of the thrombic lesion within the arterial wall depends.

Sir Rudolph Peters, of the Institute of Animal Physiology, Babraham, Cambridge, took the chair during the first part of the meeting.

# YOUNG MANAGERS IN THE UNITED STATES

During the academic years 1951–52 and 1952–53, funds were provided by the United States Government through the Mutual Security Agency for a study to be made of "the philosophy, principles and techniques of American business management" by a number of young managers from Britain. In each of the two years two groups travelled to the United States, attending the Universities of Cincinnati and Syracuse, respectively. Each course lasted for a period of nine months and the total number taking part in all the courses was sixty-three.

The young managers who carried out these studies are back at work in British industry. They have now published the outstanding impressions of the period that they spent in the United States, a summary of experience based not only upon courses of instruction but upon an overall total of 452 visits made to companies, trades unions, business associations and government departments ("Reporting Back". (Management Publications, Ltd.) 7*s.* 6*d.*).

The greater part of the book is devoted to chapters on production, distribution, finance and labour, in which the managers discuss the techniques and methods that they saw in operation. The majority of these techniques have been common practice in progressive companies in Britain for a number of years. What emerges most clearly, however, is the strong impression left in the minds of managers of this level of the general attitude towards business in the United States—an attitude more important and more fundamental than the specific techniques in which it is manifested. The report directs attention to the high social prestige attached to business in the United States, to the all-pervading competitive spirit and the ready adaptability to new methods. Stress is laid in particular on the extent to which production, prices and employment are governed by the volume of sales with a resultant cost-consciousness in every department and at all levels.

A final chapter indicates the scope of American education and training for management with its strong emphasis on the case study method and a close co-operation between the universities and industry.

## ECOLOGY OF ARID ZONES

In a recent Unesco publication*, a comprehensive list of papers on the plant ecology of arid zones is reviewed as a preliminary to further action of a practical nature.

At the second session of the Unesco's Advisory Committee for Arid Zone Research, held in Paris in September 1951, it was recommended that a commission of experts should be invited to prepare reports reviewing research on plant ecology pertaining to arid and semi-arid regions. The aim was an effective review of existing literature together with such information as Unesco might be able to collect. It was also recommended that the reports should cover ten specified regions, and that particular attention should be paid to wild plant species growing in the arid regions which might be suitable as agricultural crops. The present full and informative report is the outcome of these recommendations.

In the introduction, it is pointed out that, in view of the large part of the earth's surface that is arid, or semi-arid, there is a responsibility to make the best use of such areas, even though the major agricultural effort must necessarily, and rightly, be devoted to the more favourable climatic zones. It is held that, through the mediation of an international organization, it should be possible to examine the relevant problems of these areas on a much wider basis than can be hoped for at national centres, the more so as some of these may be working with limited resources. In undertaking this task, in consultation with other United Nations agencies, the first objective in the programme as envisaged by Unesco is the collection, sorting and use of existing information; the second is to encourage new investigations and close co-operation between research centres.

In the present volume, the résumés, discussions and bibliography, prepared by different workers, relate to investigations into the plant ecology of the arid zones of Afghanistan, India, Pakistan, Iran Israel and Turkey, Australia, Latin America, Iraq, Jordan and neighbouring territories, Egypt and neighbouring territories, Angola and South African territories, North-west Africa, United States and Canada, and tropical East Africa. In many of the reports, reference is made to the degradation of arid zone lands as a result of human intervention, particularly over-grazing and the removal of forest cover. This is strongly evidenced in the older settled areas, but is by no means confined to them. A full and accurate knowledge of the environment in any given area is needed in order to ensure a sound programme of plant introduction. This has been illustrated in practice by several notable examples in recent years. How much remains to be done in the matter of direct botanical and ecological observation emerges from the several regional reports. What can be achieved in practical agriculture, on an economic basis, remains to be seen; but some important beginnings have been made.

In that it makes readily available a fund of important information, this publication should not only be of interest to the professional botanist, ecologist and agriculturist, but also to the more general reader and, in particular, to all who are concerned with the amelioration of arid zones.

## ANIMAL ENDURANCE

An extraordinary case of bone repair and animal endurance is reported from the Dominion Museum of New Zealand (*New Zealand Sci. Rev.*, 13; March–April 1955). The shaft of the left femur of a red deer (*Cervus elaphus*) had been fractured towards the middle and the lower portion of the bone displaced farther to the left, at the same time 'telescoping' upwards, so that the two portions lay somewhat parallel to each other. In this position the two fragments were secured by the formation of two densely ossified 'bridges'. The remains of a bullet were found lodged in the bone just above the internal condyle. The impact of the bullet not only fractured the shaft of the femur towards the middle, but also the internal and external condyles. In time, ossification of the condyloid fragments cemented together the pieces, leaving deep furrows in the articular surfaces. The two 'bridges' spanning the separated portions of the shaft appear to have been built up by calluses forming over the fragments bridging the gap between the two portions of the femur and finally fusing with the separated portions of the shaft itself.

At the lower end of the upper fragment of the shaft, the medullary canal has remained open, and a certain amount of ossification taken place. The opening of the medullary canal of the lower portion of the shaft is almost completely closed, except for minute openings, by the formation of the upper 'bridge'. There is no evidence to indicate whether the animal was afterwards shot, or whether the bone was picked up after the death of the beast. It is evident, however, that the animal managed to survive for a very considerable time after it received the original injury, perhaps many months, if not several years.

The absence of predators in the country undoubtedly contributed to the survival of such a wounded animal.

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* Plant Ecology: Review of Research. Arid Zone Research, Vol. 6; pp. 377+8 plates. (Paris: Unesco; London: H.M. Stationery Office, 1955.) 2,200 francs; 45s.; 7 dollars.

# PHOTOMAGNETISM OF TRIPLET STATES OF ORGANIC MOLECULES

By Dr. D. F. EVANS
Physical Chemistry Laboratory, Oxford

It has been generally accepted since the classic work of Lewis and his collaborators[1] that the upper state responsible for the phosphorescence of many organic molecules in rigid solvents is the triplet state. The most important piece of experimental evidence was the photomagnetism observed by Lewis, Calvin and Kasha[2] during intense irradiation of fluorescein in a boric acid glass. No further results have been reported, but certain difficulties of the triplet-state hypothesis have recently been pointed out by Porter[3]. Accordingly, measurements have been made of the photomagnetism of fluorescein, 1-hydroxy-2-naphthoic acid and triphenylene (9 : 10-benzphenanthrene), which confirm and extend the earlier work.

In their experiments, Lewis *et al.* determined the absolute paramagnetic susceptibility of the triplet state of fluorescein, and found reasonable agreement with the theoretical value. The measured susceptibility depended, however, on an estimation of the stationary concentration of the triplet state, which seems very uncertain, and has not been attempted in the present work. Instead, the decay of the photomagnetism was compared with that of the phosphorescence in the case of triphenylene, which has an exceptionally long phosphorescence lifetime[4]. Since only a very small effect was obtained by Lewis *et al.*, a much more sensitive design of apparatus (Fig. 1) was used, which is an adaptation of the gas susceptibility balance described by Bitter[5].

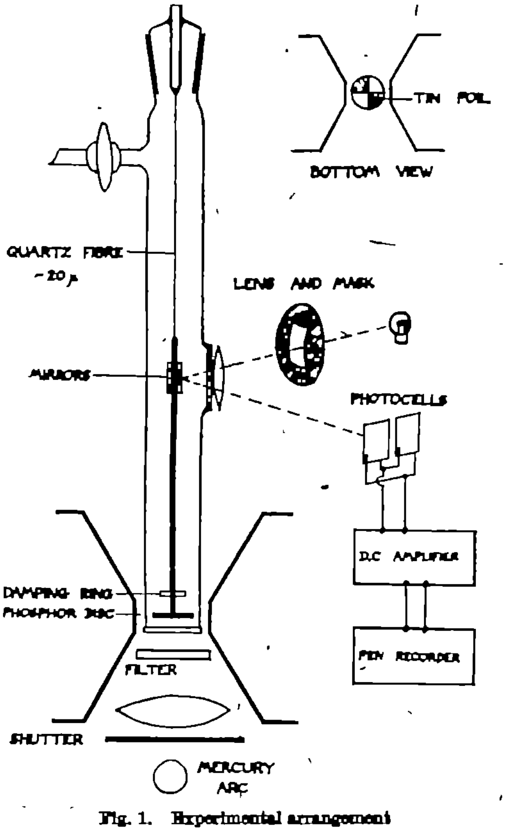

Fig. 1. Experimental arrangement

The boric acid phosphor, in the form of a thin disk (1 cm. in diameter, about 0·3–0·4 mm. thick) with alternate quadrants covered with tin foil, is suspended as shown in an atmosphere of hydrogen gas[5]. The inhomogeneous magnetic field is produced by an electromagnet run off the d.c. mains; the voltage is stabilized when necessary by 'backing off' against lead accumulators. When the disk is illuminated, a steady concentration of paramagnetic triplet molecules will be formed in the uncovered segments, and the disk will be deflected in a clockwise direction. The system, which has an undamped period of about 3 sec., is damped by the small ring of copper foil. The movement of the reflected spot of light is detected and amplified by two selenium photocells wired in series-opposition, which are connected to a push-pull d.c. amplifier and a recording milliammeter. (This arrangement has adequate sensitivity, and is simpler than one using photo-emissive cells.) In this way a continuous record of the susceptibility of the illuminated portions of the disk is obtained. Changes in susceptibility of about 0·001 per cent could be detected, corresponding to less than $10^{-10}$ mole of triplet; and it is probable that by more careful balancing of the suspension, considerably higher sensitivities could be obtained.

The samples were made by heating 0·05–0·4 parts of the organic compound with 100 parts of 'Analar' boric acid at 240° C. until most of the water was expelled[6]. The melt was pressed between two hot glass plates coated with silicone oil, and, after cooling, the thin sheet was cut into disks by gentle pressure from a sharp cork borer. The phosphors of fluorescein and 1-hydroxy-2-naphthoic acid were irradiated by light from a 500-W. Osram compact-source mercury arc. A glass condensing lens focused an image of this source on the disk, and a solution of copper nitrate or copper sulphate was used as a heat filter. It was shown with the aid of suitable filters that the wavelength of the radiation producing the photomagnetism was mainly 4360 A. and 3650 A. respectively. This was expected from the absorption spectra of the organic compounds in boric acid glass. Since triphenylene does not absorb appreciably at 3650 A., a 125-W. high-pressure mercury arc was used with a quartz condensing lens, a nickel nitrate heat filter, and (usually) a glass filter to cut off radiation of wave-lengths shorter than about 2800 A. (It has been stated[6] that boric acid glasses show intense absorption below 3100 A.; pure boric acid glasses have been prepared, however, which were reasonably transparent down to at least 2100 A.) The intensity was much less than for fluorescein and 1-hydroxy-2-naphthoic acid, but this was partly compensated by the much longer lifetime of the triphenylene triplet state, which favours a high concentration of triplet[7].

Appreciable photomagnetic effects were found in all three cases. Successive deflexions agreed within about ±2 per cent for fluorescein and 1-hydroxy-2-naphthoic acid, and a trace obtained with the latter compound is shown in Fig. 2. No deflexions were observed on exposure to light in the absence of a magnetic field. Triphenylene showed rapid photodecomposition with the formation of a blue compound. Despite this, reproducible traces could be

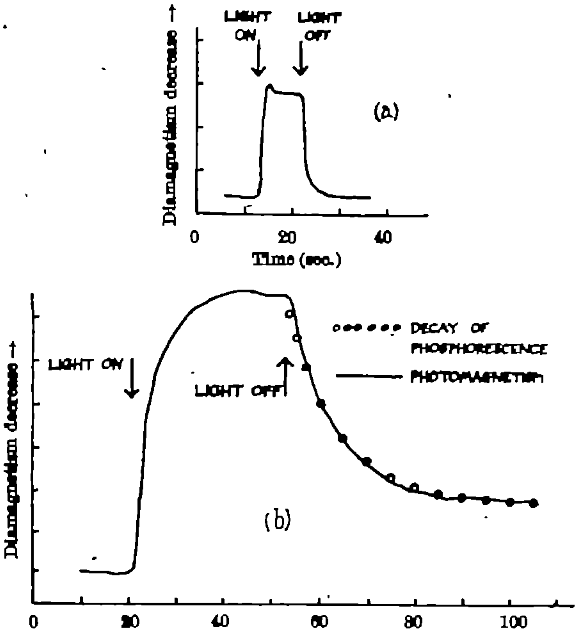

Fig. 2. Photomagnetism in (*a*) 1-hydroxy-2-naphthoic acid and (*b*) triphenylene at room temperature. The overall sensitivity was considerably higher in the latter case. The decay of phosphorescence for triphenylene is also shown, and follows accurately the expression $I = I_0 \exp(-t/11{\cdot}5)$

obtained, although successive deflexions tended to decrease in magnitude owing to competitive absorption of the exciting light. In addition, permanent deflexions were usually obtained, possibly due to permanent formation of free radicals. However, the slow rise and decay of the photomagnetism can clearly be seen in a typical trace shown in Fig. 2. After about the first two seconds the decay becomes closely exponential, with a mean lifetime of approximately 10·8 sec. The mean lifetime of the brilliant blue phosphorescence was found to be 11·5 sec. by direct measurement on the same batch of boric acid glass, using a selenium photocell and the recording system described above. These two values are in satisfactory agreement, and there can be little doubt that the same paramagnetic species is responsible for both the photomagnetism and the phosphorescence in triphenylene, and presumably also in fluorescein and 1-hydroxy-2-naphthoic acid.

It is clear from the exponential decay of both the photomagnetism and the phosphorescence that this paramagnetic species is in fact a triplet state, and not a pair of free radicals, or a free radical and an electron which slowly recombine. The recombination of a free radical and an electron after the irradiatio of certain organic compounds in glasses at lo temperatures has been studied experimentally, an found to differ very markedly from the norma phosphorescence phenomena[8]. In particular, th rate of decay of the luminescence $I$ follows a law o the type $I = I_0/t^m$, where $m$ is of the order of one.

Porter[3] has recently emphasized that in spite o the apparent general similarity between the radiationless transition from the first excited singlet to the lower triplet state, and the corresponding one from the triplet state to the ground state, these two processes actually differ very markedly in behaviour. The former is in general rapid (lifetime of the orde of $10^{-7}$ sec.[9]), and practically independent of the physical state of the molecule concerned, whereas the latter is usually much slower, and very dependent on the viscosity of the surrounding medium[8], becoming of negligible importance in rigid solvents.

It may be noted, however, that the triplet state is usually much closer in energy to the excited singlet than to the ground state, which should favour the necessary crossing of potential energy curves in the first case (see also ref. 1*b*). Also, symmetry considerations indicate that in general this transition from the excited singlet to the triplet should be the more rapid. Thus, for centrally symmetric aromatic molecules the ground state is even (*g*), whereas it is likely that both the excited singlet and triplet will normally be odd (*u*)[10]. For non-radiative processes *u*—*u* transitions are permitted, and *u*—*g* transitions are formally forbidden[11]. More generally, the symmetry with respect to rotation about an axis perpendicular to the plane of the molecule is likely to be the same for the excited singlet and triplet, but different for the ground state.

I thank Dr. E. J. Bowen and Dr. R. E. Richards for advice and encouragement, Prof. C. A. Coulson for a valuable discussion on the theoretical aspects, and the University of Oxford for an I.C.I. fellowship.

[June 6

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# AN AUXANOMETER FOR ISOLATED PLANT SECTIONS

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THE auxanometer to be described is basically unspecialized, and may be adapted to record the extension/time characteristics of a variety of tissues under a number of environmental conditions. In its present form, the machine measures in darkness the progress of extension in isolated sections of the epicotyl of dark-grown broad bean seedlings when supplied with various nutrients independently at the cut ends of the section. It has also been used on the same material immersed in water, simulating current methods of bio-assay.

Fig. 1 illustrates the mechanism. The success of the method and its potential usefulness depend on the simplicity and ubiquity of the Cambridge rocking

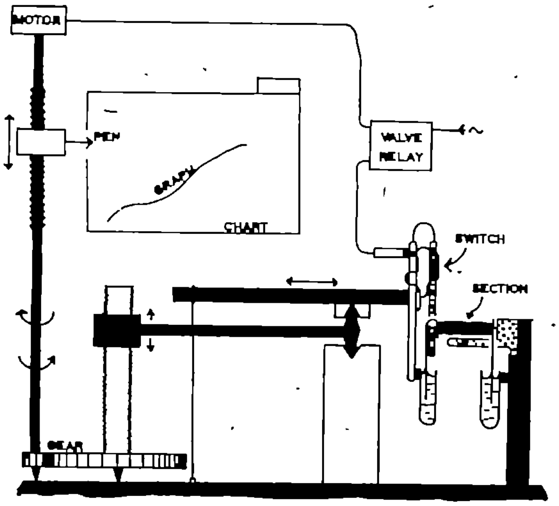

Fig. 1. The mechanism consists of a Cambridge rocking microtome driven by an Everett Edgcumbe 'Synlock' type *MRX* motor, which has two separate windings, one for each direction. The valve operates a P.O. type 3000 relay from an unsmoothed power supply. The switch controls the bias on the valve. The stippled material supporting the section is polythene, the rest of the switch being of 'Perspex'. Strips of filter paper supply the ends of the section with water from small cups holding about 1 c.c. each. The position of the chart as shown is displaced to the right

microtome. A switch is fitted to the block holder of the microtome, and is directly coupled with magnification to the recording pen. The coupling is moved in either direction by a reversible motor, the speed of which is one revolution per minute; the direction taken by the motor depends upon whether the switch is open or closed. Elongation of the section closes the switch, when the motor rotates so as to move the switch away from the section. The switch then opens, reversing the direction of rotation. As a result the switch contacts close again, and the cycle is repeated. The apparatus in fact hunts around the end of the section, the extension or contraction of which is followed by the mean position of the switch. The hunting-range is of the order of 5μ, and this will only show on the record at higher magnification than has so far been used.

The record appears as a graph of total extension against time on a chart 5 in. high, corresponding to 4 mm. extension. The graph may be converted to one of rate with time by measuring the slope with a protractor. Total extension may be measured to within about 20μ. The time-scale may be resolved to within 5 min. using a chart speed of 0·75 in. per hr. The rate of extension may be estimated to the nearest micron per minute for a minimum period of some 15 min.

The contacts of the switch are of crossed 30-gauge platinum wires, sprung such that no great change in pressure occurs as they open or close. The moving arm of the switch is spring-loaded so that the plant section is under a constant pressure of the order of 1 gm. This keeps the cut ends in comfortable contact with the filter-paper strips conducting moisture to the section.

Some typical results are shown in Fig. 2. The fluctuations in the rate of extension during the first five hours are characteristic responses to cutting, and are found in both isolated sections of stem and in lengths of stem without roots and seed but retaining the apical meristem; this is known from a previous unpublished investigation.

It has been found that if the sections are wholly or partially immersed in water, the pattern of growth normal to the tissue is lost. Under these conditions, there is an initial period of rapid extension lasting for about an hour, followed by a long phase of fairly constant rate lasting for perhaps 20 hr. However, the mode of support of the section shown in Fig. 1 was found to give results more like those previously observed in intact plants. There is a conspicuous response to handling followed by a period of decreasing rate of extension, there being little extension after about 15 hr. In the case of added auxin, the second phase is longer.

It may be noted that the graph of rate of extension has always been found to be more eloquent than the curve plotted by the machine. This total-extension/time curve does not easily indicate to the eye changes in the rate of extension that may be very significant indications of metabolic activity. Such changes usually occupy an hour or two, and are easily lost when resolution is of a comparable period, as is usual in most methods of bio-assay. Similarly, inspection of the rate/time records of individual sections often reveals meaningful phases of rate of extension that may not be exactly synchronous in all cases. Were such records to be averaged before inspection, the sequence of events in fact common to all the records would become partially or wholly obliterated. Methods of bio-assay using stem sections have in the past involved average measurements taken at quite infrequent intervals of time; as a result, the

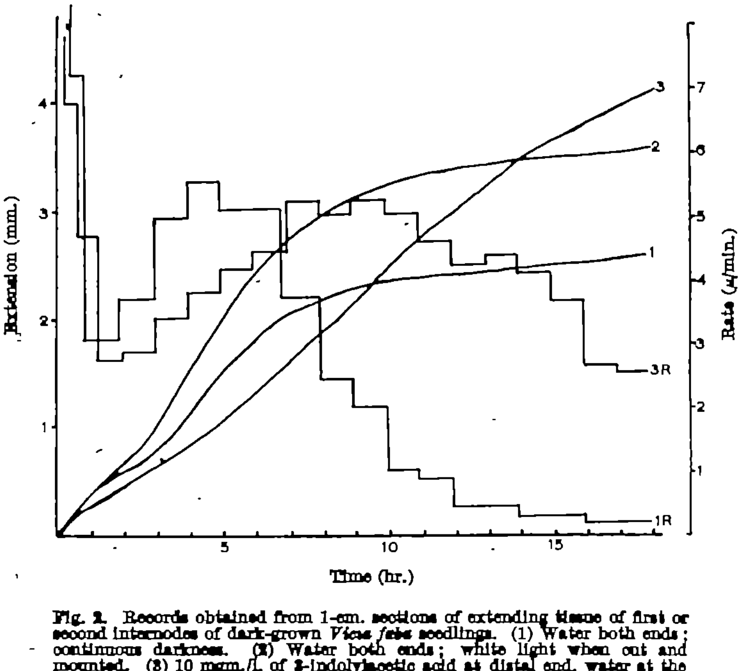

Fig. 2. Records obtained from 1-cm. sections of extending tissue of first or second internodes of dark-grown *Vicia faba* seedlings. (1) Water both ends; continuous darkness. (2) Water both ends; white light when cut and mounted. (3) 10 mgm./l. of 3-indolylacetic acid at distal end, water at the other; cut and mounted in darkness. (1*R*) and (3*R*) Curves 1 and 3 plotted as rate of extension with time

peculiarities of the initial rate of extension have not been observed or studied. Even the few observations as yet completed suggest that these initial phases are of great interest and importance, and they fully support the statements of Bennet-Clark[1] and of Audus[2].

This work has been carried out under a researc award of the Department of Scientific and Industria Research, and with the help and encouragement o Prof. W. T. Williams. [July 20

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# STRUCTURE OF POLYGLYCINE II

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VERY recently Bamford and his colleagues[1] have described their work on a second form of polyglycine, which they call polyglycine II. The purpose of this communication is to suggest a structure for this substance.

Bamford *et al.*[1] have shown clearly that polyglycine can give two types of X-ray diagram according to the method of precipitation. Polyglycine I gives strong reflexions at 4·4 A. and 3·45 A., and is thus some kind of β-structure; that is, the polypeptide chains are almost but not quite fully extended, and hydrogen bonds are formed between neighbouring chains (in approximately the same plane) to form sheets of parallel or anti-parallel chains. Polyglycine II, on the other hand, gives a very strong reflexion at 4·15 A., and a moderately strong one at 3·1 A. Only a powder diagram has so far been obtained. Bamford *et al.*[1] have shown that the X-ray picture cannot be easily explained in terms of any well-known configuration of the polypeptide chain.

The structure we propose is simple. All the polypeptide chains are parallel and each one has a threefold screw axis. The chains are packed in a hexagonal array, each chain being hydrogen-bonded to each of its six neighbours. These hydrogen bonds lie roughly perpendicular to the screw axis, and, as implied above, run in several directions and not merely in one direction as in a β-structure. This can be seen in Fig. 1, which is a projection of the structure looking down the screw axis.

Another view of the structure is shown in Fig. 2. This is a projection along the *x*-axis and perpendicular to the screw axis (the *z*-axis), which runs vertically. The easiest way to visualize the structure is to look at one of the residues at the bottom of the figure. This shows that the planar peptide group is inclined at about 35° to the fibre axis, and has its plane perpendicular to that of the paper. There is thus an infinite sequence of hydrogen bonds running from one cell to the next, perpendicular to the paper and joining residues of adjacent chains. It follows that the atoms of these residues all lie on an inclined lathe. There is another set of such lathes at a level 3·1 A. higher in the structure, but due to the 120° rotation of the screw axis these lathes run at an angle to the paper. At 3·1 A. higher again there is a third set of lathes, again at an angle to the paper. Above that the structure is repeated.

The formal crystallographic description of the structure is: $a = 4{\cdot}8$ A., $c = 9{\cdot}3$ A., space group $P3_1$, one residue per asymmetric unit. The calculated density is 1·54 gm./c.c.; observed density[1], 1·43 gm./c.c. (It is often found for this type of material that the calculated density is 5–10 per cent higher than the observed.) The co-ordinates of the atoms

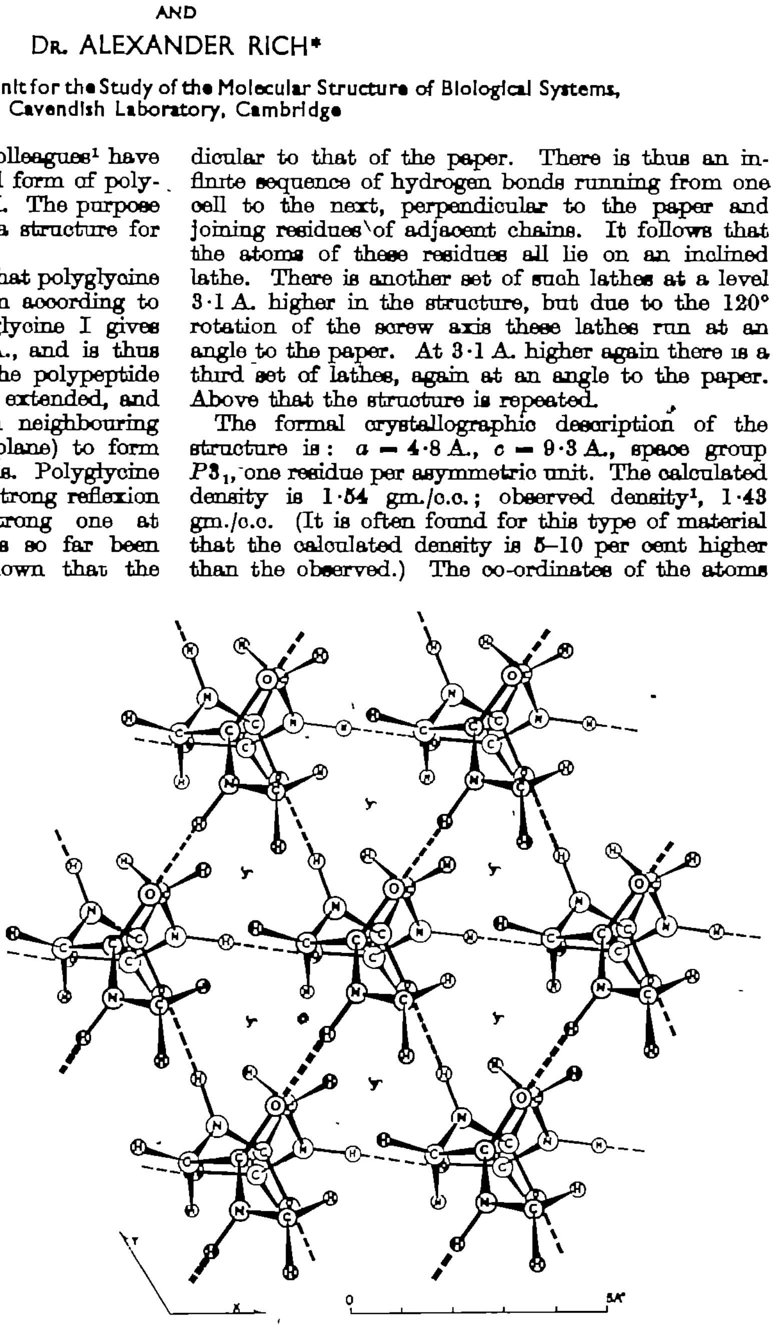

Fig. 1. A projection of the structure down the screw axis, showing seven chains. Hydrogen bonds, drawn as dashed lines, run in a number of directions linking neighbouring chains together

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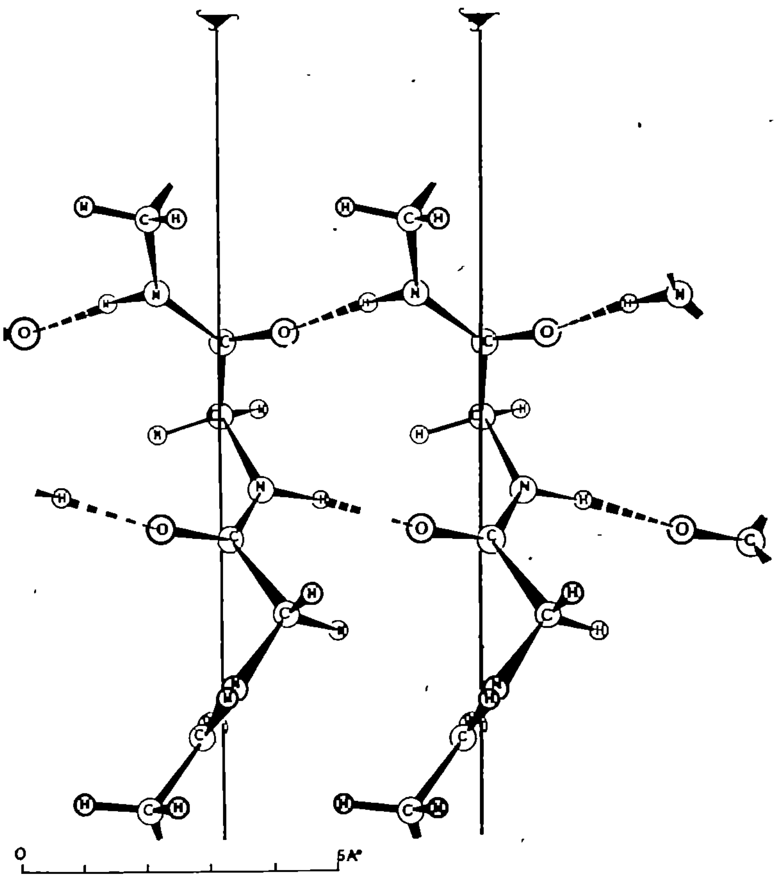

Fig. 2. A projection of the structure with the screw axis vertical. One a-axis points towards the reader; the chain on the right has been drawn as nearer to the reader than the chain on the left (see Fig. 1). Note the planar peptide groups edge-on at the bottom of the figure. The hydrogen bonds from these groups are almost perpendicular to the paper

of one asymmetric unit (excepting hydrogen atoms) are given in Table 1, to the nearest 0·05 A.

In building the structure we have adopted the standard Pauling–Corey[2] bond-distances and angles. The hydrogen bond-distance (nitrogen to oxygen) is 2·76 A., which is a little short, but quite acceptable[3]. The hydrogen bond is almost straight, as can be seen from the figures. All the van der Waals distances are acceptable, and in fact space-filling models show that the chains pack together in a comfortable manner.

Since there is no asymmetric carbon atom in polyglycine, the mirror image structure (space group $P3_1$) is equally possible.

We have calculated the spacings and intensities expected from this structure for all reflexions out to 1·8 A. Dr. C. H. Bamford and his colleagues have kindly shown us the original of the powder photograph (their Fig. 1). Their X-ray data are in good qualitative agreement with our calculations. The very strong 4·15 A. reflexion is $10\bar{1}0$. A glance at Fig. 1 shows that this will be intense. The 3·1-A. reflexion has a small contribution from 0003, but is mostly due to $10\bar{1}2$, spacing 3·09 A. The strength of this reflexion is mainly produced by the inclined planes of the peptide groups which make up the lathes described above.

We thus feel confident that polyglycine II has the structure we have described, or a closely similar structure. It should be realized, however, that there is a family of possible structures of this general type. All these would have in common polypeptide backbones with three-fold screw axes and a repeat of about 9·3 A. There are only two possible ways of achieving this backbone: the one we have described, and an analogous one in which the nitrogen atom is close to the fibre axis. Such chains can have either right-handed screws, or left-handed, and can be combined in various ways, either parallel or anti-parallel. So far as we can see, the structure we have described is the simplest member of the family. Stimulated by a suggestion by Dr. A. Elliott, we have found that it is possible to remove a chain from the structure and then replace it running in the opposite direction. All the hydrogen bonds can be remade and at first glance the modified structure looks very similar to the original, so that its X-ray diffraction pattern will also be similar. Only a very detailed study of the experimental results will enable one to say whether the simple structure is strictly correct, or only a first approximation.

Whatever the outcome of such studies, we feel that the present qualitative agreement with the experimental evidence makes it almost certain that the structure of polyglycine II is of this general type. This enables us to conclude that only polyglycine can form such a lattice—there is no room for side-chains in the lattice unless some of the hydrogen bonds are broken.

We see no special reason why a single polyglycine chain should take up this precise configuration; this is presumably dictated by the interaction between neighbouring chains, which imposes the exact three-fold screw axis. We note with interest that polyproline, the structure of which has recently been reported by Cowan and McGavin[4], and which is unable to form hydrogen bonds, takes up a similar backbone configuration.

As yet it has not been possible to obtain[1] a fibre diagram of polyglycine II. This is probably because any process used to produce orientation will tend to stretch the structure, and it will then pass over to the more extended β-form of polyglycine I.

We should like to thank Dr. Bamford and his colleagues both for showing us their X-ray photographs and for helpful discussion. [Sept. 20

Table 1. Atomic co-ordinates, in a hexagonal frame, in angstrom units

| | $C_\alpha$ | O | O | N |
|---|---|---|---|---|
| x | − 0·05 | − 1·25 | − 0·1 | + 1·1 |
| y | − 1·2 | − 0·15 | − 0·3 | + 0·3 |
| z | 0·0 | + 1·3 | + 1·15 | + 1·95 |

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Occurrence of Attenuated Strains of Myxoma Virus in Europe

Several slightly attenuated strains of myxoma virus have been recovered from the field in Australia[1]; indeed, it is now rather uncommon to recover strains having the same high virulence as the material used for initiating the epizootics, and for the subsequent inoculation campaigns. The position in Europe, however, appears to have been different. European investigators[2] have been unanimous in their observations that there has been no fall in the virulence of the virus since it was introduced into wild rabbits in France in June 1952. Experiments made in Canberra with several European field-strains have confirmed this view. Very recently, however, we have obtained evidence of attenuation of the virus in the field in Europe.

Our standard technique for the comparison of the virulence of myxoma strains consists of the intradermal inoculation of five 4-months-old laboratory rabbits with 0·1 ml. of saline containing about five rabbit-infectious doses of virus. Observations on larger groups of rabbits have shown that the survival times of the inoculated rabbits are correlated with the mortality-rates and serve as the best single criterion of virulence with these small groups of animals.

The survival times of groups of rabbits inoculated with various strains of virus obtained from naturally infected cases in Europe are shown in Table 1. The 'Lausanne' strain, kindly provided by Dr. G. Bouvier, is only a few domestic rabbit passages from the South American *Sylvilagus* rabbits, and was the strain used to initiate the epizootics in Europe (Bouvier, personal communication, 1954). The 'standard laboratory strain' is the virus used to initiate the Australian epizootics; 'neuromyxoma'[3] is the least virulent of all myxoma strains, and *KM*13 is a slightly attenuated Australian field-strain, which has been extensively studied in our laboratory and represents the level of virulence most commonly encountered in the field in Australia.

The uniform high virulence of strains from Europe up to the 'Loiret April 1955' strain is apparent, and the clinical picture of the infection caused by all these strains has been quite uniform, and distinctly different from that associated with infections by the Australian strains. Strain 'Loiret April 1955' was sent to us by Dr. H. Jacotot, of the Pasteur Institute Paris, and was obtained on April 7, 1955, from tumour material removed from a tame rabbit suffering from myxomatosis contracted naturally. It produces the large tumours characteristic of the European strains, although they develop more slowly. The strain 'Nottingham April 1955', supplied to us by Mr. J. R. Hudson, of the Veterinary Laboratory, Weybridge, England, is also attenuated. Of five rabbits inoculated with small doses of the first laboratory-rabbit passage material from a recovering wild rabbit, two died with symptoms and signs characteristic of the fully virulent European strains, one became severely ill and died thirty-four days after inoculation, and the other two suffered a relatively mild disease, although each developed large primary and secondary tumours. Experiments still in their preliminary stages suggest that limit dilution subinoculations of material taken from the severely affected rabbits produce the classical severe European type of disease, whereas similar passage of material taken from the mild cases usually produces the mild form of the disease.

Estimation of the skin titre of secondary nodules on four rabbits infected with the 'Loiret April 1955' strain ranged from $10^{8}$ to $10^{8\cdot7}$ rabbit-infectious doses per gm. of epidermal tissue twenty-five days after infection, and $10^{7}$ in one rabbit tested thirty-eight days after infection. These concentrations exceed those found in rabbits infected with Australian attenuated strains at similar intervals after infection. Similar titrations on the three rabbits which survived infection with the 'Nottingham April 1955' strain gave figures of $10^{5\cdot3}$, $10^{5\cdot6}$ and $10^{5\cdot8}$ rabbit-infectious doses per gm. on the twenty-sixth day after inoculation, which is rather lower than that usually found with Australian attenuated strains at the same stage of the disease. Consideration of the factors affecting transmission of myxomatosis (Fenner, Day and Woodroofe, in preparation) suggests that attenuated

Table 1. Survival Times of Laboratory Rabbits inoculated Intradermally with about Five Rabbit-infectious Doses of Myxoma Virus Strains recovered from Naturally Occurring Cases of Myxomatosis in Europe, and Certain Other Strains

| Locality of origin | Date of isolation | No. of passages in laboratory rabbits | Survival time (days) | Mean survival time (days) |
|---|---|---|---|---|
| Lausanne | June 1952* | 4 | 11, 12, 12, 13, 15, 16 | 13·2 |
| Edenbridge (U.K.) | October 1953 | 1 | 10, 11, 11, 12, 13 | 11·4 |
| Périgeux (Fr.) | November 1953 | 4 | 12, 12, 12, 14, 15 | 13·0 |
| La Motte Beuvron (Fr.) | November 1953 | 4 | 11, 12, 12, 12, 12 | 11·8 |
| Cornwall (U.K.) | April 1954 | several | 12, 12, 12, 13, 14 | 12·6 |
| Vienne (Fr.) | April 1954 | 1 | 11, 12, 13, 14, 16 | 13·2 |
| Indre (Fr.) | April 1954 | 1 | 11, 11, 12, 12, 12 | 11·6 |
| Eure (Fr.) | April 1954 | 1 | 12, 12, 13, 13, 14 | 12·8 |
| Seine Inférieure (Fr.) | April 1954 | 1 | 12, 12, 13, 13, 14 | 12·8 |
| Loiret (Fr.) | April 1954 | 1 | 11, 11, 12, 12, 14 | 12·0 |
| Hall (U.K.) | December 1954 | 0 | 12, 12, 13, 13, 13 | 12·6 |
| Belfast (U.K.) | January 1955 | 1 | 11, 11, 11, 11, 14 | 11·6 |
| Gaseley (U.K.) | March 1955 | 1 | 10, 10, 12, 12, 13 | 11·4 |
| Loiret (Fr.) | April 1955 | 1 | 20, 22, 27, 27, 39 | 27·0 |
| Nottingham (U.K.) | April 1955 | 1 | 11, 13, 34, *S*, *S* | 35·6 |
| Standard laboratory strain | October 1950* | numerous | 8–15† | 11·1 |
| *KM*13 (Aust.) | December 1953 | 1 | 18, 18, 22, 23, 37 | 23·6 |
| Neuromyxoma (laboratory) | 1937 | several | *S*, *S*, *S*, *S*, *S*, *S*, *S*, *S*, *S*, *S* | 60·0 |

* Dates refer to initiation of epizootics in France and Australia with these two strains.

† Forty rabbits.

*S* = rabbit survived; survivors allotted a survival-time of 60 days.

strains such as 'Loiret April 1955' will rapidly replace the virulent European strains wherever direct competition between them occurs.

We are indebted to colleagues in Europe for sending us strains of myxoma virus, especially Drs. P. Lépine and H. Jacotot, of the Pasteur Institute, Paris; Mr. . R. Hudson, of the Veterinary Laboratory, Weybridge; and Dr. G. Bouvier, Institut Galli-Valerio, ausanne.

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## Myxoma Virus in Britain

IT is well known that myxomatosis has caused a high mortality among wild rabbit populations in most parts of England and Wales, and in those parts of Scotland and Ireland to which the disease has spread. Where it has been possible to make accurate observations, a mortality-rate of about 99 per cent was found. A similar death-rate was usual in Australia during the first year (1950–51) of their epizootic, but attenuated strains were found from 1953 onwards[1].

Ever since October 1953, when myxomatosis was first notified in Britain, rabbits surviving in areas through which the disease has passed have been examined for evidence of recovery. Most of these rabbits have been found not to have been exposed to infection in the wild; but a small number have been rabbits recovered from the disease, as indicated by the presence of immune bodies in their serum. From some rabbits which were apparently recovering, strains of virus have been isolated and these have proved to be of normal virulence.

Only in one part of the country, the Sherwood Forest area of Nottinghamshire, have attenuated strains of virus been found in rabbits. In this area estate workers and the Ministry's field-officers noted from April 1955 onwards the presence of an unusual number of individuals that appeared to be recovering. One of the strains isolated at Weybridge is mentioned in the preceding communication from Prof. Frank Fenner and Mr. I. D. Marshall, and a brief note on them has been published elsewhere[2]. Myxomatosis first appeared in the Sherwood Forest area in September 1954 and, in spite of a heavy concentration of rabbits and the presence of fleas, appears to have moved and to be moving very slowly. The mortality has been erratic, on some estates less than half the rabbits being killed by the disease. Serum samples from sixty-four rabbits have been examined, and in thirty-two, immune bodies have been present. Four strains of virus have been isolated which, when inoculated into domestic rabbits, produce a 'nodular' type of infection. Œdema is less diffuse than in typical cases, but the small nodules may cover extensive areas and appear anywhere on the body, although usually more numerous on the face and ears. During the earlier stages, the œdematous nodules contain typical, fully virulent virus, but later they shrink and the skin surface dries to form a scab; and although the nodules and scabs may contain a high titre of virus, it is of reduced virulence.

Recent observations have shown that myxomatosis is again moving across the area and three recent strains of virus, although not of full virulence, are more virulent than those obtained some months ago. Immune recovered rabbits will not be killed by this second wave, but it is likely that the susceptibles will again be reduced in numbers, and the situation is being watched closely.

Fully virulent virus is producing a normal, heavy mortality only a few miles to the south.

Conditions in Britain are so different from those in Australia that conclusions based on the behaviour of myxomatosis in one country will not necessarily be applicable to the other. Mosquitoes are the principal vectors of myxomatosis in Australia, and the initial spread of the disease was more explosive than in Britain, where natural spread has been by the flea and has therefore been comparatively slow[3].

It is emphasized that the attenuation of the myxoma virus in part of Sherwood Forest is an isolated case, affects only a relatively small area, and calls for an increase rather than a slackening of efforts to destroy surviving rabbits.

We are grateful to Prof. Fenner for sending us a copy of his communication before publication and for this opportunity to describe briefly the background of the strain to which he refers.

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## Identification of Pseudocholinesterase in the Tissues of Ruminants

MOST animal tissues and body fluids contain two types of cholinesterase which have been designated as true cholinesterase and pseudocholinesterase in accordance with their physiological function[1]. Both enzymes are inhibited to about the same extent by low concentrations of eserine as well as of prostigmine. In order to measure the activities of the two enzymes separately in a mixture of both, Mendel *et al.*[2] used what they considered to be 'specific substrates': acetyl-β-methylcholine for the true cholinesterase and benzoylcholine for the pseudocholinesterase. Since the sera and tissues of ruminants do not exhibit appreciable eserine-sensitive activity towards benzoylcholine, it had been assumed that they do not possess any pseudocholinesterase[3]. However, it has recently been found that the spleen of the ox[4] and other tissues of ruminants[5] contain enzymes capable of hydrolysing butyrylcholine, an ester which is hydrolysed rapidly by the pseudocholinesterases of other species but not by the true cholinesterases[6].

A study of the characteristics of the cholinesterases in ox spleen has shown that approximately 90 per

Table 1. DIFFERENTIATION OF THE CHOLINESTERASES IN A SUSPENSION OF OX SPLEEN BY THE USE OF SELECTIVE INHIBITORS

| Enzyme | Substrate | $p(I\,50)$ values (– log of the molar concentration of inhibitor required to produce 50 per cent inhibition) with the following compounds | | |
|---|---|---|---|---|
| | | Diisopropyl phosphonofluoridate (ref. 9) | N,N′-Diisopropyl phosphorodiamido fluoridate (isopestox; mipafox) (ref. 10) | Dimethyl carbamate of 2-hydroxy-5-phenylbenzyl trimethyl ammonium bromide (*Ro*-2-0683) (ref. 11) |
| True cholinesterase | Acetyl-$\beta$-methyl choline | 6·5 | 4·7 | 7·0 |
| Pseudocholinesterase | Butyrylcholine | 8·5 | 7·7 | 8·0 |
| Eserine-resistant esterase | Butyrylcholine | 8·0 | <4·0 | <4·0 |

cent of the activity towards butyrylcholine (0·03 *M*) is due to a pseudocholinesterase, and the remaining 10 per cent to one of the unidentified eserine-resistant enzymes similar to those found in other species[7,8]. Approximately 45 per cent of the total activity towards acetylcholine (0·03 *M*) is due to a true cholinesterase and the remainder to a pseudocholinesterase. The activity of the latter enzyme reaches a maximum at high concentrations of acetyl- and butyrylcholine, the Michaelis constant ($K_s$) with butyrylcholine being $10^{-3}$ *M*. Table 1 indicates the concentrations of three selective pseudocholinesterase inhibitors required to produce 50 per cent inhibition of each of the three enzymes mentioned above; these results are very similar to those obtained under the same experimental conditions with the pseudocholinesterases, true cholinesterases and eserine-resistant esterases of other species[7-11]. The enzyme responsible for the major portion of the hydrolysis of butyrylcholine by ox spleen can therefore be classified as a pseudocholinesterase which does not hydrolyse benzoylcholine at an appreciable rate.

In this connexion, it might be noted that the relative activity of the pseudocholinesterases of other species towards benzoylcholine varies considerably and is very low, for example, in the case of the pseudocholinesterases from mouse and chicken[8]. Although benzoylcholine has been very useful as a specific substrate for the identification and measurement of pseudocholinesterase activity in most species, it is evident that the use of benzoylcholine for this purpose has led to incorrect conclusions[4] concerning the occurrence of pseudocholinesterase in the tissues of ruminants. These results, together with those of recent investigations[8,12], which show that butyrylcholine is hydrolysed much more rapidly than benzoylcholine by the pseudocholinesterases of many species, make it advisable to measure pseudocholinesterase activity with butyrylcholine as first advocated by Cohen *et al.*[6].

For identification of cholinesterases, however, it seems safer not to rely on the use of 'specific' substrates. None of these substrates is in fact specifically hydrolysed by one esterase only; acetyl-β-methylcholine is hydrolysed by the pseudocholinesterases of avian species[8,12,13], and both benzoyl- and butyrylcholine are hydrolysed by eserine-resistant esterases in certain cases[3,7,8]. Because of such exceptions the best method for identification of the cholinesterases appears to be the use of selective cholinesterase inhibitors in combination with the substrates acetylcholine, butyrylcholine and acetyl-β-methylcholine[8,12,13]. Of the three selective inhibitors tested in this investigation (Table 1), only two are generally applicable, since diisopropyl phosphonofluoridate also inhibits various eserine-resistant esterases[7,8].

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## Site of Virus-like Particles in Rous Fowl Sarcoma Cells

A SIMPLE and reliable technique has been evolved for preparing freshly collected ascites tumour cells for electron microscopy[1]. It makes use of the fact that when such cells are incubated under appropriate conditions and are brought into contact with 'Formvar'-coated slides, they change shape within a few minutes of gaining a grip on the 'Formvar'. The

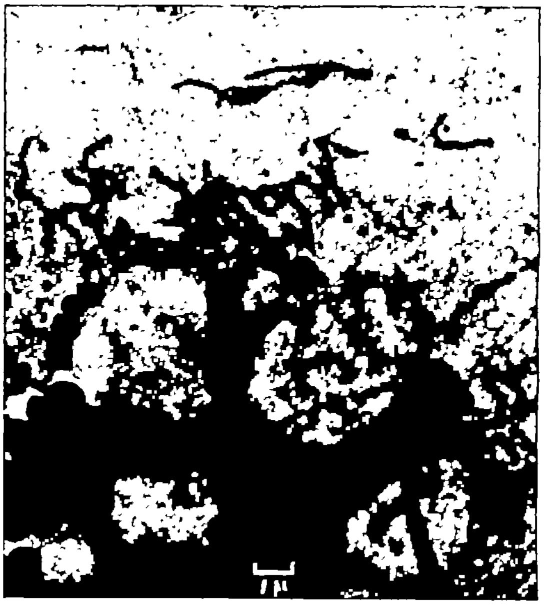

Fig. 1. Part of a thinly spread Rous ascites tumour cell. Filamentous mitochondria are scattered in the cytoplasm, which also contains the endoplasmic reticulum and osmiophilic lipoid bodies. Numerous dense virus-like particles are present in one of the vacuoles in the field. Fixation over osmium vapour was started when the cell had been *in vitro* for 17 min. and was continued for 21 hr. Electron micrograph, × 5,000

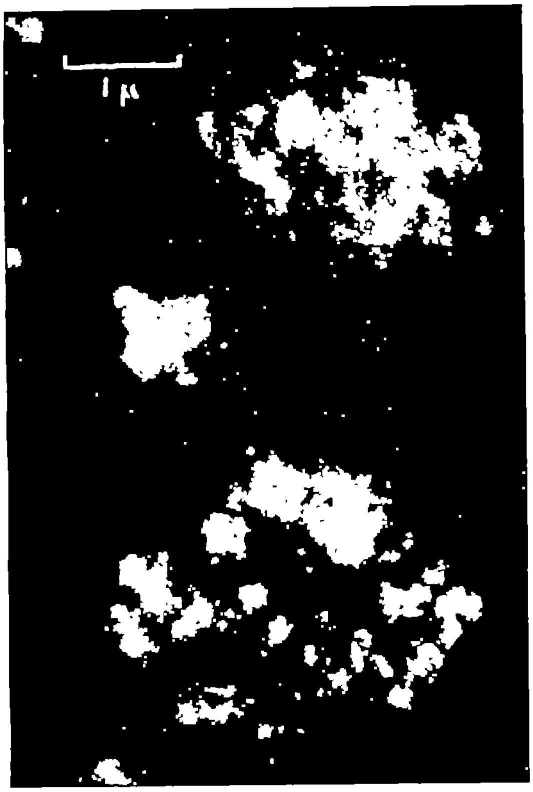

Fig. 2. Two vacuoles from another Rous ascites cell prepared as that of Fig 1, and showing the virus-like particles at higher magnification. Electron micrograph, × 15,000

change is from the round form of the free dispersed single cells to a spindle form, and an early stage in the transformation consists of the cells spreading widely and becoming extremely thin. Ascites tumour cells spread thinly in this way are very suitable for electron microscopy ; they can be fixed over osmium vapour and transferred easily to electron microscope specimen grids with samples of the 'Formvar' to which they adhere[2].

This method avoids the labour and uncertainty of the tissue culture technique for preparing cells for electron microscopy[3], allows the cells to be prepared in large numbers and makes it unnecessary to keep them for many hours in an unnatural *in vitro* environment. It has been applied to the single dispersed tumour cells of an ascites form of the Rous No. 1 fowl sarcoma[4], in which all, or at the worst almost all, the cells flatten out under the conditions used. Thus, preparations made in this way avoid the problems of sampling inherent in the examination of ultra-thin sections of Rous sarcoma material.

Some 12,000 well-preserved Rous ascites cells from seven different tumours have been examined in the electron microscope. In some of the cells from four of these tumours, virus-like particles slightly less than 0·1μ in diameter have been observed ; in the other three tumours, no cells with particles were found, although about two thousand cells were examined from each. When cells with particles have been present, their incidence has varied from tumour to tumour, ranging from less than 1 in 2,000 cells to 1 in 50 cells ; it has, however, been constant for all the preparations made from any one tumour, thus arguing against a chance artefact being responsible for the appearances in question. The particles have always been found grouped together in one or more of the vacuoles common in this type of cell (Figs. 1 and 2) and are readily seen by phase-contrast microscopy when the cells are alive. No particles have been observed free in the cytoplasm of the cells of the present series, although cytoplasmic structure is well preserved by the technique used (Fig. 1).

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## Role of 5-Hydroxytryptamine in Mental Diseases and its Antagonism to Lysergic Acid Derivatives

The possibility that 5-hydroxytryptamine plays a part in abnormal mental processes has been discussed by Gaddum[1] and by Woolley and Shaw[2]. The hypothesis is based on the findings that this substance is a natural constituent of nervous tissue, particularly of the brain[3], and that certain of its actions are antagonized by lysergic acid diethylamide[4], a drug which on oral application and in doses of only 0·5–1·0 μgm./kgm. produces pronounced psychic disturbances in normal human beings[5]. According to this hypothesis, the effects of lysergic acid diethylamide result from its antagonistic effect on the 5-hydroxytryptamine in the brain.

In the course of screening derivatives of lysergic acid diethylamide for 5-hydroxytryptamine-blocking effects, we have found in 2-brom-*d*-lysergic acid diethylamide, coded *BOL* 148, a compound which, like lysergic acid diethylamide, strongly antagonizes certain effects of 5-hydroxytryptamine, but unlike lysergic acid diethylamide does not produce abnormal psychic disturbances. The introduction of one bromine atom into the molecule of lysergic acid diethylamide thus completely alters its activity ; it loses the characteristic property of producing psychic disturbances in man but retains the strong anti-5-hydroxytryptamine action.

When comparing the central and peripheral effects of lysergic acid diethylamide with those of *BOL* 148, pronounced differences were found[6]. In normal and waltzing mice, lysergic acid diethylamide causes excitation, whereas *BOL* 148 has a sedative effect. In cats, small doses of the former cause a fall in arterial blood pressure and bradycardia, whereas the latter, tested in doses up to 1 mgm./kgm., was practically inactive. Again, the former has a strong stimulating effect on the rabbit uterus *in situ*, whereas the latter is practically inactive. We have also tested *BOL* 148 on ourselves and on some of our laboratory staff. It never produced signs of mental or psychic disturbances such as we regularly observed after lysergic acid diethylamide, even when used in doses twenty times as great. There was only a certain sedative action, consisting in a feeling of general fatigue and sometimes slight nausea.

In spite of the fact that the pharmacological effects of *BOL* 148 differ so completely from those of lysergic acid diethylamide in animals as well as in humans, it was found to share with the latter the strong anti-5-hydroxytryptamine action. Erspamer[7] had shown that lysergic acid diethylamide is a strong antagonist to 5-hydroxytryptamine on the isolated rat uterus. On this preparation and on the isolated perfused kidney of the rat, *BOL* 148 was found to be an even stronger antagonist, being about one and a half times as active. In other tests *BOL* 148 was found to have approximately the same anti-5-hydroxytryptamine action as lysergic acid diethylamide, for example, in antagonizing the effects of intra-aortic injections of 5-hydroxytryptamine on the arterial blood pressure and the renal and mesenteric blood flow of the cat, in blocking the bronchoconstrictor effect of 5-hydroxytryptamine and in antagonizing its potentiating effect on barbiturates. The anti-5-hydroxytryptamine effect of *BOL* 148 is highly specific; in doses which fully antagonized the action of 5-hydroxytryptamine, *BOL* 148 showed no signs of an antihistamine, antiadrenaline or anti-acetylcholine effect.

As the hypothesis of the cerebral functions of 5-hydroxytryptamine is based to a great extent on the fact that lysergic acid diethylamide is a strong antagonist of 5-hydroxytryptamine, the present finding that *BOL* 148 is as active as lysergic acid diethylamide in antagonizing 5-hydroxytryptamine but produces none of the mental disturbances makes it necessary to reconsider this hypothesis. It cannot be argued that *BOL* 148 lacks cerebral actions because it does not penetrate into the brain tissue; the sedative action it produces is a central effect. In addition, after an injection, *BOL* 148 could be detected in the same indirect way as lysergic acid diethylamide in extracts of the brain, when tested for anti-5-hydroxytryptamine activity. Brain extracts of mice previously injected with either *BOL* 148 or lysergic acid diethylamide exerted anti-5-hydroxytryptamine activity[8].

Our results with *BOL* 148 thus make it difficult to correlate the psychic effects of lysergic acid diethylamide with its anti-5-hydroxytryptamine property. At present, we are not justified in assuming a causal relationship between these two properties of lysergic acid diethylamide, although it may eventually be found that the 5-hydroxytryptamine in the brain is involved in the central actions of lysergic acid diethylamide. The mere fact of a pharmacological antagonism between lysergic acid diethylamide and 5-hydroxytryptamine, however, no longer provides evidence for the hypothesis that inhibition of the latter in the brain is the cause of the mental disturbances.

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## Transfer of Proteins from the Yolk to the Chick Embryo

THE transfer of antibodies from the mother to the fœtus in certain mammals, and from the hen to the egg yolk and thence to the embryo in birds, is wel established. Whether proteins other than antibodies are thus transferred is still open to question. Despite our lack of knowledge on this topic, it is generally thought, as Buxton[1] recently pointed out, that proteins pass from the blood or tissues of the hen as hydrolytic products which are reassembled into proteins within the ovum. Because of the proteolytic activity of the yolk sac and its contents, a similar mechanism is supposed to account for the passage of protein from the yolk into the circulation of the embryo.

We found recently[2] that, after intravenous injection into the hen, bovine γ-globulin and crystalline albumin, and whole lobster and rat sera are readily detected in the yolk by serological means. Further study of the bovine serum fractions in the yolk showed that they retained their respective electrophoretic mobilities on filter paper and could be displaced like the original proteins by ultracentrifugation. The bovine proteins deposited in the yolk do not interfere with development, since we have reared a number of the chicks to maturity and normal reproduction.

The experiments have now been extended to the passage of proteins from the yolk sac into the embryo. 0·3 or 1·0 ml. of 5 per cent solutions of Armour's bovine γ-globulin and crystalline serum albumin were injected into the yolk sacs of chick embryos varying in age from three to nineteen incubation days. Embryos older than six days were bled from the vitelline or allantoic arteries after various intervals of time; younger embryos were extracted *in toto* with 0·9 per cent saline. Rabbit antisera previously shown not to react in precipitin tests with rat, human and embryonic and adult chicken sera were used to detect bovine protein activity in the embryonic sera and body extracts. Fig. 1 shows the results obtained with γ-globulin. Fewer experiments have been done with albumin, but positive tests at consistently lower titres have been obtained.

Bovine γ-globulin was not detectable in sera or extracts prior to eight days of incubation. In the period between ten and fifteen days incubation, both

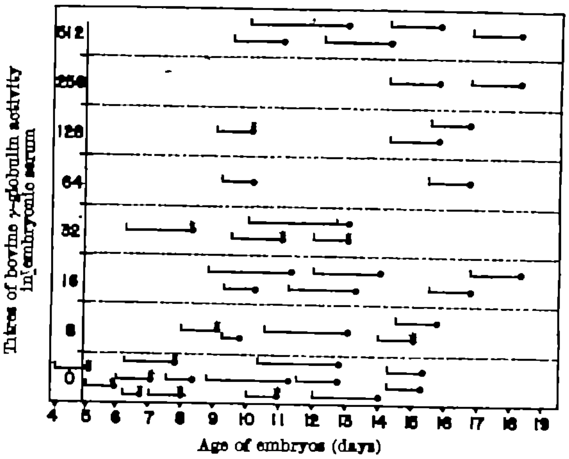

Fig. 1. Short vertical lines indicate when bovine γ-globulin was injected into the yolk sac. Black circles show when embryos were bled or extracted. * indicates pools of two or more embryos

positive and negative results were common. We have reason to believe that negative tests are obtained when the injected protein solution flows to regions of the yolk sac where it is not in contact with the yolk sac membrane. Chicks at sixteen–twenty days of incubation invariably showed bovine protein activity in their serum. These results agree rather closely with those on the uptake of antibody from he yolk. According to Brandly *et al.*[3], Dzierzgowski 1901) found that diphtheria antitoxin may pass from the yolk into the embryo "during the first 10 days" of incubation. Antibody which neutralizes the virus of infectious bronchitis of the chicken first appears in the serum of ten-day embryos[4]. Non-agglutinating antibodies for *Salmonella pullorum* were found on the eleventh day (younger embryos were not tested), but agglutinating antibodies were not detectable until the fifteenth–seventeenth days[5]. Neutralizing antibodies for Newcastle disease virus were detectable in the serum between twelve and fifteen days of incubation[3].

Brambell *et al.*[6] injected antisera produced in the pigeon and in a number of mammals into the yolk sacs of chicks at the sixth and eighth days of incubation and were able to detect only the pigeon antibodies in the circulation. It is not stated explicitly when the chicks were bled, but we infer this was done after hatching. If this is true, their results do not necessarily conflict with ours, since the mammalian antibodies may be cleared from the serum within eight–ten days, as are heterologous antibodies in the rabbit[7].

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## Reaction of Alloxan with Ascorbic Acid

It has been reported from this laboratory[1] that, although acetoacetate alone causes an increase in the susceptibility to alloxan diabetes in rabbits, the product prepared by condensing acetoacetate with glucose (namely, 2-tetrahydroxy butyl, 5-methyl, 4-carboxy furan), in the form of its sodium salt, when injected intraperitoneally or intravenously in rats and rabbits in the proportion of 1·5 : 1 with alloxan or even less, can prevent alloxan diabetes[2]. It has also recently been shown by Nath and Bhattathiry (unpublished results) that 1 : 2 dienol glucose, which is liberated from this condensation product on hydrolysis, reacts with alloxan.

West and Rinehart[3] observed that ascorbic acid, another endiol compound, reacts with ninhydrin to give rise to hydrindantin and dehydroascorbic acid, which then loses a molecule of carbon dioxide, presumably through decarboxylation. Since alloxan is structurally similar to ninhydrin and because alloxan reacts with the endiol glucose, attempts were therefore made to see if a similar reaction could also be detected between ascorbic acid and alloxan, and if so what were the products of such reaction.

Vitamin C and alloxan in molecular proportions of 1 : 1 and 1 : 2 in phosphate buffer *p*H 7·2 were allowed to react at 30°, the mixture being shaken constantly. Blank experiments with vitamin C alone were conducted under identical conditions. The vitamin C content of the mixture as well as in aliquot parts was determined from time to time by the modified titrimetric method of Bessey[4].

Dehydroascorbic acid formed during the reaction was also determined according to the method of Roe and Keuther[5], and whether a portion of it was lost due to its further transformation to something else was also calculated after the reaction had gone on for 30 min. The results are shown in Table 1.

It was observed by West and Rinehart[3] that dehydroascorbic acid formed during the reaction of ascorbic acid with ninhydrin undergoes decarboxylation, presumably through the hydrolysis of its lactone bridge and subsequent loss of carbon dioxide and production of *l*-xylosone. Attempts were therefore made to find out if the loss of dehydroascorbic acid in this reaction can also be accounted for through its further transformation as above and the liberation of carbon dioxide.

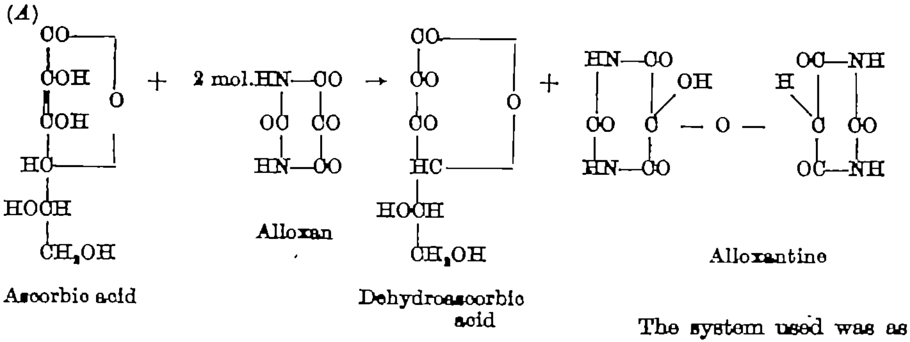
The gas evolved in the reaction between ascorbic acid and alloxan was also detected as carbon dioxide, which was estimated quantitatively by using 100 times the quantity of the reacting substances used in the above experiment. Carbon dioxide was estimated by absorption in a standard solution of potassium hydroxide by the usual method. In the first experiment, when 88 mgm. of ascorbic acid was allowed to react with an equimolar quantity of alloxan (namely, 71 mgm.), dehydroascorbic acid lost was found to be 11·6 mgm. and carbon dioxide evolved 2·57 mgm.; and in the second experiment, when the molar proportion of the constituents was 1 : 2, the amount of dehydroascorbic acid lost was 22·5 mgm. and carbon dioxide evolved 4·60 mgm.

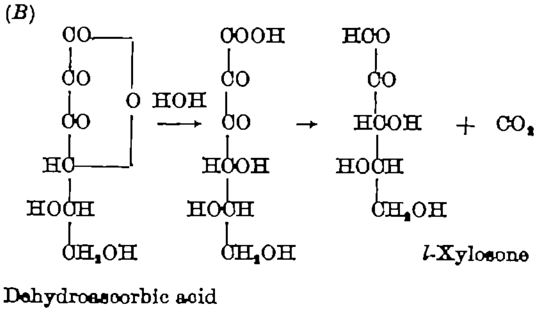
22·5 mgm. of dehydroascorbic acid on decarboxylation should yield 5·5 mgm. of carbon dioxide, which

Table 1

| No. of reactions | Contents of reaction mixture (10 c.c.) | Ascorbic acid (mgm./10 c.c.) after : | | | | Total ascorbic acid (including dehydroascorbic acid calculated as ascorbic acid) after 30 min. (mgm./10 c.c.) | Dehydroascorbic acid lost during 30 min. (mgm./10 c.c.) |
|---|---|---|---|---|---|---|---|
| | | 0 | 2 | 15 | 30 min. | | |
| 8 | Ascorbic acid, 0·88 mgm., and alloxan, 0·71 mgm. (1 : 1 mol. prop.) | 0·88 | 0·53±0·01 | 0·35±0 | 0·0 | 0·76±0·01 | 0·12 |
| 8 | Ascorbic acid, 0·88 mgm., and alloxan, 1·42 mgm. (1 : 2 mol. prop.) | 0·88 | 0·44±0·09 | 0·20±0 | 0·0 | 0·68±0·01 | 0·20 |
| 8 | Ascorbic acid only, 0·88 mgm. | 0·88 | 0·76±0·09 | 0·68±0·01 | 0·54±0·12 | 0·66±0·01 | 0·02 |

is only 0·9 mgm. higher than the observed value. It is also evident from the results that when one molecule of ascorbic acid is allowed to react with two molecules of alloxan, the loss of dehydroascorbic acid and liberation of carbon dioxide is almost double that when the molar proportion is 1 : 1, thus suggesting the possibility of one molecule of ascorbic acid combining with two molecules of alloxan, as with ninhydrin. The reaction can be represented as follows:





It is also interesting to note that although dehydroascorbic acid alone at $p$H 7·2 for 30 min. at 40° C. does not give any indication of further breakdown and liberation of carbon dioxide, it can do so during the course of this reaction.

Further work on the mechanism of this reaction is in progress.

It has been shown by Bailey *et al.*[6], Brückmann and Wertheimer[7] and others that alloxantin, unlike alloxanic acid, which is formed from the reaction of an endiol glucose with alloxan, is highly diabetogenic, thus accounting for the observation of Levey and Suter[8], who did not find any prevention of alloxan diabetes by ascorbic acid. This gives additional support for the nature of the reaction indicated above.

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May 14.

## Effect of Thioctic Acid on Glucose Oxidation by Liver Slices

STUDIES on the metabolism of $^{14}$C-glucose by live slices usually show a low incorporation of the lab into the expired carbon dioxide. Other tissues, whe studied *in vitro*, show a glucose respiratory quotien in the vicinity of 0·8, whereas when glucose is fe to intact animals it approaches the theoretical.

In the course of studies on the effect of insuli on the metabolism c liver slices, the effect c several coenzymes on th incorporation of labe from $^{14}$C-glucose, $^{14}$C-2 pyruvate and $^{14}$C-1-acetate into expired carbo dioxide has been investigated. Of the coenzyme studied, only thiocti acid has so far bee shown to have any influence on the oxidation of these substrates

The system used was as follows. All incubation were carried out for 1 hr. in Warburg vessels at 37° C. shaking-rate 96, amplitude 4 cm. Carbon dioxid was collected on a filter-paper spill soaked in potassium hydroxide in the centre well, and the reactio stopped by 0·3 ml. of 0·3 $N$ hydrochloric acid tippe from a side-arm, followed by 30 min. further shakin to absorb the released carbon dioxide. The syster consisted of: liver slices (paired throughout), tota dry weight 45–50 mgm.; Krebs–Ringer phosphat buffer $p$H 7·4; gas phase, oxygen 2 ml.; glucose 2 mgm., or pyruvate, 2 mgm., or acetate, 2 mgm. 0·04 µc. of the corresponding isotope was added t each vessel. Where required, 40 µgm. thioctic aci was added.

After incubation, the filter papers were remove and the potassium carbonate formed eluted by washing each four times in carbon dioxide-free distille water. The centre well was then washed out, th washings combined, carrier potassium carbonat (1 ml. of 0·01 $M$) added and the carbonate wa precipitated by the addition of excess bariur chloride. The precipitate was washed twice wit carbon dioxide-free distilled water, and then twic with acetone, plated, dried and counted usin a windowless tube. The results are shown in Table 1.

From these results it is seen that the presence of thioctic acid increased the incorporation of label from $^{14}$C-glucose, had little effect on $^{14}$C-2-pyruvate and decreased the incorporation from $^{14}$C-1-acetate, presumably by dilution with acetyl coenzyme A

Table 1. TOTAL COUNTS/MIN./MGM. DRIED-WEIGHT LIVER

| Exp. | $^{14}$C-Glucose Control | $^{14}$C-Glucose Plus thioctic acid | $^{14}$C-2-Pyruvate Control | $^{14}$C-2-Pyruvate Plus thioctic acid | $^{14}$C-1-Acetate Control | $^{14}$C-1-Acetate Plus thioctic acid |
|---|---|---|---|---|---|---|
| 1 | 10·4 | 23·8 | 133·2 | 142·8 | 118 1 | 94·8 |
| 2 | 21·3 | 26·2 | 404 | 419 | 161 | 116·5 |
| 3 | 23·5 | 34·6 | 591 | 552 | 261 | 166 |
| 4 | 26·2 | 34·1 | 557 | 564 | 238 | 171 |
| 5 | 19·7 | 23·6 | | | | |
| 6 | 20·8 | 24·7 | | | | |
| 7 | 26·8 | 31·6 | | | | |
| 8 | 23 2 | 31·7 | | | | |

For glucose $n = 7$, $T = 6·02$; hence $p > 0·01$; acetate $n = 3$, $T = 4·12$; hence $p < 0·05$.

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rom non-labelled sources. It is thus concluded that in liver-slice experiments more favourable conditions for glucose oxidation are produced by the addition of thioctic acid to the buffer and, conversely, in such xperiments there is normally some difficulty in the decarboxylation of pyruvic acid, although action of he coenzyme at another point in the metabolic pathway cannot be excluded.

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## Inhibition of Acyl Trypsins by Human Serum

THERE is in blood a relatively high concentration of a specific trypsin inhibitor, the nature and identity of which are not fully established. In the presence of salts, it seems to form a stable stoichiometric addition complex with the enzyme, which is practically undissociated and enzymatically inactive[1]. Similar complexes also prevail between the enzyme and a score of other natural inhibitors, whereby, in the case of ovomucoid, complex formation can be largely prevented by chemical modification of trypsin[2,3]. Thus it was recently shown that the trypsin–ovomucoid complex has a dissociation constant $K_1 = 5 \cdot 8 \times 10^{-9}$ *M*, whereas acetylated trypsin is inhibited to a much lesser degree, the dissociation constant being higher[3] by a factor of about $10^3$.

In view of the reported use of trypsin in the intravenous treatment of inflammations and embolisms[4,5], it appeared of interest to compare the resistance of various acylated trypsins[6] to the inhibition by human serum. Inhibition was determined by measuring the activity of a constant amount of crystalline native trypsin or its acylated derivatives (0·06 mgm. per total digestion volume of 7 ml., using casein as substrate) in the presence of increasing concentrations of serum. A few typical curves are presented in Fig. 1. In the case of trypsin, the activity decreases linearly with the increase of serum concentration up to about $3 \times 10^{-3}$ ml. of serum per ml. of digestion mixture. This is the behaviour expected when a stable and inactive addition complex is formed between the enzyme and the inhibitor contained in the serum. By extrapolation of the straight portion of the curve, the stoichiometric equivalence point between enzyme and inhibitor can be established, the dissociation constant of the addition complex being then calculated from the residual tryptic activity at that point. For trypsin, the calculated value is $K = 2 \cdot 2 \times 10^{-9}$ *M*. Acetyl trypsin, in contrast to its behaviour towards ovomucoid, is still strongly inhibited (dissociation constant $K = 5 \cdot 2 \times 10^{-9}$ *M*), but for the other derivatives the inhibition decreases in the order: propionyl trypsin ($K = 1 \cdot 5 \times 10^{-8}$ *M*), butyryl trypsin ($K = 1 \cdot 1 \times 10^{-7}$ *M*), itaconyl trypsin ($K = 1 \cdot 4 \times 10^{-7}$ *M*) and citraconyl trypsin ($K = 1 \cdot 5 \times 10^{-7}$ *M*). From Fig. 1 it can be seen that there is a good agreement between the experimental points and the curves calculated from the observed dissociation constants.

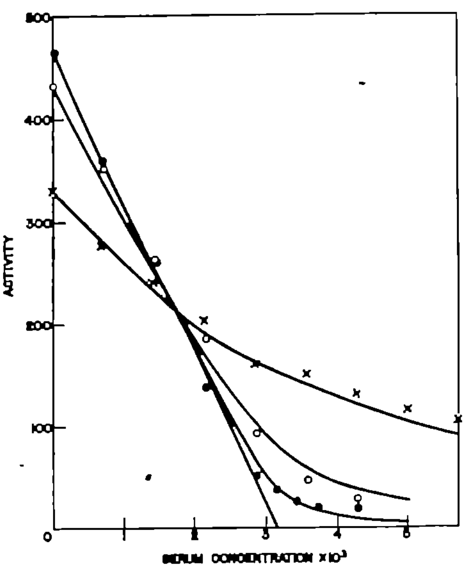

Fig. 1. Relative tryptic activities in presence of increasing concentrations of human serum. Enzyme: ●, trypsin; ○, propionyl trypsin; ×, citraconyl trypsin

The proteolytic activity of the acylated enzymes is slightly lower than that of the native enzyme, but is of the same order of magnitude. The actual decrease in activity depends on the nature of the acyl residue, as well as on the substrate with which it is measured[6]. The regular series of increasing dissociation constants of the enzyme-inhibitor complexes from acetyl- to citraconyl-trypsin follows clearly the increasing molecular volume of the acyl substituent. Thus it would appear that the increased resistance of acyl trypsins towards inhibition is not due to the blocking of the amino-groups, which were claimed to be essential for inhibition of ovomucoid[3], but can be more readily explained on the basis of steric hindrance. This steric hindrance may be of significance in explaining the mechanism of the inhibition of trypsin, as no effects of comparable magnitude ($10^3$) were observed in the action of acyl trypsins on various substrates[6].

Trypsin acts also on other components of blood. Thus its clinical use is being justified by its direct fibrinolytic activity as well as by its activation of the fibrinolytic system of the blood. Large concentrations of enzyme act also preventively, by the preferential digestion of fibrinogen, which has a high content of lysine and arginine residues, whereas the other globular proteins of the blood are relatively resistant to tryptic action, at least in the native state[4,5]. It is significant, however, that when trypsin is injected rapidly into the blood stream, it causes immediate death of experimental animals by giving rise to extensive local blood clotting[6,7]. Successful trypsin therapy seems to depend, therefore, to a great degree on a very slow rate of injection, maintaining at all times a delicate balance between the fibrinolytic and the blood-clotting activities of the enzyme. This is difficult to achieve, as large amounts of enzyme (up to 250 mgm. per rabbit were employed) are required to overcome the high concentration of serum inhibitor present. It is felt that the use of acylated trypsins, particularly the higher members of the series, would largely overcome this inconvenience, as they would maintain some of their enzymatic activity in the presence of an excess of inhibitor.

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# Characterization of a Second Pigment in Strawberries

The major pigment of the cultivated strawberry is pelargonidin-3-glucoside[1,2]. Studies reported in 1951 to the National Preservers Association showed that commercial varieties Marshall, Brightmore, Sovereign and Shasta contained a second anthocyanin in low concentration. We now present evidence that the pigment is cyanidin-3-glucoside.

The pigments were isolated by precipitation from *n*-butanol as their hydrochlorides[1]. Enrichment in the minor pigment was effected by adsorption on neutral aluminium oxide, using water as solvent. Complete separation was made on a cellulose column with a mixture of *n*-butanol and 2 *N* hydrochloric acid[3]. After concentration of the effluent under vacuum, the hydrochloride was precipitated, purified as the picrate and reconverted to the hydrochloride.

The aglucones of the pigment and of cyanidin-3-5-glucoside, from red roses, were prepared by hydrolysis with 5 *N* hydrochloric acid. These were chromatographed on paper, using butanol – 2 *N* hydrochloric acid[3]. The $R_F$ values were 0·64 and 0·64 respectively. The absorption spectrum of the aglucone was identical with that of cyanidin, in 0·001 *M* hydrochloric acid in ethanol.

The unknown anthocyanin was chromatographed together with chrysanthemin (cyanidin-3-glucoside). The observed $R_F$ values in a butanol/acetic acid/water solvent were 0·32 for both. $R_F$ values of cyanidin-3-glucoside in this solvent have been reported as 0·395 [2], 0·33 [3] and 0·30 [4]. The addition of sodium carbonate to the solution of the unknown pigment produced a blue colour, identical with that given by a crimson carnation extract[5]. A positive reaction with iron was also noted.

The unknown sugar was chromatographed with glucose and with galactose, and gave $R_F$ values in phenol/water and butanol/acetic acid/water identical with glucose. In a 2-day chromatogram with ethyl acetate/acetic acid/water[6], the unknown co-chromatographed with glucose and not with galactose. An osazone prepared from a paper eluate had the crystalline form of glucosazone.

The mono-glucosidic nature of the pigment was evident by its $R_F$ value, intermediate between cyanidin and cyanidin-3-5-diglucoside[3].

In all varieties tested, the evidence indicates the pigment is a mono-glycoside and the aglucone cyanidin. In the Shasta and Marshall varieties, the sugar moiety appears to be glucose.

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# 1:8-Dimethyldibenzothiophen in a Kuwait Mineral Oil Fraction

During examination of a fraction of a Kuwait (Middle East) mineral oil, I isolated, some time ago, a small amount of a colourless crystalline substance of melting point 152–153° which appeared, from its elementary analysis and ultra-violet absorption spectrum[1], to be a dimethyldibenzothiophen or its equivalent (found: C, 79·2; H, 6·3; S, 14·3; calc. for $C_{14}H_{12}S$: C, 79·2; H, 5·7; S, 15·1 per cent). $\lambda_{max.}$ 238, 257, 265, 273, 283, inflex. 303, 313, 327 mμ (log ε, 4·66, 4·09, 3·97, 3·83, 3·88, (2·16), 2·39, 2·52). The substance formed an unstable orange-yellow picrate of melting point 129–130° (found: N, 9·9; calc. for $C_{14}H_{12}S.C_6H_3O_7N_3$: N, 9·5 per cent) and a yellow *s*-trinitrobenzene complex of melting point 154–155° (found: N, 9·5; $C_{14}H_{12}S.C_6H_3O_6N_3$ requires N, 9·8 per cent), but could not be desulphurized with Raney nickel in boiling ethanol[2]. In this it resembled 1-methyldibenzothiophen, which Mr. J. R. Crowder in this laboratory was unable to desulphurize with Raney nickel in ethanol, although dibenzothiophen itself was converted to diphenyl in 50 per cent yield (compare Gilman and Esmay[3]). This suggested the presence of a substituent in a position flanking the sulphur atom, but with the very small amount of material available it was impracticable at the time to elucidate the structure of the compound completely. It has now been identified, by mixed melting point, as the then unknown 1:8-dimethyldibenzothiophen (m.p. 153–154°) which Kruber and Raeithel have recently isolated from a coal tar fraction[4]. These authors were likewise unable to desulphurize this compound, and also noted the formation of an unstable picrate of melting point 130–131°. I am grateful to Dr. Kruber for furnishing me with a specimen of the pure compound for mixed melting point determination. So far as I am aware, this is the first derivative of dibenzothiophen to be isolated from a mineral oil source.

The starting material for this investigation was a fraction, boiling range 330–350°, of a Kuwait crude oil. This had been obtained by distillation under reduced pressure and was extracted with furfural[5] at room temperature, and the aromatic concentrate so produced treated with picric acid in ethanol. The bright red picrate, after several crystallizations from hanol, was decomposed with sodium hydroxide and e resulting oil chromatographed on alumina. Elu- on with petroleum ether containing increasing roportions of benzene afforded fractions from which : 8-dimethyldibenzothiophen crystallized at − 70°. he crude material was purified by crystallization om ethanol and from *cyclo*hexane.

This work was supported by a grant from the ledical Research Council. I am indebted to Prof. . Morton, of the University of Birmingham, for pplying the oil fraction for this investigation, and Dr. J. W. Cook for his interest in its progress. icroanalyses were carried out by Mr. J. M. L. ameron and Miss M. Christie.

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## Nucleophilic Substitution in Vinylic Halides

NUCLEOPHILIC substitution of a halogen atom lirectly attached to a double bond, as in the vinyl nd phenyl halides, does not readily take place[1–3]. Nevertheless, cases of substitution in vinylic halides re recorded in the literature[4], and facile substitution as been reported for compounds containing electron-withdrawing substituents in the β-position with espect to the halogen[5]. An obvious analogy exists ith aromatic systems in which, as has been demonstrated by numerous experiments, nucleophilic substitution occurs readily only when electron-withdrawing groups are present at suitable positions in he ring.

In vinylic halides which can exist in geometrical someric forms, the steric course of substitution is f special interest since information about the geometry of the transition state can, in principle, be btained. We have examined the products and inetics of substitution in the ethyl-β-chlorocrotonates, the configurations of which are known[6].

Both forms readily underwent bimolecular reaction, n ethanol solvent, with thioethoxide, thiophenoxide, thoxide and phenoxide ions. An examination of roducts showed that with ethoxide ions or phenoxide ons the same product was obtained from both chloroesters. With thioethoxide ions, however, two products were obtained, their relative amounts depending on which chloroester was used. These two products, which we will call the higher boiling-point (and lower boiling-point) isomers, had very similar ultra-violet spectra and both gave acetoacetic ester on mild treatment with acid. All the evidence indicated that they were the isomeric ethyl β-thioethoxycrotonates. Essentially similar results were obtained with thiophenoxide ions as nucleophilic reagent. It was found that with appropriate precautions and under conditions in which isomerization of factors and products was shown not to occur, the products of reaction could be isolated in about 90 per cent yield. The results are illustrated in Table 1; kinetic data refer to solutions of concentrations approximately $M/20$.

A comparison of the infra-red spectra of the thioethoxy-esters with those of the chloro-esters showed that, although no unequivocal assignment of the bands could be made, the spectra in the range 600–1,700 cm.$^{-1}$ were best interpreted on the assumption that the lower boiling-point and higher boiling-point thioethoxy-esters had the *cis* and *trans* configurations respectively. Examination of the products obtained by treatment of the thioethoxy-esters with Raney nickel led to the same conclusion. From the lower boiling-point isomer we isolated, after cautious hydrolysis of the products of the reaction, *cis*-crotonic acid in about 30 per cent yield; the higher boiling-point isomer, under the same conditions, gave *trans*-crotonic acid in similar yield. On the basis of this assignment, it is seen that the reactions proceed largely, though not completely, with retention of geometrical configuration.

The transition state in substitution at a vinylic centre has been discussed by Bunnett[2] and Gold[3]. The most acceptable model for the present case is that in which the valency bonds at the carbon centre undergoing substitution become, or tend to become, tetrahedrally arranged. Since an extra *p*-orbital is required to form the $sp^3$ hybrids, the double bond is lost in the transition state and the carbon atom adjacent to the centre of substitution acquires a negative charge. On this view, and assuming that no rotation occurs in the transition state, substitution should proceed, in a synchronous process, that is, in the absence of a definite intermediate adduct, with retention of geometrical configuration and should be enormously facilitated in those molecules containing a group capable of delocalizing the negative charge formed in the transition state.

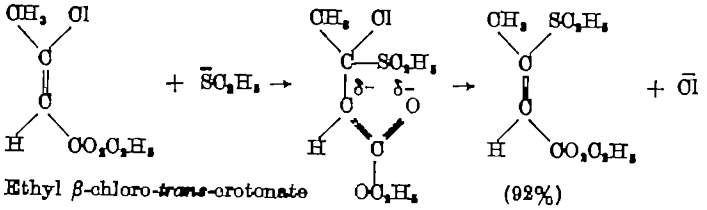
It is clearly possible to extend this formulation to include the existence of an intermediate of considerable stability. The longer the life of such an intermediate the greater will be the degree of isomerization produced by free rotation about the single bond which in the intermediate replaces the double bond of the original compound. The reactions of the ethyl β-chlorocrotonates with thioethoxide ions result in predominant retention of geometrical configuration and are best considered, therefore, as proceeding through a short-lived intermediate :

Table 1

| Compound | Nucleophilic reagent | $T$ ° C. | $k_2$ | $E$ | $\log_{10} B$ | Products |
|---|---|---|---|---|---|---|
| Ethyl β-chloro-*trans*-crotonate* | $\bar{O}CH_2CH_3$ | 0 | 0·065 | 19·2 | 14·2 | Ethyl β-ethoxycrotonate (m.p. 30·2° C) |
| ,, | $\bar{S}CH_2CH_3$ | 0 | 0·336 | 14·5 | 11·2 | 8 per cent lower b.p. isomer<br>92 per cent higher b.p. isomer |
| Ethyl β-chloro-*cis*-crotonate | $\bar{O}CH_2CH_3$ | 0 | 0·26 | 17·0 | 13·0 | Ethyl β-ethoxycrotonate (m.p. 30·2° C.) |
| ,, | $\bar{S}CH_2CH_3$ | 0 | 0·148 | 14·1 | 10·5 | 81 per cent lower b.p. isomer<br>19 per cent higher b.p. isomer |
| ,, | $\bar{S}CH_2CH_3$ | 78 | — | — | — | 87 per cent lower b.p. isomer<br>13 per cent higher b.p. isomer |

$k_2$ and $E$ are expressed in gm.mole.$^{-1}$ min.$^{-1}$ and kcal.mole$^{-1}$.

* As in the parent compounds, *cis* and *trans* refer to the configuration of the methyl and carbethoxy groups.



From studies on the corresponding unsubstituted compounds, the carbethoxy group was found to increase reactivity by a factor of about $10^4$. This large effect can be understood on the formulation given, since, as Bunnett[2] has pointed out, one of the reasons for the inertness of simple vinylic halides may well be that the carbon atom adjacent to the centre of substitution does not readily accept a negative charge.

The reactions with ethoxide ions in which only one product was isolated whichever chloro-ester was used may involve an intermediate of longer life; or alternatively, the isomer which was not found may be unstable under the experimental conditions. Since all attempts to prepare this isomer failed, we are, at the moment, unable to distinguish between these possibilities.

We thank Profs. E. D. Hughes and C. K. Ingold for their help and encouragement, and Dr. P. B. D. de la Mare, Dr. E. S. Graham and Mr. T. M. Dunn for much valuable discussion. Thanks are also due to Dr. D. J. Millen and Mr. D. Watson for measurements of the infra-red spectra and for valuable discussion, and to Mr. D. V. Banthorpe for carrying out the experiments with Raney nickel.

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## A Generalization of the Concept of Acid-Strength and Acidity

At the present time it is still difficult to compare the strengths of acids dissolved in different solvents either on an experimental or a theoretical basis. The acidity constant $K_a$ as defined by Brønsted is merely a measure of the strength of the acid in the given solvent. The acidity-functions as proposed by Hammett[1] and others[2] give only experimental means of comparing the acidity of various solutions.

We suggest that Gurney's idea[3] of an energy of proton-transfer enables one to define a universal acid-strength function which has a clear physical meaning. According to Gurney, the probability of a proton-transfer from an acid molecule to a solvent molecule is proportional to exp $(-J/kT)$, where $J$ is the energy of the proton-transfer, given by:

$$J = -kT \cdot \lg K_a + kT \cdot \lg M \qquad (1)$$

where $M$ is the number of moles c solute in 1,000 gm. of solvent. If w call the energy of proton-transfer fo the solvent molecule itself (autoprotolysis) $J_\sigma$, any molecule for which $J > J$ will not behave like an acid in the give solvent. On the other hand, any molecule for which $J < 0$ will dissociate entirely in the given solvent and will be strong acid. Under these conditions, the functio

$$X = \frac{J_\sigma - J}{J_\sigma} = \frac{\log K_\sigma/K}{\log K_\sigma} = \log_{K\sigma} K\sigma/K \qquad (2$$

is a universal acid-strength function, tending toward 1 when $J$ tends towards 0 (strong acid) and tendin towards 0 when $J$ tends to $J_\sigma$ (very weak acid). (In the preceding formula, $K_\sigma = k_\sigma/M^2$ and $K = K_a/M$, where $k_\sigma$ is the autoprotolysis constant of th solvent.)

Gurney distinguishes two parts in $J$, namely, $J_1$ which depends only on the differences between th lowest quantum energy-levels of the particles befor and after the proton transfer (intrinsic proton-transfer energy), and $J_2$, which takes into account the electrostatic energy between the particles and all interaction with the solvent after the dissociation. $J_2$ is the only part of $J$ which is dependent upon temperature, through $\varepsilon$, and the study of the temperature variation of $K_a$ makes it possible to separate $J_2$ from $J_1$, as has been shown by Gurney in several examples. The lack of experimental observations of $K_a$ in different solvents and at different temperatures makes it impossible, at the present time, to decide whether Gurney's rather simple formulæ have a general validity or not. In any event, one must expect to find a function, $J_2 = J_2(\varepsilon)$, which will enable one to calculate $J_2$ in any solvent, knowing its value in one. On the other hand, it can be shown that the value of $J_1$ may easily be derived for any solvent with the help of the following two formulæ:

$$(J_1)_{AH}^{sH} = (J_1)_{AH}^{H_2O} - (J_1)_{sH}^{H_2O} + (J_1)_{sH}^{sH} \qquad (3)$$

$$(J_1)_{AH}^{sH} - (J_1)_{BH}^{sH} = (J_1)_{AH}^{s'H} - (J_1)_{BH}^{s'H} \qquad (4)$$

where $(J_1)_{AH}^{sH}$ is the intrinsic energy of proton-transfer of the molecule $AH$ in the solvent $sH$. We see thus that it may be possible not only to derive the general function $X$, but also to calculate its value for an acid in a given solvent, when its value in another solvent is known.

The use of different solvents involves also a change in the expression for the acidity of a solution. In fact, a solvent not only influences the value of $X$ for a given acid, but also for each solvent the acidity scale will be different. This can be seen immediately if one defines the acidity not by the classical $p$H but by a new function:

$$pA = \frac{pk_\sigma}{2} - p\mathrm{H} \qquad (5)$$

A neutral solution in any solvent corresponds to $pA = 0$, and $pA > 0$ defines an acid solution. In any event, the acidity scale will always be limited by the condition

$$pA < \frac{pk_\sigma}{2} - p\mathrm{H} = \frac{pK_\sigma}{2}$$

iis means that the number of protonized solvent olecules cannot be higher than the total number of lvent molecules.

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## A New Detector for Vapour-Phase Partition Chromatography

Partition chromatography in the vapour phase has een developed as a valuable technique for analysis f mixtures of hydrocarbons or other volatile aterials[1,2]. Two detectors have been proposed for e with mixtures of chemically inactive substances, amely, the vapour-density bridge[1] and the thermal onductivity cell[2]. The application of an infra-red arbon dioxide detector to this problem has also een demonstrated recently. The vapour-density ridge has excellent sensitivity, but is difficult to anufacture, whereas the thermal conductivity cell relatively simple in construction but is somewhat ess sensitive. A detector has now been developed hat has a high sensitivity and is readily made in ny workshop. It also has other advantages over he other types of detector in use.

The detector is for use with hydrogen, or a gaseous ixture containing hydrogen, as a carrier gas. The nethod of detection is based on measurement of the emperature of the flame when the exit gas is burnt t a small jet. When an organic vapour is present n the gas, the flame lengthens and engulfs a thermoouple placed slightly above the normal hydrogen lame. The output from the thermocouple is fed hrough a suitable resistance network to a galvanoneter or recorder. The thermocouple can be of ron/constantan or platinum/platinum + 14 per cent hodium and is situated about 2 mm. above the jet nd enclosed in a draught-free container. The etector is extremely sensitive and has a zero stability f 1 per cent full-scale deflexion. The sensitivity vas determined using a mixture of 75 per cent ydrogen and 25 per cent nitrogen as carrier gas vith a 4-ft. column of 'Celite' impregnated with 18 per cent of paraffin. The column efficiency at 78° C. was approximately 1,000 theoretical plates, and 4 μgm. of benzene gave 2 per cent of full-scale leflexion.

Table 1

| Substance | % w/w determined | | | % w/w Actual |
|---|---|---|---|---|
| | 1 | 2 | Average | |
| Pentane | 10·5 | 10·3 | 10·4 | 12·2 |
| *Cyclo*pentane | 6·9 | 7·1 | 7·0 | 8·2 |
| Benzene | 13·4 | 13·6 | 13·5 | 12 9 |
| *Cyclo*hexane | 15 5 | 16·3 | 15·9 | 16·5 |
| *n*-Heptane | 14·6 | 13·9 | 14·2 | 13·0 |
| Methyl *cyclo*hexane | 15·5 | 16·4 | 16·0 | 15·1 |
| Toluene | 12·5 | 11·9 | 12·2 | 11 7 |
| *n*-Octane | 11·1 | 10 5 | 10·8 | 10·4 |
| Total | 100·0 | 100·0 | 100·0 | 100·0 |
| Carbon disulphide | 6·8 | 7·1 | 7·0 | 5·9 |
| Thiophen | 11·0 | 11 3 | 11·2 | 10·1 |
| *Cyclo*hexane | 13·9 | 14·4 | 14·1 | 15 1 |
| *n*-Heptane | 18·1 | 17·5 | 17·8 | 19·8 |
| Methyl *cyclo*hexane | 25 6 | 25·7 | 25·6 | 29 0 |
| 3-Methyl-thiophen | 24·6 | 24·0 | 24·3 | 20·1 |
| Total | 100 0 | 100·0 | 100·0 | 100 0 |

The detector is particularly applicable to the quantitative analysis of hydrocarbon mixtures, the area of any peak being directly proportional to the mass present, after correction for the heats of combustion of the substances. Thus the percentage by weight of any compound present can be found by expressing the area of its peak, corrected for its heat of combustion, as a percentage of the total corrected area of all the peaks. The analysis of the blend is reached without knowledge of the mass of the original charge. The results obtained for two synthetic blends of hydrocarbons are given in Table 1.

This method of detection has been found suitable for a number of volatile compounds including oxygen- and chlorine-compounds. Dichlorethane and carbon tetrachloride can be detected, but if the latter is present in quantities greater than 0·5 mgm. the flame is extinguished. This simple detector may be readily constructed in any laboratory from materials normally available. A complete vapour-phase chromatographic apparatus can therefore be constructed in a few days and quantitative chromatograms obtained with 2-mgm. samples by hand plotting from the readings on an ordinary spot galvanometer.

Details of this detector will be published elsewhere.

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## Reduction of Riboflavin to a Stable Free Radical using X-Rays

The following reactions probably occur when aqueous ethanol is irradiated with X- or γ-rays[1]:

$$H_2O \rightsquigarrow H + OH \qquad (1)$$

$$H + CH_3CH_2OH \rightarrow H_2 + CH_3\dot{C}HOH \qquad (2)$$

$$\cdot OH + CH_3CH_2OH \rightarrow H_2O + CH_3\dot{C}HOH \qquad (3)$$

If a second solute is introduced into this system in a much lower concentration than the ethanol, then unless reactions 2 and 3 are very slow, the second solute will not be affected by the free radicals formed in the primary act, but will be exposed instead to the action of free hydroxyethyl radicals. Riboflavin has been subjected to the action of such radicals.

Riboflavin ($10^{-4}$ *M*) was dissolved in aqueous sulphuric acid (2 *N*) containing ethanol ($5 \times 10^{-1}$ *M*). The absorption curve of the yellow solution is shown on Fig. 1 (*A*). On irradiation of the air-free solution with a dose of 16,000 r. (190 $kV_p$ X-rays) the solution became red and showed the absorption curve *B*. On admission of air the curve changed to *C*. In a parallel experiment, an identical solution of riboflavin (curve *A*, Fig. 2) was reduced with zinc to give the stable semiquinone free radical[2] (*B*). On admission of air the solution became yellow again and the absorption curve changed to *C*.

It is clear from these experiments that riboflavin is reduced by free radicals to give the same stable semiquinone free radical as is produced by ordinary

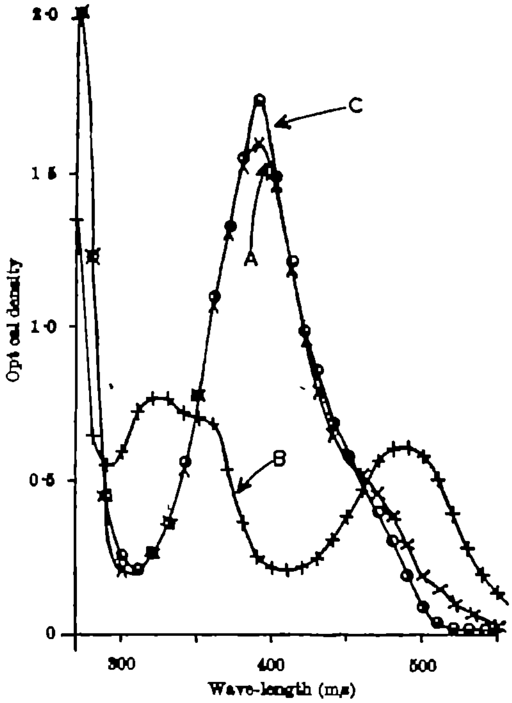

Fig. 1. Action of free radicals on riboflavin. *A* : Riboflavin control; *B* : irradiated solution; *C* : irradiated solution after admission of air

chemical reducing agents. The yield is good both in terms of radiation energy ($G = 6 \cdot 6$ molecules reduced/100 eV. absorbed) and of riboflavin reduced (95–100 per cent). The experiments may be regarded as a further demonstration that hydroxyalkyl radicals, like many other organic free radicals, have reducin properties[3], although it cannot be excluded in th case that hydrogen atoms or the secondary electro themselves may also be playing a part.

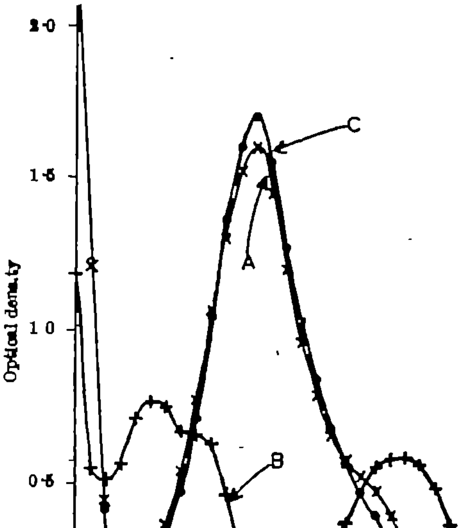

Fig. 2. Reduction of riboflavin by zinc. *A* : Riboflavin control; *B* : the half-reduced semiquinone form of riboflavin; *C* : riboflavin re-formed from the semiquinone by reaction with atmospheric oxygen

It is believed that this is the first time a stab free radical has been prepared in the liquid phase b the action of ionizing radiations.

I thank Prof. J. S. Mitchell for his interest in thi work, and Mr. A. C. Roberts for technical assistanc

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## Uranium Content of Two Iron Meteorites

AN extensive series of investigations by Dalto and co-workers[1,2] using fluorimetric and radon counting techniques has indicated that the uraniu content of many iron meteorites lies in the range $20\text{–}100 \times 10^{-10}$ gm./gm. This supports an age of only a few hundred million years for some of these meteorites, and implies a distribution coefficient of only about one hundred for a very electropositive element between the silicate and metal phases of planets[3].

At the suggestion of Prof. H. C. Urey, it was decided to check the uranium content of some iron meteorites by neutron activation analysis[4] at the Argonne heavy-water pile (*CP*-5). Our results to date indicate a much lower uranium content in the two cases studied than that reported by Dalton and co-workers for the same meteorites. We do not understand the reason for the discrepancy, but feel sufficiently confident of our results to bring them to the attention of workers in the field.

Samples of two iron meteorites (Tamarugal and Thunda), approximately 1 gm. in weight, were sealed in quartz and irradiated in the middle of the reactor in a flux of $\sim 10^{13}$ n./sec./cm.$^2$ for several days. At the same time, in the same position of the pile, a 1-gm. sample of 'mock meteorite' (an evaporated solution of iron, nickel, cobalt, chromium, manganese and copper nitrates in the proportions found in iron meteorites) spiked with a known amount of uranium (about 3 μgm.) was also irradiated. After the irradiation, the outside surface (about 1 per cent) of the meteorite was dissolved in hydrochloric acid and discarded. The remainder was dissolved in the presence of about 10 mgm. of added barium carrier and about 100 c./min. of neptunium-237. Radiochemical isolation of barium and neptunium was then carried out using standard techniques. Most of the samples were dissolved in hydrochloric acid, and, after a precautionary reduction with hydrazine, the neptunium was carried on lanthanum fluoride; in two cases the meteorite was dissolved in nitric acid and, after additional oxidation with bromate, the neptunium was extracted into hexone as the first separation step. The recovery of barium was about 50 per cent as determined by the weight; that of neptunium ranged from 5 to 30 per cent as measured by the recovered α-activity.

The presence of uranium in the meteorite should result in the production of the 2·33-day neptunium-239 activity and of the fission product 12·8-day barium-140 upon exposure to neutrons. By comparison with the production of these nuclides in the spiked 'mock meteorite', the uranium content of the meteorite can be determined.

At least three irradiations on each meteorite were carried out, with the results indicated in Table 1. Although some 10–20 c./min. of radioactivity were usually found in the isolated barium, this did not decay with the characteristics of the 12·8-day barium-140 – 40-hr. lanthanum-140 chain. Thus from the barium analyses we can only set upper limits to the uranium content of the meteorites.

Table 1. ACTIVATION ANALYSIS FOR URANIUM IN IRON METEORITES

| Irradiation number | Uranium (gm.)/meteorite (gm.) (× $10^{-10}$) | | | |
|---|---|---|---|---|
| | Tamarugal* | | Thunda† | |
| | Barium-140 | Neptunium-239 | Barium-140 | Neptunium-239 |
| I | < 3·5‡ | — | — | — |
| II | <14 | < 2·1§ | — | — |
| III | < 3·5 | < 1·7 | < 3·4 | < 1·0§ |
| IV | < 7 | <45 | <11 | <20 |
| V | < 1 4 | < 4·4 | < 1·8 | Lost |

* Dalton, Paneth, Reasbeck, Thomson and Mayne (see ref. 2) quote: 30–34 × $10^{-10}$ gm. uranium/gm. in Tamarugal.

† Dalton and co-workers (see ref. 1) quote: 55 × $10^{-10}$ gm. uranium/gm. for Thunda.

‡ The limit in irradiation I was calculated from the flux as determined by the production of cobalt-60 and iron-59, and checked by gold and bismuth monitors. No mock meteorite sample was run in this irradiation.

§ These samples were dissolved under oxidizing conditions (see text); all others were dissolved under conditions designed to keep the neptunium in a state of oxidation capable of being carried by fluoride.

Small amounts of β-activity came through the neptunium chemistry also. Although it often decayed with approximately the correct half-life, we are not sure that it necessarily was neptunium-239. The limits for the uranium content calculated from this apparent neptunium-239 activity were consistent with those from the barium analyses.

On the basis of these experiments we do not feel that we have detected any uranium in iron meteorites. Because of varying conditions, the limits set in the different experiments show some scatter; more than half are lower than 5 × $10^{-10}$ gm./gm.

The comparison with the 'mock meteorite' should obviate most of the usual corrections in this type of analysis[4]. In addition, consistent limits were calculated from the approximately known flux at the irradiation positions. Since the production of cobalt-60 and iron-59 in irradiations I, II and III agreed with this flux and the accepted iron and cobalt contents of iron meteorites, there could not have been any significant self-shadowing in the sample.

We are indebted to Prof. H. C. Urey for suggesting the investigation, for supplying the samples of meteorites, and for stimulating discussions.

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## Magnitude and Energy of Earthquakes

In a paper presented at a meeting of the Seismological Society of America on April 29, 1955[1], we have revised previous work[2] on the relation of earthquake magnitude $M$ to energy $E$ (in ergs). Methods formerly used to extend the magnitude scale for local earthquakes to teleseisms lead to inconsistencies, so that in effect three different magnitude scales are in use: (1) $M_L$, the magnitude originally defined by Richter[3] for local earthquakes in California as recorded on standard torsion seismometers. (2) $M_S$, that based on calculated ground amplitudes for surface waves of periods of about 20 sec. in shallow teleseisms. (3) $M_B$, that based on the amplitude/period ratio in body waves for both shallow and deep earthquakes.

Using new data, the following partly empirical equations have been set up:

$$\log E = 9{\cdot}4 + 2{\cdot}14\, M_L - 0{\cdot}054\, M_L^2$$
$$M_S - M_B = A\,(M_S - B),$$

where, originally[1], $A = 0{\cdot}4$, $B = 7$; further investigation suggests slight numerical revision.

Data are scarcely sufficient to establish a relation between $M_B$ and $M_L$. Tentative correlations are as follows:

| | | | | |
|---|---|---|---|---|
| $M_L$ | 3 | 5 | 7 | 9 |
| $M_B$ | 4·0 | 5·5 | 6·8 | 8·1 |
| $M_S$ | (2·4) | 4·7 | 6·9 | 8·7± |
| $\log E$ | 15·4 | 18·9 | 22·1 | 25·2 |

For a given observed shock $E$ is much lower than previously estimated. One main source for this decrease is the great difference in amplitudes recorded for similar earthquakes at different sites. In 1942 accelerograph data obtained by the U.S. Coast and Geodetic Survey at metropolitan locations (mostly on sedimentary rocks or alluvium) were correlated directly with seismograms at stations of the Pasadena group (mostly on basement rock). Closer study and experimentation now establish a mean amplitude ratio of about 2½ : 1 between the two groups of installations, with extreme values of about 10 : 1.

For further research on magnitude and energy we are now using $M_B$ as a general standard, reducing $M_S$ and $M_L$ to that basis so far as practicable. Tentatively,

$$\log E = 5{\cdot}8 + 2{\cdot}4\, M_B.$$

We recommend that, in publication, any systematic change in numerical magnitudes, or in routine methods for determining them, be deferred pending further study of the relation of $M_L$ to the other quantities.

We are indebted to Dr. Markus Båth, of Upsala, for communication in advance of publication of data and independent results closely parallel to some of those here reported.

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May 31.

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## Effects of Carbon Tetrachloride on Mitosis

We have observed that carbon tetrachloride produces striking effects on *Allium cepa*, *Allium sativum* and *Zephranthus* sp. root tips. Root tips were treated for five minutes to a half-hour in carbon tetrachloride and later transferred to normal nutrient medium and fixed at various intervals from half an hour to six hours. Among the prominent changes taking place in the resting nucleus is a dissolution of the nuclear membrane and an outflow of its contents. Similar observations have been made in root tips of *Allium cepa* treated with chloroform[1] and potassium cyanide[2]. It would appear that the lipoid layer of the nuclear membrane is either dissolved or rendered weak by the chemicals, in consequence of which the nuclear contents flow out. After treatment for 15 min. with carbon tetrachloride, resting and premitotic nuclei break up. A number of chemicals are known to produce this effect, for example, urethane[3] and nitrogen mustard[4]. Perhaps the most characteristic changes brought about by carbon tetrachloride are dissolution of chromatin in the resting nucleus and disorganization of the chromosome arms in the premitotic stages, resulting in their progressively negative reaction to the Feulgen reagent.

Mitotic stages show even more striking effects. One of the commonest is the occurrence of sticky bridges in anaphase where, due to decrease in viscosity of the matrix, the distal ends of chromosomes fail to separate[5]. Bridge formation has been reported as a result of the action of chloroform[1], ethylene glycol[6] and nitrogen mustard[7], among others. Metaphase chromosomes tend to become more or less despiralized, acquire side loops and resemble the 'lampbrush' chromosomes. Levan and Wangenheim[2] have observed a similar phenomenon in onion root tips treated with potassium cyanide. Evidently the chemical affects spiralization and induces the material of the chromosome to flow out and form loops. Delayed separation of chromatids as well as chromosome fragmentation are also common in material treated with carbon tetrachloride. The spindle, too, is affected, and results in irregular and unequal segregation of chromosomes and in polyploid nuclei.

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## Urinary Œstrogens in the Buffalo as measured Chemically

A knowledge of the level and the rate at which hormones are excreted is of considerable academic value for diagnostic and therapeutic purposes. The determination of œstrogen activity in the excreta is limited by the fact that these hormones are eliminated from the body in biologically active and inactive forms, thus necessitating chemical methods of measurement. The present work, consisting of tw experiments, was carried out to ascertain the lev and the rate at which urinary œstrogens are excrete in the buffalo and their chemical form.

Clean twenty-four hour specimens of urine wer collected from four buffaloes during the fourth mont of pregnancy, acidified with concentrated hydrochloric acid and boiled under reflux for 15 min then extracted four times with one-fourth volum peroxide-free ethyl ether. The extract was evaporate and the residue taken up in a minimal amoun of ethanol. Each alcoholic extract was added t 300 ml. of toluene and then fractionated into neutr and phenolic fractions. The phenolic fraction wa chromatographed and further fractionated by th use of Girard's reagent *T* and phthalic anhydride[1,2].

To determine the rate at which administere œstrogens are excreted in the urine, an ovariectomized buffalo was injected intramuscularly wit 10 mgm. of œstradiol monobenzoate in microcrystalline suspension, and 10 mgm. and 60 mgm. o œstradiol dipropionate dissolved in oil. Periods o seven days elapsed between the three different treatments, and urine samples were collected every si hours during the following 24 hr. Estimations o œstrogen were based on a physiochemical colorimetry[2].

When the urinary œstrogens were fractionated, œstradiol and œstrone were found whereas œstriol was absent. The titres found for urinary œstrogens (Table 1) were too low to have any quantitative significance. The pregnanediol titres, although incomplete, were of a very low order.

Table 1. Œstrogen and Pregnanediol Titres excreted per Litre of Urine by Pregnant Buffaloes

| Animal No. | Days pregnant | Œstrone ($\mu$gm.) | Œstradiol ($\mu$gm.) | Œstriol ($\mu$gm.) | Pregnanediol ($\mu$gm.) |
|---|---|---|---|---|---|
| 1 | 95 | 6 | 12 | 0 | 226 |
| 2 | 96 | 4 | 10 | 0 | — |
| 3 | 105 | 2 | 0 | 0 | — |
| 4 | 102 | 2 | 0 | 0 | 324 |

In the second experiment, only 0·5 per cent of the œstrogen injected in the third treatment was recovered in the urine specimen collected during the first six hours; while the first and second injections were not followed by any excretion of urinary œstrogens. Œstrous manifestations appeared after the dipropionate injections only.

Technical assistance given by Dr. Benjamin F. Stimmel, Rees-Staly Clinic Research Foundation, San Diego, California, is acknowledged. Thanks are due to the Ciba Foundation for providing hormone preparations. This work was carried out at the Agricultural Chemical Section, Giza, Egypt.

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[1] Stimmel, B. F., Randolf, M. A., John, D., and Conn, W. H., *J. Clin. Endocrin.*, 12, 371 (1952). Stimmel, B. F., and May, J. A., *ibid.*, 11, 408 (1951).

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# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, October 24

Institute of Navigation (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 2.15 p.m.—"From Instinct through Art to Science". (1) Mr. G. V. T. Matthews: "Animal and Bird Navigation"; (2) Mr. Alan Villiers: "The Golden Age of Navigation"; (3) W./Cmdr. E. W. Anderson: "Guided Missile Navigation". (A lecture to cadets from nautical schools.)

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Prof. F. B. Straub (Budapest): "Synthesis of Amylase in Cell-Free Systems".*

British Society for the History of Science (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. E. Wilfred Taylor, F.R.S.: "The Evolution of the Divided Circle and the Dividing Engine".

## Tuesday, October 25

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Helen Spurway: "Virgin Births".*

University of London (at Bedford College, Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. E. E. Evans-Pritchard: "The Position of Women in Primitive Societies and in Our Own" (Fawcett Lecture).*

Institution of Electrical Engineers, Measurement and Control Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. D. R. Chick and Mr. D. P. R. Petrie: "An Electrostatic Particle Accelerator"; Dr. S. E. Hunt, Mr. D. P. R. Petrie, Mr. K. Firth and Mr. A. J. Trott: "An Electrostatic Analyser for the Absolute Measurement of Proton Energies and the Establishment of Fixed Points on the High-Voltage Scale".

University of London (in the Chemistry Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. James Sutherland: The W. P. Ker Centenary Lecture.*

University College, London (in the Electrical Engineering Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. E. H. Cooke-Yarborough: First of four lectures on "Transistor Applications". (Further Lectures on November 1, 8 and 15.)*

Illuminating Engineering Society (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Report and discussion on the 1955 meeting of the International Commission on Illumination.

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. R. J. Monaghan: "Boundary Layer Effects in Supersonic Flow".

## Tuesday, October 25—Thursday, October 27

Institution of Mechanical Engineers (joint meeting with the American Society of Mechanical Engineers, in the Great Hall of the Institution of Civil Engineers, Great George Street, London, S.W.1)—Conference on "Combustion".

## Wednesday, October 26

University of London (at the Postgraduate School of Medicine, Ducane Road, London, W.12), at 2 p.m.—Prof. N. H. Martin: "Recent Advances in the Study of the Plasma Proteins".*

Society of Chemical Industry, Food Group—Nutrition Panel (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—First meeting in the new series "Nutritional Requirements and Food Fortification".

British Association of Chemists, London Section (at the Wellcome Institute, 183 Euston Road, London, N.W.1), at 7 p.m.—Mr. E. H. Vick: "Sewerage and Sewage Purification".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion meeting on "Road Traffic—Flow and Control". Chairman: Dr. W. H. Glanville. Speakers: Sir Charles Goodeve, F.R.S.; Dr. R. J. Smeed and Colonel A. H. Young.

## Thursday, October 27

University College, London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Prof. F. B. Straub (Budapest): "Mechanism of Active Transport of Potassium in the Human Erythrocyte".*

University of London, British Postgraduate Medical Federation (in the Beveridge Hall, Senate House, University of London, London, W.C.1), at 5.30 p.m.—Prof. Sir Wilfrid le Gros Clark, F.R.S.: "Hypothesis and Speculation in Scientific Research". (First of fifteen lectures on "The Scientific Basis of Medicine". Further Lectures on November 1, 3, 8, 10, 15, 17, 22, 24, 29; December 1, 6, 8, 13 and 15.)*

University of London (at Imperial College of Science and Technology, London, S.W.7), at 5.30 p.m.—Dr. A. Rényi (Budapest): "On a New Axiomatic Foundation of the Theory of Probability". (Further Lectures on November 1 and 3.)*

University of London (at Wye College, Wye, Ashford, Kent), at 8.15 p.m.—Mrs. Mary Adams: "Developments in Television".*

## Friday, October 28

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Prof. J. F. Baker and Dr. C. F. Tipper: "Notch Tensile Test".

North East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre, Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. S. F. Dorey, F.R.S.: "Ferrous Materials in Marine Engineering" (Andrew Laing Lecture).

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Edward Salisbury, F.R.S.: "Fruit and Seed Production".

## Saturday, October 29

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. W. E. Swinton: "The Story of Animal Flight".*

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Veterinary Medicine for duty at Camden Town—The Secretary, Royal Veterinary College and Hospital (University of London), Royal College Street, London, N.W.1 (October 31).

Lecturer (with a good honours degree) in Mechanical Engineering—The Registrar, King's College, Strand, London, W.C.2 (October 31).

Instrument Engineer (corporate member of a senior Engineering Institution and with experience in the management of many types of instrument services to production and research groups) with the United Kingdom Atomic Energy Authority, Industrial Group, Dounreay Works, Caithness, to be responsible to the Instrument Manager for the maintenance on site and in a repair workshop of many types of physical and electronic instruments and to provide instrument services to production and research groups—Recruitment Officer, U.K. Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting 1150 (November 4).

Lecturer or Assistant Lecturer in Anatomy—The Registrar, The University, Manchester 13 (November 7).

Senior Lecturer and a Lecturer (with a good honours degree and preferably with teaching experience) in Physics, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 7)

Junior Lecturer in Entomology—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1 (November 10).

Supervising Geologists (3) (with a university degree, preferably with honours, or equivalent, with all geology subjects at third year standard; or equivalent qualifications) in the Department of National Development, Bureau of Mineral Resources—Geology and Geophysics, Commonwealth of Australia, to plan and supervise investigations concerning (*a*) Metalliferous mineral deposits; (*b*) radioactive mineral deposits, and (*c*) sedimentary basins—The Senior Representative, Department of National Development, Australia House, Strand, London, W.C.2 (November 11).

Lecturer and an Assistant Lecturer in the Department of Physiology, University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 15).

Senior Lecturer in Physics at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 21).

Assistant Experimental Officers (with two G.C.E. passes at advanced level in mathematics and science, if over 22 a pass degree, H.N.C. or equivalent in engineering or physics, and preferably with a general knowledge or practical experience of electronics) in the Department of Scientific and Industrial Research, Mechanical Engineering Research Laboratory, East Kilbride, near Glasgow, to assist in developing electronic devices including pick-ups, amplifiers and associated equipment for precision measuring apparatus—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.132/5A.

Master to teach Physics and Mathematics to "A" level—The Headmaster, Highgate School, London, N.6.

Principal Scientific Officer (Fuel Technology and Chemical Engineering) (with at least a second-class honours university degree or equivalent professional qualifications, and with experience in chemical engineering and fuel technology) in the East African Industrial Research Organization, Nairobi, to conduct investigations into the drying of coffee and other crops; to study fuel economy in various industries and generally to provide technical assistance—The Director of Recruitment (Overseas Service Division), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.196/463/02.

Research Assistant (honours graduate) in Chemistry—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

Supervisors (with an honours degree in either engineering or physics or equivalent qualifications and with several years industrial experience) at Dounreay Works, Caithness, for the continuous operation and control of the nuclear reactors and ancillary plant—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting reference 1,128.

University Demonstrator in the Department of Veterinary Clinical Studies—The Secretary of the Appointments Committee of the Faculty of Medicine, Department of Experimental Medicine, University of Cambridge, Tennis Court Road, Cambridge.

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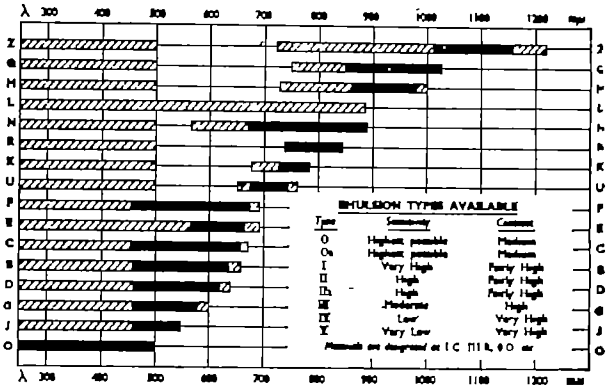

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# DEVELOPMENT OF INDUSTRIAL RELATIONS IN BRITAIN

THE wave of official and unofficial strikes in Britain in the earlier months of this year, and e official warnings which have been given in the e summer regarding inflation and Britain's balance trade, have raised many questions about Britain's onomic and industrial position. Apart altogether om the issues which arise out of the development of utomation to which reference has already been made *Nature* (176, 133; 1955), the adequacy of trade nion organization has been brought into question by e inter-union disputes, and a series of further wage aims has aroused widespread misgivings as to the ssible effect on the economy of the country. The vel-headed and realistic way in which the Trade nion Congress dealt with such questions, including utomation, at Southport, has done something to store confidence and dispel the excessive sense of nfidence in our economic affairs. Prof. J. R. icks's presidential address to Section F (Economics) t the British Association meeting was also reassuring n its suggestion that British trade unions have lready learned that it is wiser to advance wage-claims on bases other than the profits of the employer, nd that the rise in money-wages since 1945 is not a ecessary consequence of full employment, but is xplicable in terms of factors peculiar to the time hrough which we are passing, particularly the dismantling of the controls and the difficulty experienced n establishing a new pattern of relative rates after he war-time disturbance.

Mr. Alec Rodger's presidential address to Section J Psychology) was also reassuring in indicating some f the resources available for dealing with the mportant problems of the effective use of man-power and human relations in industry, while Prof. . H. Richardson has contributed to a recent issue f the *Westminster Bank Review* a useful survey of he main causes and significance of the wave of fficial and unofficial strikes, in which he also considers the practicability of various remedies. Despite he economic losses and grave inconvenience to the British public caused by strikes since the middle of 954, the average annual losses from strikes during the wenty years 1935–54 amounted to less than the quivalent of one hour's work in a year by the whole ody of work-people. This favourable record is ttributed by Prof. Richardson largely to the sense f responsibility shown both by trade union leaders nd representatives of employers' associations, and heir recognition that industrial peace is vital to their wn interests and to the economic welfare of the ountry.

It is obviously important to avoid disturbing this ense of responsibility; and though complicating actors have made the settlement of wage disputes nore delicate and difficult, particularly because nions have failed to agree on a policy, Prof. Richardson emphasizes the desirability of weighing this when onsidering any changes proposed. The essential is of British industrial relations is the regulation of wages and working conditions by voluntary collective agreements, concluded after joint negotiation between trade unions and employers' organizations. This system of collective bargaining has given excellent results during the past twenty-five years; but it implies the right to strike or lock-out in the last resort. To take away those rights and prohibit the right to strike because, as Prof. Richardson shows, there have been a number of recent strikes which were called without reasonable time for conciliation and where the settlement reached could easily have been made without a stoppage, would involve setting up an authoritarian system alien to British traditions. Nor would it be certain to eliminate the risk that workers would go on strike and that the State might in consequence be forced to adopt methods of ruthless repression.

Prof. Richardson suggests drawing a distinction between strikes against the provisions of a duly negotiated and signed collective agreement, and strikes arising out of a breakdown of negotiations on the terms of a new agreement. To declare the former illegal would strengthen the trade union movement and would not restrict the basic right to strike. It would not stop unofficial strikes, but it might reduce their number.

The proposal that a strike should only take place when the decision is supported by a majority of those concerned as shown as a result of a secret ballot is, Prof. Richardson points out, a matter for the individual trade unions. It is already the rule in many unions, and could with advantage be adopted more widely; but it could not be regulated effectively by law. Similarly, the remedy for unofficial strikes really lies within the trade union movement, including measures of discipline against the ringleaders who have flouted the authority of the union, for which measures, indeed, the rules of many trade unions already provide.

Prof. Richardson sees no dramatic solution for these problems of industrial relations. Improvement depends on the cumulative effect of a many-sided attack. Structurally, the organization of some trade unions may require improvement so as to improve the contacts between the union officials and their members, just as better contacts are also needed between representatives of employers and the leaders of the unions. The Trades Union Congress has already taken some measures to restrict conflicts between rival unions; and while it may be necessary to make better provision for the formation of new unions if contact between officials and rank and file is to be vitalized, this also is a reform which must come from within. The present rigidities and complexities cannot be corrected from outside, though public opinion could play some part if better information were made available so that the issues could be understood at an early stage.

To make fuller information quickly available for public opinion to understand the issues and indicate its attitude could also help in the settlement of particular disputes; but, as Prof. Richardson observes, leaders on both sides must recognize that, though they retain the weapons of industrial warfare, those weapons should be used so rarely as to become almost obsolete if fair dealing is shown in negotiations. Moreover, on the rank and file of the trade unions rests the obligation of loyalty to their leaders and of avoiding being led astray by irresponsible agitators. Equally, the leaders must show themselves more aware of the outlook and feelings of the rank and file. It should not be impossible to provide appropriate safety-valves, consistent with the rules; these are obviously desirable to discourage the formation of splinter groups. Indeed, if the trade unions were made less rigid and liberalized, even to the extent of permitting any body of workers which genuinely desired to leave one union for another, or to form an entirely new union, to do so in an orderly constitutional manner, there might well be less dissidence and discontent even if no new unions were actually formed.

There can be no mistaking the demands which any attempt to make trade union organization less rigid and more adapted to the industrial conditions of to-day will make on rank and file as well as on officials. So far as the official is concerned, the demands will be comparable with those made on the management side of industry. Few unions have yet made any attempt to give their shop stewards, for example, the kind of economic training which would enable them to take a responsible part when negotiations at the plant-level become necessary, or to bring the shop steward into vital touch with headquarters. The demands for leadership and training are not made on one side of industry only, however; Dr. W. H. Scott has recently pointed out that greater care should be taken to see that those appointed to managerial posts possess administrative ability and a capacity for consultative leadership, and that those appointed to senior posts should be required to undergo a course of study of administration. Similar considerations apply to the trade unions.

If the excessively bureaucratic tendencies of some trade unions are to be checked, and a balance achieved between the necessary measure of centralized administration and the no less desirable development of local initiative and responsibility, similar criteria must be applied to the selection and training of full-time officials. The delegation of greater responsibility to lay representatives by the unions is essential if we are to achieve industrial democracy and eliminate the misunderstandings, strains and restrictions which have played so large a part in engendering recent disputes; but it cannot be obtained or used creatively without appropriate attitudes on the part of officials. That in itself involves a break with existing practices in recruitment, and seeking much more widely and energetically for the kind of people who are capable of discharging responsibilities in a democratic way and exercising consultative leadership.

Apart from this, as discussions on automation have recently indicated, deficiencies in management ability or a restrictive outlook on the part of the uni official can easily hinder the enjoyment by workers and the public of the benefits of advan in industrial technique or improved manager practice. The trade union official, in fact, needs creasingly an education comparable in rigour wi that required by the industrial manager if he is to me the demands made on him for judgment, admin trative ability and technical knowledge, as well for hard, constructive thinking. This is a furth reason why, as Dr. Scott pointed out, we mu encourage the development of educational institutio outside industry, as well as promote policies with it and within the unions whereby such people can produced as well as discovered.

Here, then, this need for a new outlook on th recruitment, training and promotion of the tra union official, as well as on the function and poli of the unions themselves in conditions of full emplo ment, touches on social and educational institutio generally. We must be concerned to see that th are such as to encourage the formation of personalit and further the higher level of education demande on the part of the rank and file, as well as the great demands for education and training required by th trade union official even to discharge his primar responsibilities to members of his union. Further, will not be enough for the unions to recognize the public responsibilities. The major responsibility f avoiding industrial disputes lies with management and though there is much to be done by the union within their own organizations, management still ha a primary responsibility for the improvement industrial relations, and helping to create the con ditions favourable for the trade unions to effect thei own internal reforms.

How this can be done and the way in which th two sides interact was well brought out by Mr. Ale Rodger in his address at Bristol. Of the five basi elements in a human relations policy which Si Walter Monckton emphasized at the Internationa Labour Conference last June, the provision o information and perfection of the art of com munication are pre-eminently a managerial respons ibility. Mr. Rodger asserted that it is sadly neglecte in Britain. Although we cannot hope to pla methodically and well without facts, we have muc to do here, especially in regard to vocationa guidance, before we have eliminated a serious caus of wasted man-power.

Vocational guidance, like wise selection of per sonnel, can be a potent means of avoiding friction frustration or discontent; but it is in regard t occupational training that a new outlook is mos required. Mr. Rodger points out that later school leaving is already depriving the apprentice system and the trade unions of many of the abler boys they need, through rules which are ill-adapted to the new educational system. Nor is it simply that many apprentices are not being efficiently trained. A minor man-power crisis looms ahead: for every two boys of high capacity leaving school to-day, there will be three in 1962. Fresh thinking is urgently requir on the training of young people, especially for killed trades and in the light of the implications of automation.

Mr. Rodger made no extravagant claims for the help which the psychologist or other scientist could ive. He emphasized, however, as clearly as Prof. Richardson, the importance of dealing with the difficult problem of wage differentials; and in welcoming Mr. Hugh Gaitskell's desire to see such differentials based more securely on occupational differences in skill, responsibility, effort, danger and dirt, he pointed out that in studying these and other criteria the psychologist has a substantial contribution to make. Whether he can make it, however, depends on more han his ability to make his function clear, to ormulate his questions well and to take a fuller part in industry itself. It depends equally on clear thinking about the respective functions of management, of the trade union official and of the other experts as well as about our ultimate purposes. We must have clear ideas as to their respective roles and define our objectives before we can see clearly how these contributions interlock in any one problem and what still remains to be done. There must also be clear understanding of why changes are required, and exactly what those proposed changes are intended to achieve, on the part of all concerned before we can hope to see them adopted and put into operation.

This implies a great task of education, within, as well as outside, the trade unions themselves. Much of it must be carried out by the unions, or at least with their active co-operation, if it is to be effective; but nevertheless other bodies can assist. Discussions like those at Bristol, and Prof. Richardson's paper, help to put the issues objectively and impartially before the public; and both the Press and broadcasting can play their part, not least by presenting the facts free from prejudice and distortion. Clearly the Workers' Educational Association could play an important part in promoting a re-valuation of the functions of the trade unions in the context of full employment and technological change, and developing an outlook favourable to adjustment and not to restriction; while apart from any place in such extra-mural activities, the universities, through their departments of social science, for example, can make a large contribution to the creative thinking required to develop new procedures and forms of organization.

Deeper still in this question of education lies the development of a sense of public responsibility. It is not enough for management alone to show a greater sense of responsibility towards all those employed in an industry and to the public whose interests that industry serves. The trade unions themselves must exercise a greater sense of responsibility towards the public as well as towards their own members, and must show clearly that the privileges which are theirs to-day are not used selfishly or unworthily but with a full sense of the public welfare.

That sense of responsibility was manifest at the Southport Congress at least on the part of many leaders and delegates; but it was no less clear that much has still to be done before the implications are fully understood by the rank and file, and the unions as a whole are ready to accept whatever measures may be required to prevent the abuse of power and disregard of public responsibility. The union leaders will need all the help which can be given them both in bringing home to their members the implications of the new position of their unions in the world to-day and in solving the difficult problems of union organization involved, if we are to retain the advantages of the big union in dealing with wage and like questions, and yet the understanding of local problems, whether in a particular firm or a particular area, where the small union or the shop steward has such an advantage. There is much experience which could be placed at the disposal of the unions to help them to work out their own solutions, and the studies already carried out by the Acton Society Trust or by Dr. W. H. Scott, for example, indicate that when the trade unions come to address themselves to the task of internal reform and re-organization, they can draw on concrete and impartial studies as well as an immense amount of public understanding and support.

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# CHEMISTRY AND BIOLOGY OF THE NUCLEIC ACIDS

## The Nucleic Acids

Chemistry and Biology. Edited by Erwin Chargaff and J. N. Davidson. Vol. 1; pp. xi+692; 16.80 dollars. Vol. 2; pp. xi+576; 14.50 dollars. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.)

DURING the few years preceding the outbreak of the Second World War it was the general opinion that the chemical nature of both deoxyribonucleic acid and ribonucleic acid had been almost completely elucidated. Some anomalies, it is true, remained; but these did not seem to disturb unduly the main conclusions. Important developments, however, then occurred in the biological field. Stanley discovered that certain plant viruses were nucleoproteins containing ribonucleic acid—a result which suggested that nucleoproteins, wherever they occurred and whichever type of nucleic acid they contained, constituted biological self-reproducing units. This was followed by Caspersson's and Brachet's demonstration, the former using ultraviolet spectrophotometry and photography and the latter histochemical methods, of the widespread occurrence of ribonucleic acid in the cytoplasm of animal and plant cells and, in particular, of its high concentration in those cells in which protein synthesis could be assumed to be taking place. Finally, there came Avery's discovery, not only that the principle which transformed the rough form of Type II pneumococcus into the smooth form of Type III was a deoxyribonucleic acid, but that also this substance was specific to Type III pneumococcus. It thus became evident, first, that ribonucleic acid was much more widely distributed in Nature than had previously been thought and, secondly, that species specificity, with all its implications, might exist among the deoxyribonucleic acids of higher organisms despite the overt or tacit rejection of this idea by earlier workers.

Doubtless as a result of these developments, the past decade has witnessed a renewal of investigations, both from the chemical and biological aspects, into the nucleic acids which, if one is to judge from the bulk of literature that it has produced, have been carried out with an intensity hitherto unknown in this field. It is the object of the present work, which consists of two volumes, to give an up-to-date and detailed account of the nucleic acids in the light of these recent researches. The two volumes are devoted respectively to the chemistry and biology of the subject.

As a perusal of the first volume shows, the last word on the chemistry of the nucleic acids has not yet been spoken. Nevertheless, many substantial achievements, particularly in the development of experimental techniques, are recorded. Thus, the isolation of deoxyribonucleic acid, if not of ribonucleic acid, is now a relatively simple, if tedious, process; the application of paper chromatography, associated with the use of ultra-violet spectrophotometry, has provided a method for the determination of the bases present in both types of nucleic acid with an accuracy previously totally unattainable; and the isolation of nucleotides from hydrolysates of the nucleic acids, an operation which was so laborious and gave such uncertain results when the older chemical methods were used, can now be effected more readily and with greater certainty both by ion-exchange chromatography and by paper ionophoresis. When the use of the classical methods of organic chemistry and of specific enzymes which bring about the step-wise degradation of the nucleic acids or their hydrolysis products is combined with these newer techniques, as they have been, it is not, perhaps, surprising that some of the old conceptions of the nature and composition of these substances have been abandoned.

Nevertheless, a very substantial amount of the older work remains valid. In particular, the fundamental conception of the nucleic acids as a chain of nucleotides united together by ester linkages between the phosphoric acid group of one nucleotide and a hydroxyl group of the carbohydrate of the other still holds, as do the structures assigned to the individual nucleotides. But results with the new techniques have certainly demonstrated that the nucleotides are not combined together in equimolecular proportions, as was formerly believed and expressed in the tetranucleotide theory. They also include many other achievements, among which are the discovery, in minute amounts in the deoxyribonucleic acid from animal sources and in larger amounts in that from wheat germ, of a fifth nucleotide containing 5-methylcytosine as base; the finding that the deoxyribonucleic acid of a number of bacteriophages contains 5-hydroxymethylcytosine instead of the customary cytosine; and the precise determination of the positions of the internucleotide linkages in both ribonucleic and deoxyribonucleic acids. The question of the species specificity of the nucleic acids has, however, not yet received a definite answer. That there exist different deoxyribonucleic acids, particularly among the micro-organisms, has been abundantly proved both by chemical and biological methods. Moreover, as the results mentioned above show, the deoxyribonucleic acid from wheat germ appears to be different from that from animals. But it would, in my opinion, be taking too optimistic a view of the overall accuracy of the analytical processes employed to conclude from the later and more accurate figures obtained with animal deoxyribonucleic acids that these are species-specific. This opinion is reinforced by the evidence provided by, among others, one of the editors of this work tha the nucleic acids are not homogeneous. Should th evidence be confirmed, it will clearly considerabl diminish the value of the mass of analytical dat which has been published on the composition deoxyribonucleic acids from various sources.

Advances in the biological field, described in th second volume, represent steady progress rather tha spectacular achievements. Thus, Avery's origina discovery has been extended; the widesprea occurrence of ribonucleic acid in biological material particularly in the cytoplasm of animal cells, ha been confirmed by numerous analyses; measurements have been made, using various types of cell from different species, of the weight of deoxyribonucleic acid in single nuclei, the results being interpreted as indicating the presence of a constan amount of this substance in the nuclei of all diploid and half that amount in haploid, cells of each species and a start has been made, using the isotope-tracer method, in ascertaining the nature of the precursor used in the biosynthesis of the nucleic acids.

Dealing, as they do, with these and many othe aspects of the nucleic acids, the two volumes of thi compilation give, on the whole, a very complete and up-to-date account of the nature and occurrence of the nucleic acids and of their chemical, physicochemical and biological properties which will be invaluable to all working in this field. It will doubtless become the principal, if not the only, modern reference-book on the subject. This statement does not, however, mean that the whole work is uniformly excellent. This would not, indeed, be expected of a treatise the twenty-eight chapters of which embody the contributions of thirty-four authors. There are, in fact, many criticisms, of different degrees of importance, which might be made. Of these, I have selected three which I feel bound to make.

Owing to its size, the price of the work will render it inaccessible to individuals except through libraries. By more careful selection of the subject-matter and by the pruning of redundant material, this result could have been minimized to the benefit both of the reader and of the finances of libraries. For example, Chapter 2 is a monograph of seventy pages on ribose and deoxyribose. Most of the details which it contains belong to carbohydrate chemistry and must surely be included in the literature of that subject. It therefore seems superfluous to reproduce them here. Chapter 3, dealing with the purines and pyrimidines, is to some extent susceptible to the same criticism, but it serves better, by quoting the following sentence from it, to illustrate how far the subject-matter of the work may in places digress from the nucleic acids: "In 1943, the important discovery was made that the administration of alloxan to rabbits leads to the necrosis of the insulin-producing units of the pancreas (the β-cells of the islets of Langerhans), thereby providing a tool for the production and study of experimental diabetes".

The greater the objectivity with which a scientific treatise is written, the more valuable will it be. In my opinion, such objectivity is not always present in the discussion in Chapter 17 on the use of the Feulgen reaction for the quantitative determination of deoxyribonucleic acid in biological material. The author should have made it clear that, for obvious reasons, this reaction is never used for the estimation of deoxyribonucleic acid *in vitro*. He should also have discussed experiments which have shown that, at ny rate when one commonly used fixative is mployed, considerable quantities of nucleic acid are st from cell nuclei during the period of hydrolysis equired to produce maximum intensity of staining y this method. Instead of doing this, he is content o brush objections to one side and to regard the method as justifiable because it usually yields the desired results.

Chapter 18 is not the authoritative article which urchasers of this work are entitled to expect. The author dismisses my work with the remark: "Unfortunately many of the conclusions drawn by the Stedmans from their experimental data . . . are, in he opinion of the writer, highly questionable" without so much as mentioning the nature of the conclusions or of the data on which they were based; and this is not the author's sole lapse in propriety.

E. Stedman

## SCIENTIFIC BASIS OF MEDICINE

### Lectures on the Scientific Basis of Medicine

Vol. 2, 1952–53; pp. xi+380+29 plates. Vol. 3, 1953–54; pp. iv+398+9 plates. (British Postgraduate Medical Federation: University of London.) (London: Athlone Press, 1954. Distributed by Constable and Co., Ltd.) 35*s.* net each vol.

THESE two volumes continue the publication of the yearly series of lectures, begun in 1951, under the auspices of the British Postgraduate Medical Federation. In his preface to Vol. 2, Sir Francis Fraser, director of the Federation, explains that the topics of these lectures are selected by a committee as being ripe for presentation to an audience of young medical research workers and junior consultants and specialists. The lecturer invited to deal with each topic is a person actively engaged in furthering advance in it by original research. Sir Francis points out that the lecture syllabuses are not a mere haphazard tour around a changing scene, nor can any single annual syllabus properly be treated as an isolated entity. Each course is planned as a stage in an integrated, continuously developing survey which can only yield its full value to the student who keeps himself continuously familiar with it. It is to enable students to do this that the Federation provides these annual published volumes. Not all the lectures delivered are published; in part because accessible summaries exist, in part because their topics, though presentable in lecture form, are not yet ready for evaluation in print. Vol. 2 contains nineteen out of thirty-six lectures delivered, and Vol. 3 twenty-one out of thirty.

It is of interest to survey these volumes in the light of Sir Harold Himsworth's recent Linacre Lecture (*Brit. Med. J.*, ii, 217; 1955) on "The Integration of Medicine". They provide a partial answer to Sir Harold's plea for more comprehensive postgraduate study, and they illustrate well the difficult task of those engaged in such education to present briefly and in readily understandable form the rapidly growing and ever more specialized topics that to-day form the basis of medicine. The lectures range over chemistry, biochemistry, physics, physiology, genetics, bacteriology, virology and zoology. They are for the most part simply and interestingly written. They provide not only the junior, but also the senior postgraduate workers (whose need is almost as great) with helpful surveys of the advances in knowledge in many fields relating to medicine. It is permissible to question, however, if undergraduate medical education is now of the nature to produce more than a small proportion of young graduates sufficiently 'groundedly learned' fully to appreciate the material here offered for their understanding.

In view of Sir Harold's fear about the diminishing recruitment of medically qualified men to the non-clinical branches of medicine, it is heartening to see that, of the forty lecturers in the two volumes under review, twenty-eight are medically qualified. Moreover, a glance at the list shows that, as Sir Harold desires, they are men of authority, and no less than eleven are distinguished as Fellows of the Royal Society.

R. T. Grant

## THEORY OF JET FLOW

### Fluid Dynamics of Jets

By Prof. S. Pai. Pp. xv+227. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1954.) 37*s.* 6*d.* net.

THE theory of jet flow is a natural offspring of boundary-layer theory; but until recently it lacked, unlike its parent, the stimulus of important practical applications. During the past decade, however, the development of jet propulsion has profoundly modified the aeronautical picture, and the study of jet flow has acquired great practical significance. Jets can be used to propel aircraft, to provide lift, to assist boundary-layer control and generally to modify the aerodynamic characteristics of surfaces near which they pass or from which they emerge. Thus, there arise three main topics of interest: the flow in jets, the effects of jets on neighbouring surfaces, and the interaction of jets. Prof. S. Pai's monograph is concerned almost exclusively with the first topic, for the good reason that only the flow in jets has yet received sufficient attention to provide ready material for a book.

The book deals essentially with theoretical developments, and its appeal to the practical engineer is likely to be limited. Much of the material is not new; but it has important sections never previously published in book form, and the book is noteworthy as the first in English devoted exclusively to jet flow. Its presentation is, in the main, logical and straightforward, although occasionally the arrangement of some items is surprising. It covers very extensive ground, and therefore some important subjects are given little more than a brief mention; an initial glance at the table of contents is apt in such cases to raise unfulfilled hopes.

The first three chapters are concerned with jets of an inviscid fluid, one chapter being devoted to an incompressible fluid and two to subsonic and supersonic flow of a compressible fluid. Much of this material is classical but is none the less interesting. The remainder of the book deals with jets of a viscous fluid. The fourth chapter is concerned with laminar jet flow for both compressible and incompressible fluids, and the following two chapters deal similarly with turbulent jet flow. Here the limitations and inadequacies of mixing-length theories are fully discussed; but these theories are applied extensively in view of their success in providing useful relations of proved validity for incompressible fluids. Inadequate warning is given, however, of the difficulties in extending these theories to compressible flow.

Thus, equally plausible assumptions can lead to widely divergent results, and the available experimental data offer as yet little empirical guidance. These chapters include a brief discussion of the more important aspects of the statistical approach to turbulence and a very inadequate reference to the important topic of jet noise. An interesting chapter follows on the mixing of jets of different gases where diffusion becomes important, and the last two chapters deal with the stability of jets of incompressible and compressible fluids. The theory is presented in some detail, but more might have been made of the results. In an appendix the fundamental equations of fluid dynamics are briefly derived.

The writing lacks grace, and there is an irritating economy in the use of the definite article as well as an occasional misprint. Nevertheless, the book is clearly and honestly presented and should be welcomed by the many aeronautical scientists concerned with jet flow. A. D. YOUNG

# ENERGY FROM THE SUN

## Applied Solar Energy Research

A Directory of World Activity and Bibliography of Significant Literature. Edited by E. J. Burda. Pp. ix+298. (Stanford, Calif.: Stanford Research Institute, 1955. Published for the Association for Applied Solar Energy.) n.p.

RESEARCH on the utilization of solar energy has been greatly stimulated during recent years, and rapid developments have been made in the United States and other countries. There is an increasing realization that such applications will play an important part in the future co-ordination of world energy resources, and an Association for Applied Solar Energy has been formed at Phoenix, Arizona. As a preliminary stage in its programme to encourage research, this Association has issued the first international directory and bibliography of solar research as a record of what has been done in the past and is being attempted in the present.

This publication is much more than a mere list of references; under headings of countries, Part 1 lists the universities, other organizations and individual research workers who are engaged in solar energy activities, with brief summaries of the work in progress. Although the United States section contains more entries than all other countries together, there is evidence of an active world-wide interest in this subject. Short details are given of solar symposia that have been held since 1950, including particulars of the World Symposium on Applied Solar Energy which is to be held this November in Phoenix, Arizona.

Part 2, constituting the remainder of the volume, is a bibliography containing nearly fifteen hundred references, with short abstracts in most cases. These references are numbered and arranged in alphabetical order; and the numbers are rearranged in a cross-reference of classified subjects—for example, distillation, heaters, insolation, photo-synthesis, to give a few examples. The information is invaluable not only to those engaged in active research, but also to those commencing a study of the subject. Library facilities and staff for this publication were provided by the Stanford Research Institute under the general direction of Merritt L. Kastens, with the co-operation of Dr. Marie Telkes, of New York University.

H. HEYWOOD

# TECHNOLOGY OF TITANIUM

## Titanium in Industry

Technology of Structural Titanium. By Stanley Abkowitz, John J. Burke and Ralph H. Hiltz, Jr Pp. x+224. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd. 1955.) 36s. net.

THE development of the three structural metal of this scientific age—titanium, magnesium an aluminium—has not, in terms of the span of huma life, been fast. In each of these cases, from bein initially recognized in the laboratory, until equa recognition was attained in the industrial world, a period of time varying from three-quarters to rathe more than a century and a half has elapsed. Seemingly, but not paradoxically, because the metallurgica difficulties involved were very great, titanium, th first of this little group to be discovered, has take longer to acquire engineering status than the othe two. In 1789, its existence was clearly realized by th Rev. William Gregor. The metal did not, however, attain a position in engineering until the present decade. It—or more exactly, some of its alloys—was then shown to have a combination of qualities, such as low specific gravity when compared with iron; mechanical properties (up to about 300° C.) comparable with those of alloy steels; and, in a large numbe of media and in particular in sea water, a quit outstanding resistance to corrosion. These characteristics made it suitable for applications wher performance, rather than cost, was the primar consideration. This is, of course, the case in th aircraft gas-turbine field.

In a book of slightly more than two hundred pages, divided into ten chapters, the authors attempt to cover the production of the metal, its chemistry and physics, and manipulation in mill, forge and worksho of both it and of some of its many alloys. The tas they have thus undertaken is a formidable one. Their book is of necessity superficial. It is not, however, inaccurate, and indeed has merit. It contains more than twenty excellent photomicrographs and some good graphs in relation to a numbe of the mechanical properties of some of the man titanium alloys. With regard to their fatigue and creep characteristics, however, the treatment is disappointing. This is unfortunate, for it is thes qualities which are of the utmost importance in th field in which the metal and its alloys are at presen finding their greatest application. Against thi criticism, it is but fair to state that the work is, in most respects, up to date. For example, the authors disclose, as has only recently been appreciated, the unexpected but tremendous influence of hydrogen on titanium. In excess of a hundred parts per million, this gas, which markedly alters the microstructure of the metal, is deleterious. When the metal contains double this amount, a number of undesirable characteristics, for example, grave reduction in such essential engineering properties as ductility, impact and fatigue resistance, may well arise.

To conclude: anyone having a somewhat detached interest in titanium and its alloys will find this well-produced book, in spite of its relatively high cost, a worthwhile introduction to a very large subject. O the other hand, should the potential reader be alread involved in the production and/or use of titanium an its alloys for structural and/or mechanical purposes, i will often prove wanting—due to the magnitude of it scope, it inevitably lacks depth. P. L. TEED

# THE NEW SCHMIDT TELESCOPE OF THE HAMBURG OBSERVATORY

By Dr. O. HECKMANN

Director

DURING the summer months of 1954, a new Schmidt telescope was installed at the Hamburg Observatory in Bergedorf, some fifteen miles east of the city of Hamburg. The instrument was under test during the succeeding ten months, and on August 19 and 20 its dedication was celebrated by an astronomical meeting in Hamburg devoted to various matters of technique, method and programme related to the new type of telescope. The instrument was already planned in 1936, when Dr. W. Baade, of Mount Wilson Observatory, was to become director of the Hamburg Observatory, to the staff of which he had belonged during 1920–31. The instrument was tentatively designed to have an aperture of 80 cm. and a mirror of 100 cm. diameter with a focal length of 160 cm. ($f$ : 2). But Baade stayed in Pasadena because a still larger Schmidt telescope was to be put at his disposal, the 48-in. (= 120 cm.) Schmidt of Mount Palomar ($f$ : 2·5) completed after the War. The Hamburg instrument could not be realized until, in 1948, the German currency recovered. The original plans were somewhat changed by increasing the diameter of the mirror from 100 cm. to 120 cm. and the focal length from 160 cm. to 240 cm.; so its dimensions are about two-thirds of the Palomar instrument.

The design of the Hamburg instrument has been influenced by that of its larger Californian counterpart, but there are some noteworthy differences. The first is the fact that a double tube was chosen, so as to avoid flexure of a magnitude that could cause deterioration of the definition of the optical images when an objective prism of some 400 kgm. is put in front of the correcting plate. Indeed, when moving the instrument from zenithal to horizontal position the correcting plate is shifted by less than 0·1 mm., which is very satisfying. Secondly, there is an automatic temperature compensation of focus; this is provided by three rods regulating the distance of the mirror from the plate-holder but—and here is the difference from the Palomar 48-in.—using rods of approximately the same high thermal inertia as that of the mirror. In order to avoid very rapid temperature changes, the whole tube is protected by a felt cover 15 mm. thick covered with canvas. Thirdly, the mounting is of the fork type; but the fundamental idea is to have all movable parts supported exactly below their common centre of gravity. This is achieved by making the centre of gravity the centre of a sphere, part of which consists of a ground steel zone of 2 m. radius, at the base of the very heavy yoke of the fork. Fig. 1 demonstrates this better than any verbal explanation. The steel zone rests on self-adjusting oil pressure-bearings; so the adjustment of the polar axis of the instrument is carried out without working against gravity.

The instrument is moved by electrical controls into any desired position by means of 'Selsyn' motors. The two guiding telescopes can be adjusted so that their flexure relative to the main tube vanishes. They are easily accessible by means of a car which, by an electrically driven hydraulic piston, can hoist a platform with the observer. He can control all motions of the car from his seat. A hydraulic lever can be substituted for the platform when the mirror is to be taken from the instrument for aluminizing.

Whereas the mounting of the instrument was manufactured in the machine tool works of Heidenreich and Harbeck in Hamburg, the optics and the tube were made by C. Zeiss of Jena. In spite of the political tensions between the east and west of Germany, the two firms found a reasonable way for their mutual collaboration.

The mirror consists of the low-expansion glass *ZK*7, the correcting plate and the 4° prism of glass *UBK*7, which is transparent to the ultra-violet. The optical quality of the prism has not yet been investigated. The properties of the system mirror plus correcting plate are as follows: In the extremely steady air of the Zeiss laboratory, we could estimate visually that distances smaller than 0·5″ could be resolved. When used for celestial photography, unsteadiness of the air and the diffusion of light in the emulsion become of increasing influence, so that the smallest star images on the average are about 2·5″, that is, about 30μ. So we may say that the performance of the instrument is limited by the seeing conditions and not by its optical quality. The

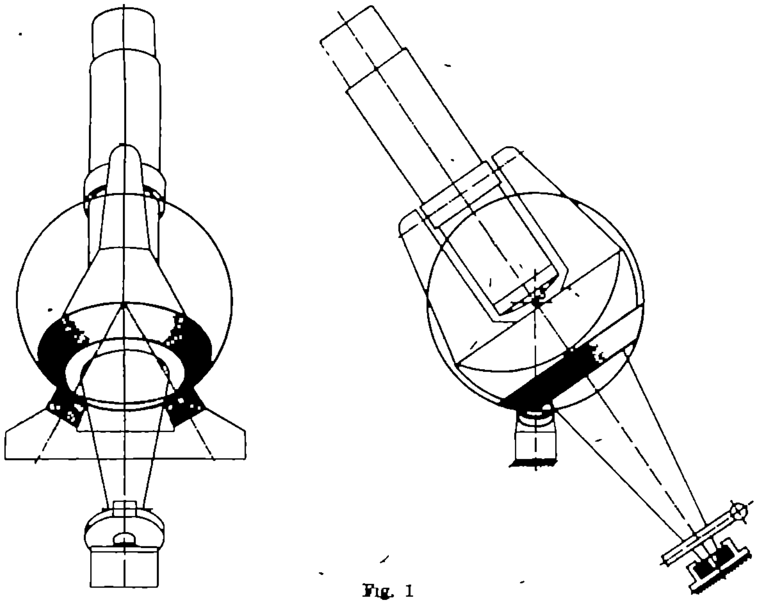

Fig. 1

square plates cover a field of 5° × 5°. If they are not thicker than 1 mm. they never break when bent to a sphere of 2·4 m. radius, as is necessary in all orthodox Schmidt telescopes not using field lenses.

As regards the observing programme with the instrument, I feel somewhat uneasy because of the wealth of problems which eventually can be undertaken; so I hesitate to say much. The most serious danger is to begin programmes which can be easily photographed but which are difficult to evaluate on account of the enormous amount of informatio afforded by a single intelligently taken photograph

We plan to work on galactic clusters, known a well as hitherto unknown. Work on variable star is also possible. Further, we are interested in th distribution and colours of extragalactic nebulæ. I addition, the objective prism makes possible a searc for several kinds of special stars. Further, shoul the number of plates threaten to overwhelm us, w shall be glad to pass on material to astronomers wh are willing to evaluate it.

# VETERINARY MEDICINE AT CAMBRIDGE

## By Prof. L. P. PUGH

Professor of Veterinary Clinical Studies

THE Cambridge School of Veterinary Medicine is derived substantially from ideas and recommendations contained in the two reports of the Loveday Committee on Veterinary Education in Great Britain (1938, 1944). Before this, however, in 1923, a chair of animal pathology had been established, and Prof. J. B. Buxton appointed as the first professor and director of the Institute of Animal Pathology. Later, in 1935, the University, in consultation with the Royal College of Veterinary Surgeons, proposed a scheme for courses in the pre-clinical subjects which would lead to certain exemptions from the examinations for membership of the Royal College and to a postgraduate diploma, after qualification and registration had taken place, the final two years being spent at one of the existing veterinary schools. The first report of the Loveday Committee approved the 1935 scheme; but in 1944 the same committee decided to go further and recommended that all veterinary schools in Britain should become integral parts of universities. It also proposed that a School of Veterinary Medicine should be located at Cambridge which would provide both pre-clinical and clinical training, and would lead to a degree in veterinary medicine. These recommendations were accepted by the Ministry of Agriculture and by the University.

In 1947, the chair of animal pathology which Prof. T. Dalling had vacated during the War was filled by the appointment of Prof. W. I. B. Beveridge, and he became the director of the Institute of Animal Pathology. This Institute continued actively to pursue research into the diseases of animals. In 1949 the Institute became a departmen within the Faculty of Biology 'B' of the University

In 1950, the present writer was appointed at the first professor of veterinary clinical studies, to organize a new Department within the Faculty of Medicine. These studies were to comprise all those subjects usually included under the broad headings

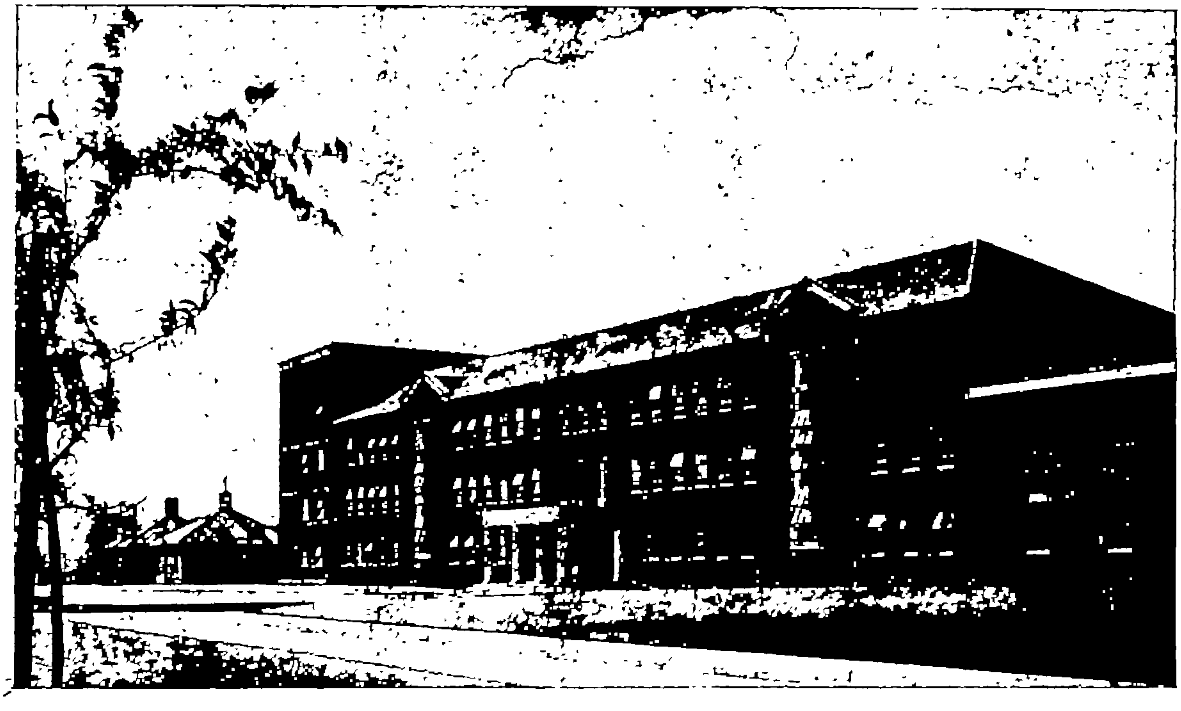

Fig. 1. The Veterinary School, Cambridge. Main teaching and research block, with the end of the hospital on the left.

Fig. 2 Unposed photograph of an operation on a dog in progress

of animal health, animal surgery and veterinary medicine.

The buildings of the new Veterinary School, which were opened by H.M. The Queen on October 20, are located within two miles of the city centre on about ne hundred and twenty acres of farm land. Here e Departments of Animal Pathology and Veterinary nical Studies are ideally situated both for teaching d research into the diseases of livestock and, at e same time, are able to maintain a close association with the other cognate sciences.

There are obviously two pre-requisites for teaching and research into veterinary problems: (1) an adequate supply of normal animals, for the study of the maintenance of health; and (2) an ample supply of clinically affected animals. The first requirement was met by getting together a dairy herd, sheep, pigs, ponies, and poultry in suitable numbers. These farm animals provide material for studies of the normal which, for the student, must precede an introduction to the sick. The techniques of the physical handling of animals, their management singly or in groups, nutrition with all its variations, breeding, pregnancy and parturition, observations of behaviour and the functioning of the healthy body, production of milk, and so on, are exercises conducted for purposes of training. The second requirement, clinical material, has been met largely by providing a veterinary hospital service to the practitioners in the surrounding counties. Operating theatres, rooms for radiology and other specialized types of examination of patients have been set up and are now in full use on a consultative basis. A large clinical-pathology section has been formed in the Department of Veterinary Clinical Studies which will act as the natural liaison between that Department and the Institute of Animal Pathology.

Team research into the disease problems of farm livestock will constitute an important part of the programme of the School. Already research into such varied subjects as virus pneumonia of pigs, hæmolytic disease of the new-born, parasitic diseases of cattle and sheep, respiratory and other diseases of birds, are all being actively studied.

The establishment of a veterinary school, fully functioning in all its varied interests, must certainly take time. Building delays have unfortunately resulted in the first graduates of the Cambridge School obtaining their degrees before the completion of the teaching block. Those that follow them will reap the benefit of being able to work in the finished buildings in which all the interests of the Departments have been congregated.

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Prof. Pugh has set forth his aims and ideals in his inaugural lecture given in Cambridge on March 8*. He traces the inception of the idea of a school for clinical veterinary studies to Sir Clifford Allbutt, regius professor of physic in the University of Cambridge for thirty-three years until his death in 1925. Allbutt constantly advocated a *rapprochement* of studies relating to the diseases of man and animal. In Oxford there was a similar movement due to Sir Henry Acland, regius professor of medicine there. The first step towards this end was the establishment of a chair of animal pathology in Cambridge; but there the matter rested until shortly before the Second World War, when a scheme for veterinary education similar to that followed by medical students was prepared. This opened the way to fulfilment of the recommendations of the Loveday Committee.

Clinical studies, broadly speaking, comprise preventive and curative medicine. Preventive medicine has arisen largely from a knowledge of causal agencies, and it has led to an appreciation of the social significance of human medicine and the economic significance of veterinary medicine. With the decline in economic importance of the horse, the interest of the veterinarian has turned towards farm animals and their place in agriculture. In curative medicine similar methods have been applied in both human and veterinary medicine. But the practical side of veterinary medicine must depend more on economics than sentiment, and will increasingly lean towards the maintenance rather than the restoration of health—that is, preventive medicine.

The knowledge of the clinician is based on the advances made by workers in many branches of natural science, mainly in university institutes; and his tendency to become an empiricist must be resisted. The exact observation and measurement of disease and the experimental study of its processes must not be separate disciplines. Here the veterinarian has an advantage, in that experimental conditions can be maintained. Nevertheless, the veterinary hospital functions as any other teaching hospital, and the ethical obligations and limitations are comparable to those accepted in human medicine and surgery.

The common ground existing in the study of disease processes in man and animals is the attempt to interpret disease in terms of function and func-

* "Veterinary Clinical Studies at Cambridge". By Prof. L. P. Pugh. Pp. 26. (Cambridge: At the University Press, 1955.) 2s. 6d. net.

tional co-ordination. To place the Department of Veterinary Clinical Studies in the Faculty of Medicine of the University of Cambridge is thus a step towards the comparative approach to medicine. The clinician has already learned to go to the pathologist and biochemist for aid, and it is regrettable that he has not turned more often to the physiologist. The latter works particularly with the dog and the cat—two animals with which the veterinarian is concerned—and it is time that many of the findings with laboratory animals should be extended to the farm animals.

Prof. Pugh concludes as follows: "Basically there are two problems. Is there a place in the intellectual structure of this University for a clinical department, and is there a place for a veterinary school? I hope that the opinion advanced may at least 'provoke those it cannot convert'.

"I have tried to express the aim that veterinary medicine must develop its own science of experimental medicine; I have suggested an approach to this problem in the hope that not only will it enlarge our understanding of disease, but will make for a closer relationship with the other scientific disciplines and create a logical sequence of ideas in teaching. In pursuing this object, the veterinarian's interest in different animals suggests that it is ultimately by a comparative approach that a clinical department can best play its part in the furtherance of knowledge and that, by this approach, the fundamental similarities and dissimilarities between species, in which I include man, may be profitably exploited".

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# CAVITATION IN HYDRODYNAMICS

Cavitation is a subject of growing scientific and technical interest, and the first international symposium to be devoted entirely to it was organized by, and held at, the National Physical Laboratory, Teddington, during September 14–16. The word itself was coined sixty years ago by R. E. Froude to describe the process which he visualized as responsible for the unexpectedly poor performance of high-speed propellers fitted to a naval vessel just then completed; his imaginative speculation that the very low pressures existing in some regions of the flow through the propeller caused the formation of cavities in the water was soon shown to be correct by Parsons, and since then naval architects have frequently been concerned to detect and overcome the harmful effects of this breakdown in homogeneous flow. The same problems were later found to occur in hydraulic machines, and more recently cavitation phenomena have become important in such different fields as ultrasonics and underwater projectiles and explosions. This has naturally led to more detailed study of the basic mechanism of cavitation, and during the past few years much has been learned about the behaviour of individual cavities and the factors which control their inception, while considerable progress has also been made in understanding the nature of erosion damage due to cavitation.

It was because of this recent increase in research on cavitation problems that it was considered appropriate to hold a symposium at Teddington to discuss the progress made; because of the special interests of the Ship Division of the National Physical Laboratory, the problems of cavitation in hydrodynamics were selected for special examination, and the programme of the meetings was designed to proceed from discussion of the fundamental physics of the phenomena to consideration of the hydrodynamic effects of cavitation on performance and damage, and to methods recently developed for their study. The symposium was divided into six half-day sessions, at the first of which an opening address of a general nature was presented, while the other five sessions, at which a total of twenty papers was given, were each devoted to a different aspect of hydrodynamic cavitation. In addition to these formal meetings, a further informal session was arranged during the symposium to meet the wishes of those particularly interested in ultrasonic cavitation for a discussion of their problems. A total of about a hundred and thirty delegates from fourteen countries attended the meetings, of whom more than half took an active part as authors of papers or as contributors to the discussions. Special care was taken to give adequate time during the sessions for discussion by firmly limiting each author to fifteen minutes when presenting his paper, and several of the ensuing discussions were extremely lively and instructive. The symposium proceedings, including summaries of these discussions, will be published by H.M. Stationery Office in about six months.

The opening address, given by Mr. P. Eisenber (United States Office of Naval Research), was critical review of recent progress in cavitat research, and discussed the origin and stability entrained gas nuclei and their effects on incepti the influences of turbulence and boundary-layer flo conditions, the present knowledge of the dynamics of transient and steady-state cavities, and the status of research on theories of cavitation damage. He concluded that during the past few years there have been two main accomplishments: the basic problems have been more sharply defined, and the physical phenomena that must be considered in their investigation have been more clearly identified. Mr. Eisenberg emphasized that the questions awaiting answer for immediate engineering application are the very ones which require an understanding of some of the most complex and least understood phenomena in hydromechanics. The chairman, Dr. J. F. Allan (superintendent of the Ship Division of the National Physical Laboratory), commended this conclusion, and forecast that developments in ship propulsion would bring cavitation into more prominence and accentuate the need for practical solutions to its difficulties.

The second session, with Dr. R. W. L. Gawn (superintendent of the Admiralty Experiment Works) as chairman, was concerned with the factors governing inception of cavitation. The effects of dissolved and entrained gas content, the ability of water to sustain considerable tensions under dynamic conditions, and the growth of gas nuclei, particularly those in boundary-layer flows, were the main topics of discussion. It was clear that a means of determining the spectrum of entrained bubble size in flowing water was much needed, and that acoustic methods, often used as criteria of cavitation inception, offer possibilities in this direction. This discussion led naturally to the consideration of experiment techniques, the subject of the next session, at which Prof.

W. P. A. van Lammeren (Netherlands Ship Model Basin) was in the chair. Instruments for measuring fluctuating forces, pressures and velocities and others specially developed for new Admiralty large-scale test facilities were described, while one paper gave details of high-speed photographic methods (with pictures taken at rates of up to 1 million per second) designed for studies of individual bubbles in ultrasonic cavitation, which have a life-cycle, during which intense collapse pressures are generated, encompassed in 1 μsec. A paper outlining the performance characteristics of a small experimental water tunnel led to a vigorous discussion of the virtues of re-absorption devices (inelegantly but widely known as resorbers) in large-scale cavitation testing rigs. Many new water tunnels, including a large new propeller tunnel to be built for the National Physical Laboratory, incorporate expensive resorbers, and the general consensus of opinion seemed to be that these are desirable provided sufficient money is available.

Even large test facilities for ship propellers and water turbines can only handle models which are small compared with their prototypes, and thus scale-effect factors are of great importance in cavitation studies. The papers at the fourth session of the symposium, under Prof. J. W. Daily (Massachusetts Institute of Technology), dealt with this thorny problem, and the relative importance of the significant parameters, particularly the Froude, Reynolds and Weber numbers, was discussed. One paper gave some disturbing preliminary results from a series of geometrically similar model propellers, and another showed remarkable Admiralty photographs of propeller cavitation patterns taken during ship trials of a destroyer and other naval vessels. The following session, with Mr. F. S. Burt (Admiralty Research Laboratory) as chairman, was concerned with a related problem—the effects of cavitation on the hydrodynamic performance of foils. Valuable data on the properties of hydrofoils under super-cavitating conditions (when fully developed, steady-state cavities spring from the leading edge) were given in a group of papers and supplemented in the discussion. A pleasant, and valuable, interlude here was an excellently produced film, with full colour and sound, showing some of the pioneering work being done at the California Institute of Technology. Finally, the delegates turned their attention to the vexed question of cavitation damage, and the papers delivered at this session presented very different views on the mechanism of damage erosion, the upholders of the two schools of impingement attack and corrosion fatigue being in evidence. The qualities of cathodic protection as a damage inhibitor, and the role of gas in water as a damage 'cushion', were also argued. The damage potential of cavities of fixed type, shown to have a fiercely periodic nature with violent downstream collapse conditions, was also brought out; and if this session cannot claim to have resolved the opposed views, it certainly did much to clarify them. Mr. Eisenberg, chairman at this session, persuaded Prof. J. Ackeret (Zurich), a pioneer in this field, to remind the delegates of some highly pertinent effects of shock waves in causing damage, and in his own closing remarks commented that the programme of the symposium had clearly brought out the central problems for discussion. Dr. Allan, responding for the National Physical Laboratory, regretted that the delegates had had to remain almost silent on the problems of cavitation noise; but hoped that in spite of this the meetings would encourage further research which would extend our knowledge and control of cavitation phenomena. Dr. Allan felt that this research should not be organized on an internationally agreed programme, perhaps not even on a national basis, but that individual workers should pursue their own interests and meet at intervals to exchange views. This suggests that the first conference on cavitation problems will be followed by others.

A. Silverleaf

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# DEATH AND THE AFTER-LIFE

The general theme, "Disposal of the Dead, and Beliefs in an After-Life", was selected as the main part of the programme of Section H (Anthropology and Archæology) at the recent Bristol meeting of the British Association, because experience had shown the need for a common topic about which anthropologists and archæologists desired each to hear what the others had to say, and the theme chosen provided scope for participation by nearly all elements in the section. With one or two exceptions, the papers were grouped in the sessions as indicated by the headings.

## From the Origin of Man to the Mesolithic Period

The evidence from pre-Neolithic peoples was discussed in the opening session by Dr. Kenneth Oakley, Mr. Miles Burkitt and Dr. L. H. Wells. In his paper on "Earliest Evidence of Disposal of the Dead", Dr. Oakley remarked on the tendency, among gregarious non-human primates, for the dying animal to leave the sleeping-place of the troop. He then dealt with cannibalism, which was widespread before disposal of the dead by ceremonial or careful burial became regular. All the remains of Pekin man in the Choukoutien cave deposits are judged to be the debris of cannibal feasts. The bones of Neanderthalers in the Krapina cave appear to have been deliberately broken, and many were charred; the female skull from Ehringsdorf shows evidence of mortal blows; the breaking of the Steinheim skull was evidently deliberate, and all the eleven Solo (Ngandong, Java) skulls have their bases and facial bones missing as if broken for extraction of their brains. The base of the Neanderthal skull found within a ring of stones on the floor of the Goat's Cave in Monte Circeo has clearly had the foramen magnum enlarged for this purpose. Therefore, it appears that head-hunting and brain-eating were characteristic of these early periods.

Mr. Miles Burkitt then dealt with "Middle and Upper Palæolithic Burials". It was not only the 'old man' of the family, but also women and children who were carefully buried. At La Chapelle aux Saints, it is true, there was only one burial of a man in a sepulchral cave, with evidence that the interment had taken place with care and ceremony; but at La Ferrassie the whole family were buried in what presumably had been their home, with care and possibly some sort of ritual, as the body of one of the children was covered by an artificially cup-marked stone. Other Mousterian burials are known. Whether the reason for this care for some of the dead was fear or love, or a belief in some sort of after-life, we can never know. The burying of implements and bones of animals with the dead would seem to suggest that the mourners thought the dead might need these at some time.

In Upper Palæolithic times we also have plenty of evidence for careful burial; and here, too, discoveries suggest that some sort of ceremony occurred at the interments. Cro-Magnon and Chancelade are sites to mention, as well as some burials at Mentone where the body of the male occurs laid out with his head on a stone pillow, and partly covered with pierced shells. The female was entirely covered with unpierced shells. In most cases ochre was sprinkled over the bodies—possibly imitating life-blood.

The practice of careful burial continued into Mesolithic times. Apart from elaborate burials, such as Ofnet (where, as Dr. Wells later mentioned, severed heads probably imply ritual head-hunting), there is plenty of evidence of simpler procedure but yet indicating careful burial—as at Hoëdic, Téviec, Nugem and Arpea.

Dr. L. H. Wells concluded the first session with a review of the pre-Neolithic evidence from Britain, and in the course of his paper described the Cheddar skeleton as the finest Upper Palæolithic cave-burial in Britain, and expressed the view that some of the skeletons from Aveline's Hole (Mendip) were definite burials. The Mesolithic population of Britain may well have been derived from Upper Palæolithic groups.

## Evidence from Living Primitive Peoples

The funerary customs of living primitive races were discussed by Dr. R. M. Berndt, Dr. Jack Goody, Mr. G. W. B. Huntingford and Mr. Hitoshi Watanabe. Dr. Berndt being abroad, his paper on "Cannibalism in the Eastern Central Highlands of New Guinea" was read by Dr. Goody. Cannibalism was described as "a most nourishing and hygienic means of disposing of the dead", the practice of which is common and not abnormal in the area described. The Eastern Highlanders of New Guinea put much emphasis on warfare, and are somewhat careless of death. Behind this attitude, however, is a belief in an after-life, in reunion with the original creative beings, and eternal residence in some kind of spirit world, or alternatively in rebirth. The newly dead are considered to have much the same needs as the living, and when they appear to their kin in dreams, it is often to ask for food, warmth or fire.

Eating human flesh is not confined to members of one sex, nor is it restricted to eating one's own kin, or members of the same district or village. Men do not hesitate to eat the flesh of a female, or women that of a male, while an enemy is eaten just as readily as a member of one's own kin. People avoided eating victims of the dysentery epidemic which followed the Second World War. Human meat is regarded primarily as food, and not eaten to absorb the power or strength of the deceased.

Dr. Goody's paper was on "Death and Social Control among the Lo Dagaa of the Gold Coast". He expressed the belief that "the conflict between the mortality of the human body and the immortality of the body politic is resolved by the belief in a future life". Only situations of rapid social change can admit scepticism in this field. Lo Dagaa beliefs include punishments meted out by the Ferryman at the River of Death to debtors, witches, thieves, and to those who have refused legitimate requests. There are also the punishments inflicted in the Land of the Dead by the high god himself. The Lo Dagaa funerals are dual, consisting of: (i) the mortuary ceremony (disposal of the body), and (ii) subsequent ceremonies (connected with eschatological beliefs). Orientation of the body differs for men and women, and childless adults have a form of burial different from those who have had children. The temporary deposit of grave-goods is known among this tribe.

Mr. G. W. B. Huntingford spoke on "Nandi Beliefs in a Future Life". In common with many other East African tribes, the Nandi of Kenya rely on the hyæna to dispose of their dead. A hyæna must not be looked in the eyes in the daytime (according to the Nandi), because the spirit of a dead person may be looking through them. Every person is believed to have a shadow-soul which dies with him, and a heart-soul which passes with the body into a hyæna and finally enters the spirit-land underground. This spirit-land is considered to contain trees, grass, hills, water, sun and moon, as in this world. The spirits are believed to have cattle and grow wheat: yet there is the incompatible belief that they live on the goods provided by the living. Grave-goods placed with the dead are removed from the tomb after one day, to be re-used by the living.

The final paper on living peoples was given b Mr. Watanabe on "Disposal of the Dead by the Ai of Japan". According to the Ainu, the dead are m in the underworld by a watch-dog; from the unde world the fire-god sends the good dead to the (upstream) village of deities, and the bad dead to the (downstream) wet underworld. The welfare of the dead depends partly on correct observance of rituals and taboos by the living, who practise them carefully, since good spirits can confer punishments and blessings on the living. The corpse is dressed in clothes which are worn inside-out (an excellent example of reversal of procedure for the dead, met with also in parts of Oceania). Food is offered first to the fire-god, then to the dead, and finally it is eaten by the mourners. After the funeral feast, the corpse is extended with head upstream. All the grave-goo are ceremonially broken to release their spirits to accompany the dead to the after-life. Both tomb and grave-goods are covered with magical twigs and plants to keep away evil spirits. Post-funerary rites are performed after the dead are considered to have reached their destination. (It is hoped that Mr. Watanabe's paper will be published in full in *The Advancement of Science*.)

## Evidence from American Archæology

Evidence from South and Central American archæology was outlined in papers by Dr. G. H. S. Bushnell and Mr. Adrian Digby. Dr. Bushnell, dealing with ancient Peru, referred to the two main traditions of burial, both dating back at least to the formative period in the first millennium B.C. The first (north coast) was of recumbent burials, at first generally flexed but sometimes extended, and later almost without exception extended. A gold plaque in the mouth is frequent, and bamboo tubes for food offerings, extending to the surface of the ground, occur but are rare. The second tradition (south coast and southern highlands) had bodies seated in a crouched posture and generally wrapped in textiles to form a bundle, which may have a false face. The richer burials in both areas were elaborate, the southern mummies being wrapped in many layers of textiles, some richly decorated. The Tiahuanaco expansion spread the southern tradition over the whole coast and it prevailed everywhere until the Spanish conquest.

There seems to have been at all times a belief in the continued being of the body or at least of the bones. In Inca times it was believed that nobles and good commoners went to a happier life with the sun, and bad commoners went to hunger and misery within the earth; but the mummies were treated with the consideration appropriate to a living person. This points to a belief in a soul apart from the mummy.

Burial and the after-life among the Maya of south-east Mexico and adjoining areas between about 100 B.C. and A.D. 900 were considered by Mr. Adrian Digby. He referred to their elaborate ceremonial centres embodying temples, courts and pyramids, in some of which burials have been found. For example, at the bottom of the pyramid below the Temple of Inscriptions at Palenque in Mexico, there was a sarcophagus decorated with the design of a tree symbolizing life and rebirth, resembling that shown springing from a wounded victim on a pre-Columbian Maya manuscript. Belief in immortality is suggested by certain practices, such as modelling the features of the dead in bitumen on the skull; deposit of red ochre with some important burials; deposit of jadeite beads, perhaps to serve as money in the after-life; and occasional ceremonial killing of vessels placed with the dead.

## Evidence from Egyptian Archæology

Dr. Margaret Murray, doyen of Egyptologists, in an address memorable for its clarity of exposition, confined her review of Egyptian funerary evidence to the prehistoric and predynastic material. The Badarian burials were single, flexed as in sleep, facing the west—the Land of the Dead. The Amratian burials were communal, contracted, and again faced the west. A few exceptions may have belonged to a special cult or been foreigners. The body was sometimes dismembered, and in certain instances the head was removed and either a pot or an ostrich egg substituted. In other instances the head was preserved on its own. Gerzean burials tended to be single, contracted, and in deep graves. Lastly, those of the Semainean culture were usually single and contracted, often in wooden coffins. The bones were sometimes disarranged and piled in square heaps. A skull cult, perhaps involving scooping out the brain, was not unknown in predynastic Egypt and continued in later times.

## Evidence from British Archæology

The remaining sessions were devoted to a consideration of the British evidence from the Neolithic period almost to the present day. Dr. H. N. Savory drew upon some recent excavations in his paper on "Communal and Separate Burial in Neolithic Britain"—a paper which covered two distinct though partly overlapping cultures between 2000 and 1500 B.C. Dealing mainly with the evidence from the south-west, he stressed the rarity of articulated corpses in long barrows, caused probably by transfer from a temporary deposit elsewhere. Deliberate breaking and rearrangement of bones suggested that fear of haunting played a part in the cult. In separate burials, solicitude for the after-life is more clearly indicated by richer grave-goods, food offerings and occasional ritual breaking of the objects rather than the bodies. The encircling wall or ditch of the round barrow defined the ceremonial precinct and may be related to 'henge' monuments, although the latter were not primarily sepulchral.

"Inhumation and Cremation in the British Bronze Age, and Related Beliefs" were handled by Mr. L. V. Grinsell against the background of the less fragmentary evidence from the Ægean, Scandinavia, Brittany and elsewhere. He gave instances of occasional substitution for grave-gifts of representations of them, and of ceremonial funerary breakings. The grave-goods we find when barrows are opened are only the more durable of those originally placed with the dead, and it is only in accidental circumstances that the perishable objects are preserved—as in the tombs of the Altai region in western Siberia, where preservation was due to freezing.

In describing "Beliefs in the After-Life in Iron Age and Roman Britain", Prof. I. A. Richmond explained how "the classical world impinged upon the prehistoric, and studied the barbarian world for its own sake while tolerating native custom within its own wide borders". This renders a separation between Iron Age and Romano-British beliefs almost unreal. Wine-filled tombs of Iron Age chieftains in East Anglia match the beliefs of Trimalchio ("Let me enjoy [the funeral wine] now!"), while Mommsen's Lingonian chief, cremated with his hunting gear, would have understood the hunting scenes on tombstones of later Pictland. Higher beliefs are reflected in Plutarch's traditions from the Western Isles or by St. Cuthbert's vision of Aidan's soul. In Roman Britain, tombstones portraying daily life reflect belief in survival of a personality thus recorded, as does the "Agricola". Cavalry tombstones of victory over barbarians have more in common with Rhineland monuments commemorating victory over death. The funeral banquet refers both to after-life and ancestor-worship. As subsidiary decoration, sphinxes and lions typify death, pine-cones immortality, vines and *amorini* the Dionysiac mysteries. The soul's journey to the Blessed Isles is suggested by Tritons or dolphins.

Disposal changed from almost universal cremation to burial, less for economic reasons than because of growing belief in individual survival. Special care for the corpse is represented by the gypsum-filled coffins at York, while the Dionysiac idea of death as sleep is evoked at Chester by the figure of a sleeping child.

Dr. H. R. E. Davidson followed with an account of the funeral customs of the Anglo-Saxons, "the first people in the British Isles whose funeral practices can be studied in the light of their literature". Archæologically, nearly all the earlier practices recur in this period: cremation, partial cremation, ritual fires, food offerings, funeral feasts, mutilation of the body, real and symbolic grave-goods, animal sacrifice, ship-funerals, etc. According to Snorre Sturlason, the higher the smoke from the pyre, the more lofty the position of the dead in heaven. There is evidence for ritual fires with inhumations as well as cremations. The body was often beheaded and may have been mutilated in other ways. Broken grave-goods occasionally occur.

The period from Anglo-Saxon times to the present day was covered by Miss Violet Alford and Mr. Grinsell. In her paper on "Dance and Song in connection with Funerary Rites", Miss Alford mentioned the continuance of *pleureuses* in the Pyrenees, Mexico, Co. Kerry and elsewhere, and referred to the 'wakes' at funerals in the British Isles. Funeral dances were usually the current regional dances—jigs and reels in Ireland, reels and country dances in Scotland. Folk memories of barrow-burials live in folk-song and ballad. Denmark shows examples of a son obtaining a magic sword from his father's barrow, and the visit of 'royal maidens' to dead men in their 'earth-house'. "The Unquiet Grave", a well-known English folk-song, recounts the visit of the dead man to his sweetheart, who is disturbing his rest by her excessive grief.

"The Survival and Recurrence of Primitive Funerary Beliefs and Customs in Recent Times" was the title of the concluding paper given by Mr. Grinsell, who directed attention to the occasional recurrence of ceremonial breaking of grave-objects at funerals in the Ægean and even in Britain; the placing of coins in the mouth or hand of the dead; and the placing of white (generally quartz) pebbles on graves. Shakespeare's reference ("Hamlet", Act V, Sc. i) to the placing of "shards, flints, and pebbles" on the grave of a suicide suggests the survival of pre-Christian practices in such instances.

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In an earlier paper which was not actually part of the general theme, Mr. L. Biek, of the Ministry of Works Archæological Laboratory, described the development of scientific techniques for obtaining evidence from burials, including the X-ray examination of a cinerary urn and its contents; examination of bronze implements to decide whether they had passed the funeral pyre; and study of 'silhouettes' of inhumations which have otherwise vanished.

A special exhibit to illustrate some main aspects of the theme was arranged at the Bristol City Museum, the aspects chosen being the ceremonial breaking of grave-goods at funerals; food offerings to the dead; the journey to the after-life (including the part played by the Ferryman of the Dead); the location and nature of the after-life; and the various methods adopted for the treatment of the dead.

The programme was concluded by Prof. E. O. James, who in his summing up indicated the change in emphasis from 'disposal of the dead' to 'beliefs in an after-life' from Upper Palæolithic times onwards. There is much archæological and anthropological evidence for belief in human survival; but the belief in immortality tends to involve more advanced philosophical concepts.

The results of the programme were felt to be eminently satisfactory. A full or large attendance was maintained throughout, and the percentage of younger people at the sessions was larger than for some years. Of the fifteen speakers present, eight attended all the sessions, three about half, and the remaining four came mainly to deliver their own papers, either breaking their holidays or in the midst of heavy commitments. Not a few of the audience came from other sections; but the most noteworthy result was the large number of archæologists and anthropologists whose minds became enriched by hearing the papers, and this applied both to the lecturers and to members of the audience.

I am grateful to all the speakers who kindly provided summaries of their papers, which have been used (together with my own notes) in preparing this account. L. V. Grinsell

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# MANCHESTER COLLEGE OF TECHNOLOGY

## GRANT OF A CHARTER

By Dr. B. V. BOWDEN

Principal

THE recent grant of a Charter to the Manchester College of Technology marks another important stage in the development of the College, which traces its history back to a Mechanics Institute founded in 1824 by eleven far-sighted Manchester business men, who each contributed £634 for the purpose. By 1905 it had acquired such a reputation at home and abroad that the University of Manchester created a Faculty of Technology which was incorporated in the College.

Thus for the past fifty years the College has discharged two quite separate and vitally important functions. It has trained full-time university students for university degrees, and it has also trained large numbers of full-time and part-time students in a variety of subjects which lead to qualifications other than degrees. This interesting association of university and non-university work will continue under the new constitution. The College will still be part of the University of Manchester, from which it derives so much of its academic strength. The standard of non-university work will be constantly raised by the elimination of the more elementary studies. Courses for Higher National Certificates will still be provided; but the most important progress in this section will be in the provision of part-time or short full-time courses of postgraduate or refresher type. By this means the developments which take place so rapidly in technology will be brought to the notice of engineers and scientists engaged in industry.

No other institution in Britain has quite the same association of university and non-university work, an association of the greatest importance in meeting the needs of industry for technologists of varied training and background.

The College has always been fortunate in the support which it has received from industry, and there are already signs that such support will be forthcoming on an even greater scale under the new regime. In return, the College will strive to serve industry by making available specialized equipment, by consultation with members of the staff on scientific and technical problems as well as by training personnel.

Situated in the heart of the most intensely industrialized area in the world, the College must play an important part in providing the increased number of highly qualified scientists and technologists essential for the national welfare. To achieve this purpose, further expansion will be necessary—expansion in enrolments, in staff and in accommodation and equipment. A start has already been made; for the session 1953–54, 670 students were following full-time university courses in the Faculty of Technology. It was then planned to double this number by 1962 and a most encouraging start was made last October, when the number of new enrolments increased by 45 per cent; there is a further increase in the present session.

New chairs in municipal engineering, applied physics, industrial administration, textile chemistry and chemical engineering have been created, and more are envisaged.

Building extensions approved in 1928 are now coming into use; these extensions were, however, planned to relieve congestion existing thirty years ago, and further space is now essential. Preliminary steps have already been taken to provide a campus for the College and to meet future needs.

From small beginnings more than a hundred and thirty years ago the College has developed to its present stature, and it is confidently expected that, with the additional prestige bestowed by the Charter, its progress in the future will be no less remarkable.

# OBITUARIES

## Dr. R. C. L. Perkins, F.R.S.

Dr. R. C. L. Perkins, the distinguished entomologist, best known for his work on the fauna of the Hawaiian Islands, died on September 29 at Bovey Tracy, Devon, at the age of eighty-eight.

Robert Cyril Layton Perkins was born on November 15, 1866, at Badminton, Gloucestershire, the second son of the Rev. Charles Mathew Perkins. He was educated at the Merchant Taylors School in London. In 1885 he won an open classical scholarship to Jesus College, Oxford; but after two years at Oxford he changed to science.

In 1891 Dr. Perkins was chosen by a committee appointed by the Royal Society and the British Association to undertake an investigation of the land fauna of the Hawaiian Islands. For nearly ten years he worked strenuously for this committee, collecting material in all parts of the Islands. In 1899 his comprehensive volumes on the insect groups and birds began to appear in the "Fauna Hawaiiensis", and continued until 1913, when he completed the general introduction to the whole series. By this time he had already received the Linnean Society's Gold Medal for 1912.

During 1902–4 he worked for the Agricultural Department of the Territory in various capacities. But in 1904 the Hawaiian Sugar Planters' Association put him in charge of the new insect department of its experimental station. His work here with O. H. Swezey and F. Muir was mainly concerned with studying and controlling the pests of sugar cane, by introducing their natural parasites from their countries of origin.

Dr. Perkins was forced to retire in 1912 through ill-health acquired in the strenuous field-work under the exacting climatic conditions of Hawaii. He settled at Newton Abbot in Devon, but continued to work on his accumulated Hawaiian collections and to write about them for more than twenty years. He also continued his studies of British insects and made outstanding contributions to our knowledge of Strepsiptera, bees, crabronid wasps and sawflies. He was elected a Fellow of the Royal Society in 1920 and in 1951 an honorary Fellow of the Royal Entomological Society of London, of which he had been an ordinary Fellow for more than fifty years.

In 1901 he married Zoe, daughter of A. T. Atkinson, superintendent of public instruction, Honolulu, Hawaiian Islands; she died in 1940, and there are three surviving sons of this marriage. In 1942 he married Mrs. Clara Senior, of Highweek, Newton Abbot, and she died in 1949. His last days were sad ones, with blindness and failing strength. His loss will be regretted by the many who felt the inspiration of his genius and who experienced the encouragement he showed to those younger and less talented than he was.

Robert B. Benson

## Mr. H. L. Kirke, C.B.E.

Mr. Harold Lister Kirke, formerly head of the Research Department and assistant chief engineer of the British Broadcasting Corporation, died in London on August 25 at the age of sixty. He served in the First World War as an officer in the Royal Fusiliers, the Signals Branch of the Royal Engineers and the Royal Corps of Signals. Later he joined the Marconi Company and was concerned with the early development of radio telephone transmitters. He was one of the small band of enthusiastic engineers who established the Writtle experimental broadcasting station in 1922, and two years later he joined the staff of the B.B.C. In 1925 he became head of the development section, which later became the Research Department of the Corporation; and in this capacity he was responsible for many of the technical advances made by the B.B.C. over the ensuing twenty-five years.

Important contributions were made by Kirke to the development of high-quality sound broadcasting at various stages from the studio through the transmitters and aerial systems to the technique of reception. Latterly, his study of the problems associated with sound broadcasting at very high frequencies was particularly valuable, and the decision of the B.B.C. to adopt the V.H.F. frequency-modulation system was based to a great extent on his research work.

Kirke was an active member of the Institution of Electrical Engineers; he was chairman of the Radio Section during 1944–45, and a member of Council from 1947 until 1950. He was also a Fellow of the Institute of Radio Engineers of New York, and was vice-president in 1952. He played a leading part in forming the Acoustics Group of the Physical Society, and was chairman of the Group in 1947. He was appointed C.B.E. in 1947.

Many of those engaged in radio research over the past quarter of a century will remember Kirke as an enthusiastic and pleasant companion at technical visits and demonstrations, and as a wise counsellor at meetings of boards and committees. It was with great sorrow that all his colleagues and associates learnt of his retirement through illness in 1952, two years after his appointment as assistant chief engineer of the B.B.C.

R. L. Smith-Rose

## Lieut.-Colonel W. French, C.B.E.

Lieut.-Colonel William French, a member of the Council of the City and Guilds of London Institute, who was superintendent of the Institute's Department of Technology during 1934–49, died on September 18. Colonel French had had a varied career in the law, in the army during the First

World War, in the civil administration in Iraq, and in the iron and steel industry, before going to technical education. He joined the "City and Guilds" in 1929 at a time when the Institute was slowly recovering from the First World War. The subsequent remarkable expansion of its work until 1939 and the resumption of expansion from 1942 were largely due to his wise guidance. His major contribution was the building up of the Institute's system of advisory committees, where representatives of industry and education together plan and keep up to date the schemes of syllabuses and examinations upon which technical education, particularly at craft level, is based both in Britain and overseas. This advisory committee system transformed a rather rigid external examining body into an instrument sufficiently flexible to meet the developing needs of industry, yet sufficiently stable to maintain the high standards for which the "City and Guilds" has always stood.

Colonel French was especially successful in his personal relationships with the officers of the Board of Education and local education authorities, technical college staffs and those in industry (then fewer in number) who saw the need for better technical education. With his love of craftsmanship, his passionate concern for the well-being of young people, his transparent honesty and his pungent humour, he unobtrusively did much between the Wars in the technical education field to dispel misunderstanding and to promote that co-operation among technical examining bodies, teachers' organizations and professional and industrial bodies which nowadays is taken for granted. During the Second World War, though hampered by ill-health, he played a useful part in discussions preceding the drafting of the 1944 Education Act and, after the War, in the negotiations that ultimately led to the formation of the Associated Examining Board.

CYRIL LLOYD

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# NEWS and VIEWS

## Atoms for Peace Awards

DR. JAMES R. KILLIAN, jun., president of the Massachusetts Institute of Technology, is to be chairman of the Organization and Planning Committee of Atoms for Peace Awards. In addition to Dr. Killian, the Committee will include Dr. Detlev W. Bronk, president of the Rockefeller Institute for Medical Research and president of the National Academy of Sciences; Dr. Ralph J. Bunche, Under-Secretary General of the United Nations; Dr. Arthur H. Compton, formerly chancellor of Washington University; Mrs. Douglas Horton, formerly president of Wellesley College; Dr. Mervin J. Kelly, president of the Bell Telephone Laboratories; and Dr. Alan Waterman, director of the National Science Foundation. The Atoms for Peace Awards, it will be recalled, were established last summer as a memorial to Henry Ford and Edsel B. Ford by a Ford Motor Company Fund appropriation of 1,000,000 dollars. It will provide 100,000 dollars annually for ten years to be spent in helping to provide incentives for the world's scientists, inventors and engineers—without regard for nationality or political belief—towards finding new ways in which atomic energy can be used for the welfare of mankind. It is now announced that the Executive Committee of the Massachusetts Institute of Technology has agreed that the headquarters of the new institution be located at the Institute. In inviting Dr. Killian and the Committee to undertake the planning and organization of the Awards, Mr. Henry Ford II expressed the hope that the Committee "would set up the organization of the Awards so that the organization would be an independent corporate entity, entirely separate and divorced from Ford Motor Company".

In informing Mr. Lewis Strauss, chairman of the Atomic Energy Commission, of the establishment of the new institution on July 25, Mr. Ford described it as a response to the hope expressed by President Eisenhower at the July meeting of the "Big-Four" in Geneva that "private business and professional men throughout the world will . . . provide an incentive in finding new ways that this science can be used . . . for the benefit of mankind and not for destruction". Mr. Ford said at that time, "We would propose that when the organization of this new memorial fund is completed, the Board of Trustees of Atoms for Peace Awards appoint each year a competent International Jury of Awards for the purpose of selecting from among the world's scientists, inventors and engineers—without regard for nationality or political belief—the individual or group of individuals who, in the Jury's judgment, has made the greatest contribution during the year to peaceful uses of atomic energy; that the individual or group so selected be granted with appropriate ceremony the Atoms for Peace Award for that year; that the annual Award carry, in addition to a suitable medal to be designed and cast for the purpose, an honorarium of 75,000 dollars; that, if during any year the International Jury of Awards or the Board of Trustees finds no candidates pre-eminently meriting the Atoms for Peace Award, the sum at the disposal of the memorial fund be used that year for scholarships and fellowships most likely to contribute to the advancement of the new science of peaceful application of atomic energy".

## Massachusetts Institute of Technology: Prof. F. O. Schmitt

PROF. FRANCIS O. SCHMITT, at present head of the Department of Biology of the Massachusetts Institute of Technology, is relinquishing his post to take up the special appointment of Institute professor, and will be succeeded in the Department by Prof. Irwin W. Sizer, at present associate professor of biochemistry. The post of Institute professor is a special one designed to recognize outstanding achievement and to give its holder freedom to concentrate on research and advanced teaching; the only other person at the Massachusetts Institute of Technology who holds this rank at present is Prof. John C. Slater, the distinguished solid-state physicist. Prof. Schmitt's special field of study is in the use of the electron microscope for biological research, a field in which he became interested through his early work in X-ray diffraction and polarization optics for the study of the molecular organization of biological cells. After graduating from Washington University, St. Louis, in 1924, he did research work there, and also in Berkeley (California), London and Berlin. He became head of the Department of Zoology in Washington University and then in 1941 he went to the Massachusetts Institute of Technology, the year in which the first electron microscope for use in an academic biological laboratory was installed (now there are six such instruments in operation there). During recent years Prof. Schmitt has been working on the isolation of various protein molecules, using especially the giant nerve fibre of the squid. He is at present making studies of collagen in connexion with rheumatoid arthritis and the tanning of leather.

### Physics at Newcastle: Prof. W. E. Curtis, F.R.S.

The recent retirement of Prof. W. E. Curtis from the chair of physics at King's College (University of Durham), Newcastle upon Tyne, marks the end of a thirty-year period of considerable expansion in the Department of Physics of which he has been director. After holding the posts of lecturer in the University of Sheffield and reader in King's College, London, he went to Newcastle, to what was then Armstrong College, in 1926, as successor to Prof. Henry Stroud. He at once set himself to organize research in the Department and soon had a school of students working in his own subject of spectroscopy, to which later other branches of research were added. The teaching staff on his arrival consisted of four lecturers, a number which has been more than doubled in the ensuing years, while a reader and a professor of theoretical physics have been added to the staff. Beside directing the Department, Prof. Curtis has taken an important part in the administration of the College, being for several years sub-rector. Throughout the First World War he served in the Royal Navy, and during the Second he was in the Ministry of Home Security and then in the Armament Research Department, being superintendent of applied explosives during 1943–45. His work in spectroscopy was recognized by his election to the Royal Society in 1934, and during 1950–52 he was president of the Institute of Physics. Though he has now retired from his chair, Prof. Curtis still has a number of scientific activities, and he is at present remaining in Newcastle.

### Royal Society Antarctic Expedition

The advance party of the Royal Society International Geophysical Year Antarctic Expedition will leave Southampton on November 22 in the M.V. *Tottan* (540 tons) and will prepare the installation of a scientific research station on the Antarctic mainland, on the shores of the Weddell Sea, south of the Falkland Islands. Conditions permitting, it is hoped to set up the station in the Vahsel Bay region (78° S., 35° W.), which is one of great scientific interest for geophysical studies, and, if successful, a further party, eighteen strong, consisting mainly of scientific research workers, will sail in a year's time to relieve the advance party and complete the Royal Society's Antarctic station for the International Geophysical Year (July 1957–December 1958). The station will be one of twenty-two international geophysical stations being set up on the Antarctic mainland by British Commonwealth countries, the United States, the U.S.S.R. and other countries. The advance party will be under the command of Surgeon Lieut.-Commander D. Dalgliesh and will consist of three scientific workers—an electronic engineer from the Army, a radio-astronomer from Jodrell Bank (University of Manchester) and a meteorologist from the Meteorological Office—and six others. The pilot programme of scientific observations includes surface meteorological measurements, ionospheric research, auroral studies, measurements of atmospheric ozone and glaciological observations; among the scientific instruments will be an all-sky camera which will photograph the aurora australis. The chartering of the ship and the provision of all supplies has been done by the Falkland Islands Dependencies Survey acting through the Crown Agents, on behalf of the Royal Society. The Royal Society has been associated with Arctic and Antarctic expeditions for nearly two centuries: in 1772, in association with the Admiralty, it instructed Captain Cook to "explore the high southern latitudes with a view to determining the existence of a great antarctic continent".

### B.B.C. Colour Television Experiments

For some time past, the B.B.C. Research Department has been studying the technique of colour television, and recently a programme of experimental transmissions was started outside normal broadcasting hours. On October 20, Sir Harold Bishop, director of technical services, presented a special demonstration for the Press. This comprised the transmission over a closed circuit at the Alexandra Palace station, of still pictures, a short travel film and a number of 'live' camera shots, all of which were reproduced at the receiving end as attractive colour pictures. The technique used in this work is based on the American N.T.S.C. (National Television System Committee) adapted to the British 405-line definition and the normal bandwidth of black-and-white television in Britain. In this system, the red, green and blue components of a coloured picture are 'combined' into a pair of 'chrominance' signals, and a brightness or 'luminance' signal. The latter (luminance) signal can be made to give a compatible picture to a viewer possessing a black-and-white receiver; and the most important purpose of the present series of experimental transmissions is to determine whether this compatible reception—of a black-and-white picture from colour transmissions—is satisfactory. Viewers participating in these experiments are asked to report on any differences experienced in the sound and vision reproduction as compared with the normal reception of the regular black-and-white programmes. Sir Harold Bishop said that the results of these tests would be reported to the Postmaster General's Television Advisory Committee; but he thought it unlikely that a colour television service for Britain would be ready for at least three years.

### British Museum (Natural History)

The British Museum (Natural History) has purchased a new specimen of *Scelidosaurus*, a genus which is geologically the oldest armoured dinosaur. Up till now it has been known by one almost complete but somewhat distorted skeleton, already in the Museum, collected and prepared by James Harrison a century ago, and by a few isolated bones of a young *Scelidosaurus* more recently preserved in the Lyme Regis Museum. The latest acquisition was found about a year ago by Mr. J. F. Jackson, of Charmouth, a well-known collector of fossils. He discovered a large slab of Lower Liassic limestone which, on splitting, showed the bones of the hind leg, the hip girdle, and some of the backbone; there are also indications of the young stages of the bony plates of the back.

During the past few months the Department of Entomology of the Museum has been searching along the south coast of England from Kent to the Isle of Wight for two moths, *Hydraecia hucherardi* and *Lithophane lapidea*. Apart from their rarity, the interest of these two species, which are inhabitants of central and southern Europe, is in the further evidence their occurrence in southern England provides of the gradual change of the climate of the British Isles, a change which is already well supported by botanical evidence. Many specimens of *H. hucherardi*, the larva of which burrows in the roots of the marsh mallow, have been obtained, and the principal features of its life history have been ascertained; very few *L. lapidea* have so far been collected. Other recent work of the Museum includes a collecting trip to Yugoslavia by Mr. R. L. Coe, in order to obtain Diptera, more than nine thousand specimens being collected, during which contacts were made with the staffs of various scientific institutions. Another member of the staff, Mr. P. N. Lawrence, visited the south of France, where he collected more than four thousand specimens of Collembola in the neighbourhood of the Eastern Pyrenees. A very fine series of hydroid medusae from Plymouth and elsewhere, numbering about fifteen hundred specimens, has been presented to the Museum by Mr. F. S. Russell, director of the Marine Biological Association of the United Kingdom, Plymouth, and a collection of approximately a thousand slides of foraminifera from various horizons from the Cretaceous to Recent has been presented by Miss M. A. Waller.

## The Ishihara Test and Defects in Colour Vision

An interesting article by Mr. Peter Cavanagh on "The Ishihara Test and Defects in Colour Vision" has been published in *Occupational Psychology* (29, 1; 1955). The investigation was originally undertaken for the guidance of psychologists working in the Industrial Rehabilitation Units of the Ministry of Labour and National Service during the Second World War, and the Ministry has suggested that it should be given wider circulation. It is true that many people with defective colour vision are unaware of their condition, since they see all the things that other people see and they know what colours these things are said to have. This may be fairly adequate for ordinary life; but in certain critical situations they can run into difficulties and even danger, so that it is important that people should be tested for the accuracy of their colour vision. As with all tests concerning human beings, infallibility cannot be claimed; but, used with adequate controls, the test has proved to be of great value. Mr. Cavanagh discusses the incidence and types of defective colour vision, its congenital nature, as well as its occupational implications, with a detailed study of the test, its limitations and value and the technique for reducing error.

## Council for the Preservation of Rural England: Report for 1954–55

The twenty-ninth annual report, for 1954–55, of the Council for the Preservation of Rural England (pp. 30; London, 1955) is again a fully documented account of the action taken during the year to safeguard the amenities of rural England. On town and country planning, the Council welcomed the statement of the Minister of Housing and Local Government expressing determination to stop further unrestricted sprawl of the great cities, but regrets the fact that, apart from London, no other great city has defined a formal 'Green Belt' around it. Among other matters to which the Council has given its attention are the control of unsightly advertisements, the location of a number of mineral-working sites, the position of television stations and the distribution of electricity undertakings, the conservation of Nature, the landscape treatment of roads and bridges, pollution of the air, sea and rivers, and the preservation of buildings. In a separate report published by the Sheffield and Peak District Branch of the Council (pp. 30; Sheffield, 1955), an account is given of the vigorous opposition being made to the proposed road-racing circuit in the Peak National Park. Such a circuit was approved in principle by Derbyshire County Council on May 4 without consulting the Peak Park Planning Board; this one-sided action is possible because highway authorities are not subject to planning control.

## Association of Applied Biologists: Jubilee Volume

In September last year the Association of Applied Biologists celebrated its fiftieth anniversary by a five-day session in which many distinguished biologists took part and many interesting papers were communicated. The proceedings of the jubilee meeting have now been published as Vol. 42 of the *Annals of Applied Biology* (pp. 414+8 plates. Cambridge: University Press, 1955; 25s. net). In all, some thirty-nine speeches and papers are recorded. Some of these deal with general topics such as the changing problems of applied biology, contributed by Sir John Russell, progress in plant pathology by E. C. Stakman, and the contribution of pure science to applied biology by V. B. Wigglesworth. The others relate to a variety of special topics, including the pests of crop plants and of stored products, nematodes, virus and other diseases, the use of growth-regulating substances, education and extension services, crop protection, and the forecasting and assessment of plant diseases. Detailed references to individual papers cannot be made here, but the jubilee volume may unreservedly be recommended to readers in this field as one of exceptional interest and importance.

## Sheffield Interchange Organization: Work during 1954–55

At the twenty-second annual general meeting of the Sheffield Interchange Organization, held at the Central Library, Sheffield, another firm was admitted to the Organization, bringing the total membership to forty-one, including the University, the City Library, and industrial and government research institutions. 2,649 books, periodicals and other scientific and technical papers were exchanged during 1954–55. Among the matters under consideration were the difficulties experienced by members in obtaining United States government research reports within a reasonable time, and problems encountered in tracing and consulting university dissertations which might be of interest to industrial research workers. The City Librarian was asked to approach the appropriate authorities regarding the quicker supply of American reports, and he reported correspondence with the Standing Conference of National and University Libraries, which is attempting to standardize practice and remove some of the restrictions on the freer use of theses. It was agreed that all applications for this material should be made through the City Libraries in future. It was reported that the use made of the deposit collections of British, Canadian and American atomic energy reports in the Sheffield City Science and Commerce Library is increasing. These may be borrowed by any research worker or organization in the United Kingdom, and many have been lent in this way; but an increased number have been asked for by firms in the South Yorkshire industrial area served by the City Science and Commerce Library.

## Photometric Studies of a Lunar Eclipse

A PAPER in *Publications de L'Observatoire de Genève* (Sér. *A*, Fasc. 51; 1955) on "Observation of the Total Eclipse of the Moon on January 18–19, 1954", by M. Golay, deals with the results, obtained at the Observatory of Geneva, of the lunar eclipse of January 1954. The observations were carried out with the Schaer refractor, 20 cm. aperture, and were specially directed to a photometric study around 5750 A. This region was selected because Barbier and his collaborators had suggested many years ago that the region 5750–6000 A. should be specially studied, and four photographs were taken in the band 5600–6100 A., each with an exposure of 4 min. From the results a few deductions are made, some of which will be published later. It seems that certain rays may have travelled through a considerable depth of ozone; in addition, certain discontinuities referred to are in accordance with Danjon's law on solar cycles, and it is very probable that 1954 will prove to be the minimum of solar activity.

## Welsh Folk Museum, St. Fagans: New Handbook

SUCH is the speed of development of the Welsh Folk Museum at St. Fagans that a new edition of the handbook is welcome (pp. 29. Cardiff: National Museum of Wales, 1955; 1*s*.). The attractive format is similar to that in previous issues, though visitors and others will appreciate descriptions of the recently re-erected Stryt Lydan barn, the Esgair Moel woollen factory, the Abernodwydd and Kennixton farmhouses. It is interesting to note that three other buildings, including a Unitarian chapel dated 1777, have been accepted for re-erection. A part of the much-needed Museum block is now under construction.

## Washing of Treated Bronzes

IN the August issue of the *Museums Journal*, Mr. R. M. Organ, of the Research Laboratory of the British Museum, discusses the difficulties encountered in washing treated bronzes. These are shown to be due to the presence of corrosive agents in the untreated objects and to the effects of the reagents usually employed. Practical methods of washing and for controlling the process by measuring electrical conductivity are described.

## The Night Sky in November

NEW moon occurs on Nov. 14d. 12h. 01m., U.T., and full moon on Nov. 29d. 16h. 50m. The following conjunctions with the Moon take place: Nov. 8d. 05h., Jupiter 6° N.; Nov. 12d. 01h., Mars 6° N.; Nov. 16d. 07h., Venus 0·2° S. In addition to these conjunctions with the Moon, Mercury is in conjunction with Spica on Nov. 2d. 11h., Mercury 4·5° N.; Jupiter with Regulus on Nov. 8d. 13h., Jupiter 0·3° N.; Venus with Antares on Nov. 12d. 22h., Venus 4·1° N.; and Mars with Spica on Nov. 16d. 18h., Mars 3·2° S. Mercury rises at 5h. 10m. on November 1, which is nearly 1¾ hr. before sunrise, and may be seen for a short time in the eastern sky, stellar magnitude 0·7. Its proximity to Spica on November 2 has already been referred to. About the middle of the month, it rises an hour before sunrise and will not be easily observed; after this it draws closer to the sun, reaching superior conjunction early in December. Venus sets at about 17h. 10m. during November; its stellar magnitude remains −3·3, and the visible portion of its illuminated disk varies from 0·963 to 0·924. This decrease is just balanced by its decreased distance from the earth—from 152 to 142 million miles—in consequence of which its stellar magnitude remains unaltered. Mars rises about 4h. 20m. throughout the month. About November 9 it is a little south of θ Virginis, and its easterly movement takes it near κ Virginis at the end of the month. Its stellar magnitude varies from 2 to 1·9 owing to its distance from the earth decreasing from 232 to 216 million miles. Jupiter rises at 0h. 15m., 23h. 30m. and 22h. 40m. on November 1, 15 and 30, respectively. Its close approach on November 8 to α Leonis, which is about two magnitudes fainter than Jupiter, has been pointed out. Saturn, in conjunction on November 16, is too close to the Sun for favourable observation during the month. The Andromedid meteors appear towards the end of November, but this shower is much less prolific than it was in previous years; owing to strong moonlight, they will not be visible this year. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Nov. 9d. 03h. 23·5m., 55 Leo (*R*); Nov. 24d. 22h. 23·3m., 19 Psc. (*D*); *R* and *D* referring to reappearance and disappearance, respectively.

## Announcements

DR. J. S. CARTER, deputy chief inspector of alkali, etc., works, has been appointed chief inspector in succession to Mr. W. A. Damon, who is retiring; Mr. Damon will continue with the Ministry in an advisory capacity.

THE second World Congress on Fertility and Sterility, sponsored by the International Fertility Association, will be held in Naples during May 18–26, 1956 and will consist of twelve separate sections dealing with various topics, one of which will be on veterinary problems in animal reproduction. A general lecture will be given at the Congress by Prof. Nils Lagerlöf, of the Royal Veterinary School, Stockholm, on "Biological Aspects of Male Infertility". Those wishing to read papers must send in typed summaries by November 30 and full copies by January 31. All correspondence should be addressed to Prof. Edmundo G. Murray, Ayacucho 1375, Buenos Ayres, Argentina.

MESSRS. EDWARDS HIGH VACUUM (London), Ltd., have recently re-designed their model of the cold-cathode type of electron diffraction camera based on Prof. G. I. Finch's original design. Leaflet *E*.156/1 gives full details of the new model, which incorporates the latest vacuum valves, unions and fittings and pumping equipment, together with information concerning the electron diffraction technique and its applications.

# MARINE ORGANISMS AND BIOGEOCHEMISTRY

At the Bristol meeting of the British Association, a joint session between Sections D (Zoology), B (Chemistry) and C (Geology) was devoted to papers on the topic of "Marine Organisms and Biogeochemistry". Dr. C. F. A. Pantin, who was in the chair, stressed the value of joint meetings. It is in these borderline fields, he said, that many complex and interesting problems are found, which for a variety of reasons are generally more difficult to solve than those of the traditional scientific disciplines.

The first paper, by Dr. J. D. H. Wiseman, of the British Museum (Natural History), was on the rates of accumulation of nitrogen and calcium carbonate on the equatorial Atlantic floor. The rate of accumulation of nitrogen is, under ideal conditions, a measure of biological activity, and similarly the rate of accumulation of calcium carbonate is a measure of the productivity of those organisms which secrete calcium carbonate, provided there has been no solution subsequent to deposition. Dr. Wiseman said that geochemically it is significant to determine these rates, and to discover whether a change can be correlated with an alteration in some fundamental property in the upper layer of the sea. The investigation has been carried out on sixty sections each approximately ½ cm. thick. These were taken continuously down an equatorial Atlantic core, collected by the Swedish Deep-sea Expedition of 1947–48. Sedimentation in this core had apparently been continuous, and there was no evidence of disturbance by benthonic organisms, or through other causes.

In order to compute, from the percentages of nitrogen and calcium carbonate, rates of accumulation, it was necessary to determine the weight of dried salt-free sediment in a column of unit area through each section in its original moist condition (hereafter called weight of sediment in the section), as well as the number of years (the age) required to deposit each section. The weight of sediment in a section of known thickness can be computed from its chlorinity. The reason for this is because in highly calcareous deep-sea sediments, composed for the most part of planktonic foraminifera and a clay component, there is a relation between the weight of salt-free sediment in 1 c.c. of the moist sediment and its salt content. Age computations are, therefore, made from the weight in each section of selected elements, the rates of sedimentation of which have been shown to remain constant with time. Dr. Wiseman said that to understand the method it is necessary to appreciate the origin of the non-biological components of deep-sea sediments. The components may be divided into two classes: the hydrogenous components, and the unweathered high-temperature minerals derived from the lithosphere. Included in the hydrogenous components are the secondary minerals formed by ionic reactions in the continental hydrosphere. There are also substances precipitated in the marine hydrosphere—for example, as hydroxides—and some probably in the form of alumino-silicate sols. In addition, there are elements chemically scavenged from sea water. The high-temperature lithogenous minerals are derived from the land, as well as from submarine rocks and volcanoes. Minerals from this source are fortunately very rare in this core.

If the rate of sedimentation of any one of the components of either class changed, this would in general be reflected in a change of chemical composition. For example, if there were a sudden addition of the lithogenous mineral ilmenite, this would be shown by a change in the titanium percentage when expressed on a carbonate-free basis, as well as in the iron/titanium ratio. Dr. Wiseman then gave the theoretical reasons for constancy in the rate of sedimentation of the hydrogenous components in those areas of the deep-sea floor where there had been no superimposed complications. Changes in the rate of sedimentation of the non-biological components were found in terrigenous sediments (derived largely from the land), and in some deep-sea sediments, especially those from volcanic regions, or where there had been sediment transportation by turbidity currents. It was therefore essential, before computing age, to check from the chemical composition of each section that the rates of accumulation of the selected elements had remained constant with time, and that there had been no post-depositional chemical movement.

The percentages of iron and titanium, expressed on a carbonate-free basis, as well as the iron/titanium ratios, showed in this core no appreciable variations. From this it was concluded that there were no significant changes in the rates of accumulation or post-depositional movement of these two elements. The age of each section was computed from the iron and titanium percentages, and where there were notable percentage differences between the two results (the greatest was 12 per cent), it was possible to make an objective choice.

A graph of the rates of accumulation of calcium carbonate for each section shows that the annual rate varies between 0·9 and 1·1 mgm./cm.$^2$ during the past 7,000 years; then there is a rapid fall, and at approximately 15000 B.C. the rate is 0·28 mgm./cm.$^2$. Similarly, the annual rate of accumulation of nitrogen varies between 2·4 and 3·6 × 10$^{-4}$ mgm./cm.$^2$ during the past 7,000 years, followed by a rapid fall to 1·1 × 10$^{-4}$ mgm./cm.$^2$ at approximately 16000 B.C.

Biological examination has demonstrated that when the foraminiferal assemblage was of a warmer type, the rates of accumulation of both calcium carbonate and nitrogen were higher. This conclusion is strongly supported by the temperatures (Table 1) at which the shells of planktonic foraminifera were deposited. These temperatures are based on oxygen-18 measurements, carried out by Dr. C. Emiliani.

Dr. Wiseman concluded that, in the equatorial Atlantic Ocean about 15000 B.C., when the upper layer of the sea was about 5 deg. C. cooler, the rates of accumulation of both nitrogen and calcium carbonate were approximately a third of their present-day values.

The second paper, by Mr. M. V. Strong, of the British Petroleum Research Station, was on iron bacteria as rock-forming organisms. Mr. Strong said

Table 1

| Section No. | *P3* | *P46* | *P48* |
|---|---|---|---|
| *Globigerinoides sacculifera* | 24·3° C. | 21·2° C. | 20·1° C. |
| *Pulleniatina obliquiloculata* | 21·0 | 17·9 | 17·1 |
| *Globigerina dubia* | 19·7 | 15·0 | 13·6 |
| *Globorotalia menardii* | 18·7 | 16·8 | — |
| *Globorotalia tumida* | 15·3 | 13·6 | 13·8 |
| Annual rate of accumulation of calcium carbonate | 1·00 mgm./cm.$^2$ | 0·46 mgm./cm.$^2$ | 0·34 mgm./cm.$^2$ |
| Date of mid-point of section | A.D. 1200 | 11750 B.C. | 12800 B.C. |

that the object of his paper was to bring to the attention of microbiologists organic remains, apparently bacterial, preserved in Permian rock salts. Most of the material investigated is from a deep bore-hole at Eskdale. Some of the forms described by Mr. Strong are identical with those in lower Palæozoic rock salts of Saskatchewan. It is of considerable interest that this organic material has so far been found only in red rock salts, in which the iron is present in minute hæmatite crystals, or possibly goethite.

The organisms occur as bright red discrete aggregates, which float upwards on dissolving the salt; the most common forms being needles up to ½ mm. in length. They may be sinuous or straight, and are apparently without branches; the threads may form a network, or may be set in a fine membrane of yellowish material. Rarely the threads show a swollen termination, either cylindrical or spindle-shaped with a grooved point. They are highly resistant to heat and acids, and no internal structure has been seen.

Another common form includes fragments of membranous tissue, sometimes apparently structureless, and at other times enclosing a close mesh of threads. A third form is a cyst-like, lozenge-shaped sac of permeable membrane, enclosing liquid. The length is ½–1 mm. and the width slightly smaller. Twisted threads recalling *Gallionella* occur in the form of ribbons. Mr. Strong suggested that the deposits of hæmatite found on certain islands in the Persian Gulf may be due to the solution of salt plugs in sea water.

The third paper, on the biogeochemistry of strontium, was by Dr. H. J. H. Bowen, of the Atomic Energy Research Establishment, Harwell. Since the advent of nuclear fission, there has been considerable interest in the biological fate of strontium, as two of its isotopes are among the longer-lived fission products of uranium-235. In particular, strontium-90 constitutes the major hazard, since its half-life is approximately twenty years. The element is readily taken up by plants, and in consequence may be concentrated in the bones of animals feeding on contaminated fodder. Although strontium is widely distributed in Nature, little is known about its behaviour in living organisms, apart from the fact that it tends to follow calcium. Limited knowledge about the biological behaviour of strontium is due in part to the lack of sufficiently sensitive analytical techniques for determining small amounts of the element, as well as to chemical interference of calcium, which in biological material is always present in large amounts. Spectrometric determinations are never very precise, and can seldom determine less than $10^{-8}$ gm./ml. of the element. The method of activation analysis, developed at Harwell, is sufficiently precise to determine $10^{-7}$ gm./ml. of strontium and is a major advance in the study of the inactive element. The method is used for investigating the occurrence of strontium in rocks, plants, marine organisms and sea water.

In view of the similarity of strontium to calcium, the calcium/strontium ratio is a better index of concentration by an organism than its absolute content. For example, the ratio is 50/1 in sea water, whereas in marine algae (*Laminaria*) it is about 10/1, and in molluscan shells about 200/1. Dr. Bowen concluded from these figures that *Laminaria* prefer strontium to calcium by a factor of five, whereas molluscs reject strontium from their shells by a factor of four. The calcium/strontium ratio in sea water is remarkably small compared with the ratio in most igneous and sedimentary rocks, where it ranges from 100/1 to 1,000/1. Strontium is, therefore, an element which accumulates in the sea, whereas calcium is removed by marine organisms and, to a small extent, by chemical precipitation.

In contrast to its behaviour in marine algae, strontium is neither rejected nor accumulated by the majority of land plants. The calcium/strontium ratio in the plant is generally similar to the available ratio in the soil on which the plant grows. However, in the Bristol district, where there are deposits of celestine, the strontium content of the soil is very high, and plants from this soil reject strontium in favour of calcium. In the Avon Gorge, a locality rich in strontium, one of the rare plants, the Bristol rock cress (*Arabis stricta*), may accumulate strontium. Further work is, however, required, because the low calcium/strontium ratio may in part be due to strontium contamination on its leaves.

J. D. H. WISEMAN

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# SURFACE RHEOLOGY

## ANNUAL CONFERENCE OF THE BRITISH SOCIETY OF RHEOLOGY

THE annual conference of the British Society of Rheology was held in the Washington Singer Laboratories of the University College of the South West, Exeter, during September 22–24. Dr. S. Gregg (University College, Exeter) opened the conference with a paper on the effect of adsorption on the strength of brittle solids. After summarizing the general theory of the subject, he described his recent experimental work, assisted by Dr. D. Dollimore and Dr. A. Desai, on the strength of compacted disks of compressed powders, broken *in vacuo* and in controlled atmospheres. Adsorption isotherms were prepared. The density of elastic energy located between two planes at distance $a$ apart is $\frac{1}{2} \cdot \frac{\sigma^2}{E} \cdot a$, where $\sigma$ is the stress and $E$ Young's modulus. Although, in the case of glass at the rupture point the value of $\sigma_{\max.}$ is calculated to be $10^{11}$ dyne cm.$^{-2}$, the experimentally measured value is about one-hundredth of this amount. The discrepancy is attributable to the weakening effect of the adsorption of water molecules on the surfaces of incipient cracks. The reduction in surface energy on exposure to vapour, $(\gamma_{\text{vac.}} - \gamma_{\text{vap.}})$, in relation to the amount adsorbed per gm. of solid is $\frac{RT}{SM}\int_0^p x \, d \ln p$, where $S$ is the specific surface, $p$ the pressure of adsorption and $M$ the molecular weight. Graphs relating the breaking strength of disks of compacted calcium carbonate, kaolin and boric acid powders, measured under different states of adsorption and desorption, together with derived graphs relating strength and surface energy, etc., were shown.

When benzene vapour replaced that of water in the experiments the strength of the disks remained practically unchanged, although the vapour had been strongly adsorbed with a consequent fall in surface energy. Dr. Gregg explained this anomaly as being due to the relatively large size of the benzene molecule, the ingress of the vapour into the cracks being prevented. In the discussion the meeting supported this view, and considered explanations of other anomalies found under conditions of supersaturation, and the partial absence of hysteresis with boric acid during adsorption and desorption.

In a paper on lubrication by films of solid materials, Miss E. Kay spoke on an investigation at the Royal Aircraft Establishment, Farnborough, made jointly with Mrs. E. Bielak and Dr. E. W. J. Mardles, in which a wide variety of fine powders, including metallic stearates, waxes, polytetrafluoroethylene, molybdenum sulphide, graphite, etc., dry and dispersed in liquid media, were examined under different conditions and between various bearing surfaces. Dry lubrication is often preferable both under the condition of a wide temperature-range, such as that with aircraft, −80° C. to beyond 250° C., and with light mechanisms of precision when oil seepage and creep, even of 'non-spread' oils and with use of 'epilame' barriers, tend to produce dry bearings and alteration in the inertia of fine moving parts. It was found that with a dry lubricant, although a higher coefficient of friction may be obtainable, the coefficient changes but little over a wide temperature-range. A wide scatter of results obtained with powders under some conditions is attributed to the inclusion of moisture or of oil, to failure of the surface to retain the solid lubricant and to physical changes. Considerable attention is required to find the best method of applying solids for different lubricating purposes.

Members of the meeting then discussed the effect of particle size and shape and the relative merits of dry powders and their use in oil and grease dispersions.

A. F. Latham with Dr. K. G. A. Pankhurst (British Leather Manufacturers Research Association, Egham) spoke on surface viscometry—the tanning of protein monolayers. Insoluble monolayers, spread on a water surface, may exist in a variety of states of aggregation ranging from a rigid two-dimensional 'solid' to an almost perfect surface 'gas'. Mr. Latham described the design and use of a rotational viscometer for measuring the viscous drag of these surface films and distinguishing between Newtonian and non-Newtonian flow.

Protein monolayers exhibit a wide variety of surface rheological properties according to the surface pressure. The changes are reversible and, in the case of serum albumen, can be interpreted by change from the α- to β-keratin pattern. The surface viscosity of collagen is much lower than that of serum albumen due to reduced inter-chain linkage; but, when spread on a tanning material such as mimosa tannin, the surface viscosity increases by nearly a thousandfold. Mr. Latham described how use is made of the rate of formation of cross-linking to investigate tanning reactions. In reply to queries, he spoke on results obtained with a number of substrates and on the technique used for examining various rheological properties of the monolayers.

In a paper on surface films of poly-di-methyl siloxanes on organic liquid substrates, Dr. W. H. Banks (Printing, Packaging and Allied Trades Research Association, Leatherhead) considered the spreading behaviour of a silicone fluid of average molecular weight 2,000, its surface films having the property of suppressing the foaming of oils and the mottling of paints. The special apparatus developed for the study was described, and graphs were shown relating results obtained for film pressure and film area. Hysteresis effects were observed. Lycopodium was used for observing the rate of spreading on a variety of organic liquids, which was found to be in accord with the relation $l \propto \sqrt{t/\eta}$, $l$ being distance moved, $t$ time in sec. and $\eta$ the viscosity of the substrate. The movement of the surface films caused a gradient in the substrate, a film of thickness 25 A. being sufficient to cause motion. In the discussion that followed, members considered possible mechanisms of action of silicone fluid films in suppressing foaming, mottling, evaporation and surface turbulence.

In their paper on the rheological properties of dispersions as criteria of the degree of wetting, Dr. E. W. J. Mardles (Farnborough) and Mr. A. de Waele (Gestetner, Ltd.) first pointed out the difficulties of ascertaining the degree of wetting of a solid surface by a liquid using the Young–Dupré equation modified by Harkins. Contact angles at 'equilibrium' may not exist due to the presence of adsorbed liquid films beyond the periphery of the pool, and the spreading of a liquid over a solid surface can be shown to be non-Newtonian. Although there is some correlation between heats of immersion of powders in various liquids and the rheological properties of their dispersions, numerous exceptions occur due possibly to the fact that the wetting of a surface by a liquid continues over a long period of time. Evidence of this is given by a decrease with time in the viscosity of a freshly made dispersion, by the decrease in the coefficient of friction by oil between bearings during several hours of wetting, and by electrical conductivity measurements which, in the case of a dispersion of carbon black in liquid paraffin (British Pharmacopœia), continued to change over a period of twelve months. The authors presented results in graphical form indicating the effect of adding wetting-agents on the rheological properties and conductivity of a number of suspensions. Using one powder dispersed in a variety of liquids, or several different powders dispersed singly in the same liquid, the concentration by volume being the same, the rate of aggregation of the particles (indicated by the rheological constants, by the sedimentation-rate and volume, and by conductivity tests) was found to vary considerably, the variations being related to the degree of wetting of the particles by the dispersing media.

The conference included an afternoon visit to the works of the Exeter Brick and Tile Co., Ltd., when Dr. H. H. Macey gave a talk on rheological problems connected with clays and ceramics. At the annual general meeting of the Society, Prof. J. G. Oldroyd was elected president.

E. W. J. Mardles

# INDUSTRY AND TECHNICAL EDUCATION IN GREAT BRITAIN

A CONFERENCE on "Industry and Technical Education", organized by the Regional Advisory Council for the Organization of Further Education in the East Midlands and by the North Midland Regional Council of the Federation of British Industries, was held at the College of Technology, Loughborough, on April 21, 1955, and the report of the conference has now been published*. It contains the text of the chief addresses and summaries of the discussions at the two sessions.

At the first of these sessions, which considered the relation between part-time, full-time and sandwich courses, Dr. H. L. Haslegrave, putting the point of view of the technical college, expressed the opinion that the technical college is concerned with the development of the whole man, his character and his mind, and that the best training in the application of knowledge is to use it by actually doing things. He emphasized the importance of technical colleges, as well as industry, making full use of their personnel even if it involves a policy of concentration of courses. He thought that the field for full-time courses of three to five years is restricted to branches of industry in which extensive practical training is unnecessary or in which facilities for such practical training do not yet exist. Courses for semi-skilled and skilled personnel, for technicians and for professional men should be regarded as of equal importance. Putting the point of view of the engineering industry, Air Commodore W. C. Cooper said that for the professional engineer or technologist a full appreciation of the economic factors is as essential as high standards of technical competence and knowledge. He thought, however, that there is a danger of overstressing the need for such men and women, because in the main the new knowledge must come from those who have received the equivalent of a full-time university education of at least three years, and he questioned the desirability of employing those so trained in technological applications. He did not think that the sandwich course is the ideal form of training for technical staffs, preferring an industrially based residual training in industrial colleges specifically created for the purpose.

Mr. R. B. Simpson, speaking for the textile industry, thought that, for persons fifteen years old leaving secondary modern schools, technical colleges provide the opportunities and encouragement to obtain the qualifications which employers can recognize as an accepted standard of achievement in their particular sections of the textile industry. The technical colleges also have to cater for grammar-school boys, particularly those who have failed to achieve the necessary subjects at the Ordinary level of the General Certificate of Education to enable them to go forward to a degree. For graduates, they provide the courses, possibly a sandwich course, leading to an associateship of the Textile Institute. The discussion also emphasized the importance of developing loyalties in young people, by showing them how their work helps both their companies and contributes to the welfare of the whole community, and the value of those who are technically qualified and possess the ability to get the best out of their workpeople.

The second session was concerned with the promotion of increased co-operation between industry and technical education. Mr. R. E. Wood dealt with the functions of the governing body and advisory committees of a technical college, and stressed particularly the value of part-time staff from industry. Mr. F. Stephenson, dealing with the work of local education authorities in this field, thought that the Regional Advisory Council is the most effective means for promoting increased co-operation; but he also stressed the value of adequate grants to students and of major awards for full-time students at technical colleges. Mr. J. C. McMeeking, reviewing the existing machinery for promoting co-operation, thought that, though it goes a long way towards meeting the needs, it could be improved by giving more attention to the needs of small firms and by making craft training in colleges more practical. Every effort should be made to release more teachers for periods in industry, and it is desirable to include more members from industry on governing bodies as well as to obtain the active interest of the foremen and middle-management. Conferences of technical teachers and industrialists (including foremen) would be of mutual benefit.

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* Report of the Conference on Industry and Technical Education. (Organized by the Regional Advisory Council for the Organization of Further Education in the East Midlands and the F.B.I. North Midland Regional Council, and held at the College of Technology, Loughborough, 21 April 1955.) Pp. iii+41. (London: Federation of British Industries, 1955.) 4s.

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# ENGINEERING AND PURE SCIENCE

FOR the twenty-third Andrew Laing Lecture which he delivered on December 10, 1954, to the North East Coast Institution of Engineers and Shipbuilders, Sir Edward Appleton chose as his subject "The Partnership of Science and Engineering". That there is a natural partnership between science and engineering may be illustrated by innumerable examples, current and historic, and, in developing his theme, Sir Edward selected his illustrations from widely varied fields. His aim was, however, not so much to demonstrate the existence of this partnership as to emphasize its importance under modern conditions.

Making a clear distinction between pure science and engineering based on the principle that the aim of engineering is essentially 'constructional', Sir Edward went on to consider the differences between scientific discovery and invention. A scientific discovery, he pointed out, does not necessarily involve invention, although it will, in general, increase the area of invention, and conversely an invention is not necessarily directly associated with scientific discovery. Speaking of the essential distinctive quality of invention, Sir Edward said that the inventive step must contain more than deductive reasoning. "Indeed," he remarked, "my own view is that the impact of an invention on the minds of others skilled in the art, should engender surprise."

The development of engineering as an art has from its early beginnings stimulated inventions and discoveries which can properly be classed in the field of pure science, and likewise advances in scientific knowledge have been turned to account in the practice of engineering. As a notable example of collaboration between the engineer and the pure scientist, Sir Edward referred to the development of vacuum technique during and subsequent to the First World War. Before the First World War the gas pressure in electric lamp bulbs was of the order of $10^{-3}$ mm. of mercury, while at the present day the residual gas pressure in certain valves can be as low as $10^{-8}$ mm. of mercury. It is largely as a result of these improvements in vacuum technique and their influence on the 'longevity' of thermionic valves that projects such as that of trans-Atlantic telephone cables have become practicable. In the submerged repeaters of the present trans-Atlantic cable, there are some three hundred valves, and the success of the scheme depends upon these valves having lives of the order of twenty years. The development of the thermionic valve has provided the technical basis for the building up of an entirely new subject, namely, that of electronics.

The release, in useful form, of the energy of nuclear fission is, of course, the supremely important new application of physical science in the field of engineering. After describing the basic phenomena of the disruption of the uranium-235 nucleus and mentioning that the first self-sustaining pile generating heat by a nuclear fission chain was set up by Fermi in Chicago in 1942, Sir Edward stated that, in the nuclear energy station at present under construction in Cumberland, the reactor temperature would be maintained at about 400° C. and that carbon dioxide gas under pressure would transfer heat from the uranium-graphite core to steam-raising equipment which would operate electrical generating equipment of normal type. Because of the temperature limitation in the reactor, however, it is unlikely that the overall efficiency of this station will exceed 25 per cent. Sir Edward went on to mention the principles of the 'breeder pile' and the problems associated with it. He then remarked: "You will have seen that the subject is now so far developed that much of the work is out of the hands of the physicist working alone. But I do want to stress that our nuclear engineer will be dealing with problems which, as an engineer—be he civil, mechanical or electrical—he will never have encountered before. Materials will have to take on for him an entirely new meaning." There would be problems associated with materials hitherto unfamiliar in engineering practice, important because of their neutron-absorbing properties, together with exceedingly important metallurgical questions concerned with the development of materials for use at temperatures much higher than those which had been common in the past. "It seems to me," he went on, "that our interest in the nuclear energy field should be one of intense preoccupation. I see, ahead, the development of an enormous industry based on technology—the industry of not only supplying ourselves with nuclear electricity generating stations, but of supplying other countries with them and possibly selling them fissile materials which we have ourselves produced from fertile uranium or thorium."

Remarking that his examples had so far been drawn from the realm of physics and engineering, Sir Edward turned to several instances of the co-operation of the chemist and the engineer. He took first that of the extraction of germanium from flue dust. This metal, which is now of immense importance as a semiconductor for the manufacture of diodes and triodes for the electronics industry, may be present in a proportion of the order of 0·5–1·0 per cent in flue dust. A novel metallurgical treatment has been developed which is much more successful in extracting the metal from certain dusts than the ordinary acid treatment. Sir Edward then mentioned some of the problems associated with the manufacture of titanium and zirconium, the use of sodium benzoate as a corrosion inhibitor and finally, as an example of existing technological development facilitating the work of the pure scientist, the application of the technique of distillation to such laboratory processes as the fractionation of isotopes.

In his concluding remarks, Sir Edward referred to the importance of the development of automatic methods in the manufacturing industry. This is a revolutionary development which will call for statesmanship on the part of both management and labour. He also spoke with approval of the policy of the Atomic Energy Authority in respect of regarding industrial firms as the appropriate bodies to carry out the design as well as the construction of nuclear power plants. He regarded it as essential that nuclear scientific and engineering knowledge should be available to manufacturing firms. The close and effective partnership of science and engineering is, in his opinion, something which is absolutely vital to the economic progress of Great Britain.

# NATIONAL PHYSICAL LABORATORY NOTES ON APPLIED SCIENCE

THE latest publications in the series "Notes on Applied Science" of the National Physical Laboratory, Teddington*, illustrate the wide range of investigations undertaken by the Laboratory, since all three are based on actual experience at the Laboratory. No. 10 in the series, "Noise Measurement Techniques", deals with the measurement of noise, defined as "any sound which is undesired by the recipient"; and is intended to act as a guide to the choice of methods and techniques suitable for the measurement of the physical characteristics of noise in varying circumstances. In two introductory sections, the general, physical and subjective characteristics of noise and the principles of broad-band and narrow-band analysis are discussed, and the remainder of the booklet is devoted to a detailed description of noise-measuring equipment, its operation and calibration. Microphones, pre-amplifiers, output meters, recorders and analysers are given full and adequate treatment, and the booklet concludes with a brief, illustrated, account of the Mobile Acoustical Laboratory at Teddington.

The second booklet, No. 11, is concerned with wind effects on bridges and other flexible structures, and is based on wind-tunnel research carried out in the Aerodynamics Division of the Laboratory, where extensive investigations have been made recently on the oscillatory effects of winds on models of two proposed suspension bridges—the Severn Bridge between Beachley and Aust, and the Runcorn–Widnes Bridge over the River Mersey. Most of the booklet is devoted to oscillatory effects although brief reference is made also to static wind loads; while bridges are the primary concern of the booklet, much of the content is also applicable to other flexible structures, such as tall chimney stacks, transmission lines and buildings. It is emphasized that an examination of the history of bridge failures reveals that a bridge ails because of both static action of wind (that is, a tendency to give the bridge a steady deflexion) and dynamic action (that is, a tendency to set the bridge oscillating), and that, in addition, the dynamic effects can occur in two ways, termed aerodynamic instability and buffeting. The experimental methods to investigate static action, aerodynamic instability, and buffeting on bridges are described in detail and the necessary equipment and the models used at the Laboratory are illustrated.

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* National Physical Laboratory: Notes on Applied Science. No. 10: Noise Measurement Techniques. Pp. iv+40+8 plates; 2s. net. No. 11: Wind Effects on Bridges and other Flexible Structures. Pp. iv+14+7 plates; 1s. 6d. net. No. 12: Calibration of Temperature-measuring Instruments. Pp. iv+47+2 plates; 2s. net. (London: H.M.S.O., 1955.)

The third booklet, No. 12, entitled "Calibration of Temperature-Measuring Instruments", refers to a different but important section of the National Physical Laboratory's work, namely, the maintenance of standards, and in this particular case to the basic scales of temperature and the instrumental means by which they are realized. It is the most up-to-date text on the subject, and should receive the widest possible circulation. It sets forth clearly what is meant by a temperature scale, and draws a careful distinction between accuracy and reproducibility in temperature measurement, quoting as an example that the sulphur boiling point, defined as 444·600° C., may be reproduced with the platinum-resistance thermometer to about 0·005 deg. C., but its value by gas-thermometer observation is not known to better than ±0·1 deg. C. The various arrangements for the realization of the primary fixed points, including the triple point of water, and the necessary precautions to be taken, are described in detail, in addition to the primary standard and working standard instruments used at the Laboratory. One section is devoted to a description of the methods used for the routine testing of temperature-measuring instruments, and another to the baths and furnaces used in comparison tests with standard instruments; in an appendix, the definition of the 1948 International Temperature Scale is reproduced.

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# METABOLISM OF PROPIONIC ACID IN ANIMAL TISSUES

By Dr. MARTIN FLAVIN[*], PRISCILLA J. ORTIZ and Prof. SEVERO OCHOA

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ANIMAL tissues can oxidize propionic acid; but the mechanism of this oxidation has long remained obscure. Some workers believe that this fatty acid undergoes α-oxidation to yield acrylic, lactic and pyruvic acid[1–3], the latter being oxidized to carbon dioxide and water via the citric acid cycle. However, experiments on the distribution of carbon-14 from labelled propionate in tissue glycogen[4] and acetyl groups[5], or in lactate[6], indicated the occurrence of a symmetrical intermediate between propionate and pyruvate, such as would be formed if propionate or acrylate were first carboxylated to succinate or fumarate, followed by oxidation of the dicarboxylic acid through the citric acid cycle. This possibility appeared to be strengthened by the finding of bacterial enzymes which catalyse the reverse reaction, that is, the decarboxylation of succinate via succinyl coenzyme A, to propionate[7]. More recently, an adenosine triphosphate-dependent conversion of propionate to succinate by fixation of carbon dioxide has, in fact, been reported to occur in liver extracts[8].

## Biosynthesis of Methylmalonate

We have found that dialysed extracts and ammonium sulphate fractions of pig heart, supplemented with propionyl coenzyme A, adenosine triphosphate and magnesium ions, fix carbon-14 dioxide to form a compound easily hydrolysed by alkali to yield carboxyl-labelled methylmalonic (*iso*succinic) acid[9]. The latter has been identified by (*a*) paper chromatography and autoradiography, (*b*) recrystallization with carrier, and (*c*) recovery of radioactivity in a derivative, C-methylbarbituric acid, or in propionic acid and carbon dioxide following decomposition at 150°. Under optimal conditions for the synthesis of methylmalonate, no succinate is formed by the pig heart preparations. The conversion of propionate to methylmalonate has been independently observed by Katz and Chaikoff[10] in rat liver slices.

The requirements for methylmalonate synthesis are shown in Table 1. It may also be seen in the table that propionyl coenzyme A can be replaced, although less effectively, by a mixture of propionate and coenzyme A. Under these conditions, propionyl coenzyme A is undoubtedly formed through reaction 1, catalysed by the acetate activating enzyme[11,12], which is also active with propionate.

$$\text{Propionate} + \text{CoA} + \text{ATP} \rightleftharpoons \text{Propionyl CoA} + \text{AMP} + \text{PP} \quad (1)$$

Little or no fixation (or exchange) of carbon-14 dioxide was observed with acrylyl or succinyl coenzyme A in place of propionyl coenzyme A, or with succinate or

Table 1. REQUIREMENTS FOR ENZYMATIC SYNTHESIS OF METHYLMALONATE FROM CARBON-14 DIOXIDE AND PROPIONYL COENZYME A

| Components | Carbon-14 dioxide fixed (per cent)* |
|---|---|
| Complete system† | 6·0 |
| „ „ + coenzyme A | 6·0 |
| No enzyme | 0 |
| No adenosine triphosphate | 0·03 |
| No magnesium chloride | 0 |
| No propionyl coenzyme A | 0·02 |
| „ „ „ propionate | 1·5 |
| „ „ „ methylmalonate | 0·1 |
| „ „ „ succinate | 0·02 |
| „ „ „ succinyl coenzyme A | 0·01 |

* Results from several experiments.

† Consisting of following components (in μmoles): tris(hydroxymethyl) aminomethane buffer, pH 7·0, 50; magnesium chloride, 2; reduced glutathione, 5; adenosine triphosphate, 2; propionyl coenzyme A, 1; potassium bicarbonate-$^{14}$C, 10; pig heart extract with 5 mgm. protein. Volume, 1·0 ml. Other additions, each 1 μmole except succinyl coenzyme A, 2 μmoles. Coenzyme A added in the last four experiments. Incubation 60 min. at 25°. Heart and other extracts prepared by homogenizing fresh tissue in a Waring blendor with 4 volumes of 0·05 *M* potassium phosphate buffer, pH 7·4, containing 0·2 *M* potassium chloride, and centrifuging 15 min. at 25,000 *g*. Supernatant dialysed overnight against 0·02 *M* potassium phosphate buffer, pH 7·0, containing 0·001 *M* neutralized L-cysteine. All operations carried out at 3–4°. Fractions obtained from the extracts by precipitation with ammonium sulphate between 30 and 50 per cent saturation, and dialysed as above, have also been used.

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[*] Postdoctoral fellow of the American Heart Association. Most of this work was done while the author was assigned from the Laboratory of Cell Physiology, National Heart Institute, National Institutes of Health, U.S. Public Health Service.

methylmalonate plus coenzyme A in place of propionate and coenzyme A.

The requirement of adenosine triphosphate for the synthesis of methylmalonate from propionyl coenzyme A and carbon dioxide indicates that phosphate bond energy is utilized in this reaction and recalls the results of Bachhawat *et al.*[13] with a possibly analogous reaction, the carboxylation of β-hydroxy*iso*valeryl coenzyme A to β-hydroxy-β-methylglutaryl coenzyme A.

As already mentioned, the immediate product of the adenosine triphosphate-dependent carboxylation of propionyl coenzyme A in pig heart extracts is not free methylmalonic acid but an activated form of this compound. Thus, on addition of hydroxylamine at the end of incubation for an hour of pig heart extract with coenzyme A, adenosine triphosphate, magnesium ions, propionate and carbon-14 dioxide, about 80 per cent of the carbon-14 dioxide fixed in non-volatile compounds can be recovered in the methylmalonmonohydroxamic acid area of paper chromatograms, and 20 per cent in free methylmalonic acid. Control experiments excluded the possibility that free methylmalonic acid is formed first and activated afterwards. Similar results are obtained when hydroxylamine is present throughout the incubation, except that, in this case, there is formation of unlabelled propionhydroxamic acid besides labelled methylmalonmonohydroxamic and methylmalonic acids. Whether or not any diactivated methylmalonate is formed during the incubation cannot yet be stated.

## Isomerization of Methylmalonate

In contrast to the pig heart preparations, dialysed extracts of rat heart, liver or kidney, or of sheep kidney, with little or no succinoxidase activity, form both carboxyl-labelled methylmalonic and succinic acids (or labile derivatives thereof) from propionyl coenzyme A and carbon-14 dioxide, in the presence of adenosine triphosphate and magnesium ions. Succinate was identified by paper chromatography followed by autoradiography, and by recrystallization with carrier. It can be readily differentiated from methylmalonate by heating with acid permanganate—a treatment which quantitatively destroys methylmalonate but does not affect succinate.

These results suggested to us the possibility of an enzyme-catalysed interconversion of methylmalonate and succinate, a hypothesis that was quickly shown to be correct by the finding that methylmalonate-1-$^{14}$C is largely converted to succinate (or a labile derivative thereof) on incubation with the above dialysed liver or kidney (but not pig heart) extracts[9]. In fact, this isomerization is usually the only reaction which methylmalonate can be shown to undergo in the crude extracts. Under some, as yet poorly identified, conditions, 5–10 per cent of the radioactivity of carboxyl-labelled methylmalonate can also be recovered as carbon-14 dioxide, presumably due to a more or less direct decarboxylation, rather than to oxidation of succinate. As shown in Table 2, the conversion of methylmalonate to succinate requires coenzyme A and adenosine triphosphate, and is markedly increased by the presence of magnesium ions. These requirements suggest activation of methylmalonate to methylmalonyl coenzyme A as a preliminary step for isomerization. It should also be noticed (Table 2) that the reaction is inhibited by malonate. Experiments to ascertain whether succinate can be converted to methylmalonate have so far given negative results, but further work will be required to decide whether the primary isomerization reaction is reversible.

Table 2. REQUIREMENTS FOR ENZYMATIC CONVERSION OF $^{14}$C-METHYLMALONATE TO SUCCINATE

| Components | Carbon-14 appearing as succinate (per cent) |
|---|---|
| Complete system* | 81 |
| No enzyme | 0 |
| No adenosine triphosphate | 0 |
| No coenzyme A | 10 |
| No magnesium chloride | 25 |
| Complete system with 0·005 *M* malonate | 0 |

* Consisting of following components (in µmoles): glycine buffer pH 9·0, 100; magnesium chloride, 10; reduced glutathione, 8; adenosine triphosphate, 8; coenzyme A, 1; methylmalonate-1-$^{14}$C 0·5; potassium bicarbonate, 10; rat liver extract with 15 mgm protein. Volume, 1·0 ml. Incubation, 60 min. at 25°.

When carboxyl-labelled methylmalonate is converted enzymatically to labelled succinate, the radioactivity of the latter does not seem to be *significantly* decreased by the presence of large pools of potassium bicarbonate, propionate or propionyl coenzyme A in the reaction mixture (Table 3)[9]. Since methylmalonic acid might react as an asymmetric compound on enzymatic isomerization, carboxyl-labelled methylmalonic acid was prepared in two different ways by incubation of pig heart extracts, in the presence of coenzyme A, adenosine triphosphate and magnesium ions, either with carbon-14 dioxide and propionate or with carbon dioxide and propionate-1-$^{14}$C. Both preparations were used, separately, in the experiments of Tables 2 and 3. Similar results with methyl-labelled $^{14}$C-methylmalonate (prepared by Dr. H. Castro in this laboratory) provide further evidence that the isomerization reaction involves the conversion of the whole carbon skeleton of methylmalonate to succinate. These results appear to rule out not only a decarboxylation of methylmalonate to carbon dioxide and propionate or propionyl coenzyme A, followed by recarboxylation to succinate, but also the intermediary formation of a carboxymethylmalonate derivative followed by the loss of one of the labelled carboxyls, since both carboxyl groups of methylmalonate are retained in the succinate formed. The elimination of a possible tricarboxylic intermediate is of particular interest, since the formation of such a compound might otherwise account for the apparent stimulation of the isomerization reaction by the bicarbonate ion ($HCO_3^-$) (Table 3). Purification of the isomerizing enzyme or enzyme system may throw light on the mechanism of this novel reaction, as yet without precedent in biochemistry. It is of interest to note that although methylmalonic acid was isolated twenty years ago from the urine of normal rats by Boyland and Levi[14], and has been found in the urine more recently in other labor-

Table 3. CONVERSION OF $^{14}$C-METHYLMALONATE TO SUCCINATE IN PRESENCE OF BICARBONATE, PROPIONATE AND PROPIONYL COENZYME A

| Additions to complete system* | Carbon-14 appearing as succinate (per cent) |
|---|---|
| None | 75 |
| Potassium bicarbonate (30 µmoles) | 100 |
| Potassium bicarbonate (30 µmoles) and propionate (5 µmoles) | 97 |
| Propionyl coenzyme A (3 µmoles) | 64 |

* Complete system and incubation as in Table 2, except that only trace amounts of methylmalonate-1-$^{14}$C were used.

tories[15,16], there had been no other indications that his compound might be a metabolite in the mamnalian organism.

As might be expected from the inhibitory effect of nalonate on the isomerization reaction (Table 2), in he presence of malonate relatively less succinate and nore methylmalonate are formed by liver extracts, rom propionyl coenzyme A and carbon-14 dioxide, han in the absence of malonate (Fig. 1). This result uggests that an activated methylmalonate may be n actual intermediate in the conversion of propionate to succinate; but an alternative interpretation, namely, that methylmalonate may be converted to succinate through some common precursor of the two dicarboxylic acids, has not been excluded. The hypothetical common precursor could not, however, be in isotopic equilibrium with carbon dioxide, propionate, or propionyl coenzyme A.

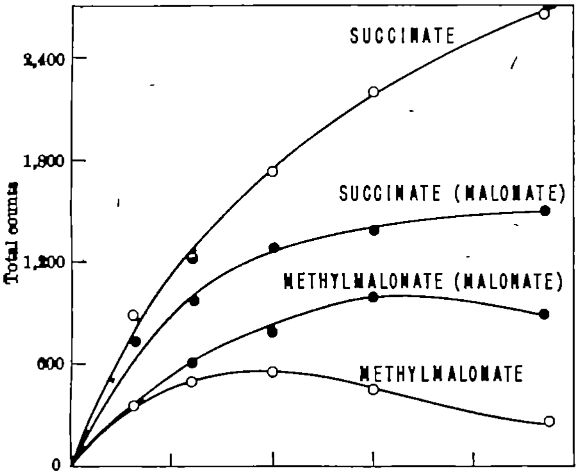

Fig. 1. Formation of methylmalonate and succinate by liver extracts, in the presence of carbon-14 dioxide, propionyl coenzyme A and adenosine triphosphate, and the effect of malonate. One of the reaction mixtures contained (in μmoles), tris(hydroxymethyl)aminomethane buffer, *p*H 7·0, 750; magnesium chloride, 70; reduced glutathione, 50; adenosine triphosphate, 75; propionyl coenzyme A, 3·5; potassium bicarbonate-$^{14}$C, 70; extract of rat liver acetone powder with 250 mgm. protein. Volume, 11 ml. The other reaction mixture contained 0·01 mole malonate besides the above components. Incubation at 25°

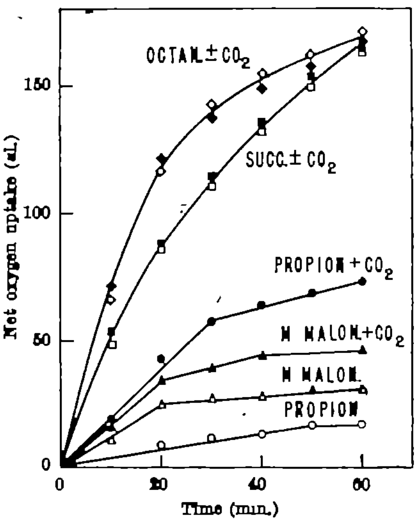

Fig. 2. Oxidation of propionate, methylmalonate, succinate, and octanoate by rat liver homogenates. Each Warburg flask contained (in μmoles), potassium phosphate buffer, *p*H 7·4, 90; potassium chloride, 150; magnesium sulphate, 15; adenosine triphosphate, 3; cytochrome *c*, 0·004; substrate (potassium salts), 3; enzyme suspension, 1·5 ml. Volume, 3·0 ml. Gas, air; temperature, 30°. Alkali-soaked filter paper in centre well. Two flasks were run with each substrate, one containing, in addition to the above components, 20 μmoles potassium bicarbonate, the other 35 μmoles tris(hydroxymethyl)aminomethane buffer, *p*H 8·3. The final *p*H in all flasks was about the same, around *p*H 7·6. The oxygen uptake in the absence of added substrate (about 20 μl. in 60 min. in all cases) was subtracted. Enzyme suspension prepared by homogenizing the livers of 24-hr. fasted rats with 2 vol. of ice-cold 0·013 *M* phosphate buffer, *p*H 7·8, containing 0·013 *M* potassium chloride, in a Potter–Elvehjem homogenizer. The suspension was mixed with an equal volume of the same solution and the mixture centrifuged at 2,200 *g* and 0° for 3 min. The sediment was taken up in a volume of phosphate–potassium chloride equal to that of the diluted homogenate, the mixture centrifuged and the sediment resuspended once more as above

## Oxidation of Propionate and Methylmalonate

Experiments with rat liver homogenates (Fig. 2) show that oxidation of propionate is markedly dependent on the presence of bicarbonate ions, whereas that of methylmalonate, although stimulated by bicarbonate ions, is not so dependent. On the other hand, the oxidation of succinate and octanoate by the same preparations is not affected by the presence of bicarbonate ions. The homogenates were prepared as described by Lehninger and Kennedy[17]. Since methylmalonate is oxidized, this compound (or, more likely, an activated derivative) could be an intermediate in propionate oxidation. Stimulation by bicarbonate ions of methylmalonate oxidation may be related to the above-mentioned stimulation of the isomerization reaction. Carbon dioxide-free water as well as carbon dioxide-free solutions of the various reagents were used for the experiments of Fig. 2. In addition, the *p*H of the reaction mixtures with no added bicarbonate was adjusted to a value close to the value of those with added bicarbonate, so that the observed results are due to the bicarbonate ion, and not to the effect of increased *p*H.

The above results indicate that, in liver homogenates, propionate is oxidized exclusively through a pathway involving preliminary carboxylation. The same conclusion has recently been reached by Wolfe[18], whose experiments with rabbit liver homogenates clearly exclude α-oxidation of propionate via lactate, and demonstrate its oxidation through succinate. Thus, the conclusions of Huenneckens *et al.*[8] and Mahler and Huenneckens[9] are not borne out by the more recent work.

The pathway of propionate and methylmalonate oxidation in animal tissues suggested by our experimental results is shown by the sequence below:

$$\begin{tikzcd}
\text{Propionate} \arrow[r, "\text{(CoA, ATP)}"] & \text{Propionyl CoA} \arrow[d, "\text{(CoA, ATP)}"] & \\
\text{(Succinyl CoA ?)} \arrow[d] & \text{Methylmalonyl CoA} \arrow[l, "?"'] & \text{Methylmalonate} \arrow[l, "\text{(CoA, ATP)}"'] \\
\text{Succinate} \arrow[r, "O_2"] & CO_2 + H_2O &
\end{tikzcd}$$

The fact that the oxidation of methylmalonate is slower than that of propionate (Fig. 2) does not exclude this scheme, since activation must precede oxidation of these compounds and may limit to different degrees the rates of oxidation of the free acids. In separate experiments with the rat liver homogenates, where the activation of propionate, methylmalonate and octanoate by adenosine triphosphate and coenzyme A was followed through the formation of hydroxamic acid, it was found that the activation of methylmalonate was very slow, that of propionate was about four times faster, and that of octanoate seven times faster than that of propionate. While octanoate is activated by a fatty-acid activating enzyme[19], through a reaction analogous to (1), the nature of the enzyme catalysing the activation of methylmalonate is unknown. Methylmalonate is not activated by the phosphorylating enzyme of Kaufman *et al.*[20], which catalyses the reversible formation of succinyl coenzyme A, adenosine diphosphate and orthophosphate, from succinate, coenzyme A and adenosine triphosphate. Likewise, there is no transfer of coenzyme A from acetoacetyl coenzyme A to methylmalonate in the presence of highly purified coenzyme A transferase[21], which catalyses the reversible transfer of coenzyme A from acetoacetyl coenzyme A to succinate. While the product of carboxylation of propionyl coenzyme A might be methylmalonyl coenzyme A, which could then undergo isomerization, it is not known whether the immediate product of the isomerization reaction is succinyl coenzyme A, some other form of activated succinate, or succinate itself. Furthermore, as already mentioned, the results so far obtained do not exclude a common precursor of both methylmalonate and succinate as the immediate product of the carboxylation reaction. The separation and purification of the enzymes involved may help to decide these questions.

A full account of this work, which was aided by grants from the National Institute of Arthritis and Metabolic Diseases (Grant *A*-529) of the National Institutes of Health, United States Public Health Service, the American Cancer Society (recommended by the Committee on Growth, National Research Council), the Rockefeller Foundation, and by a contract (*N6onr* 279, *T. O.* 6) between the Office of Naval Research and New York University College of Medicine, will be published elsewhere.

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# METALLIC TRANSFER IN DRILLING AND ITS SIGNIFICANCE IN ORTHOPÆDIC SURGERY

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It is common practice in modern surgery to insert pieces of metal into the body in order to strengthen or replace a damaged bone. As these are often left in place for considerable periods, it is clearly essential that they should be inert in tissues, and interfere as little as possible with repair and normal physiology. Body tissues are corrosive to most metals, and orthopædic surgeons take great care, therefore, that all the plates, screws and bolts which are to be left in a patient are of the same material and are made of metal which has a very high corrosion resistance[1]. It is well known that corrosion may be influenced by many factors. For example, mechanical deformation of the surface, differential aeration, fretting corrosion, and changes in the *p*H value of the medium all have marked effects. The relative importance of these different phenomena has been discussed by a number of workers (see, for example, Evans[2]).

In earlier communications[3,4], attention has been directed to a further factor which should be considered, namely, the nature and composition of the metal tools used to manipulate the screws, bolts and plates. It was demonstrated by a radioactive-tracer technique that it is almost impossible to insert a screw or bolt without appreciable amounts of the tool becoming plucked out and transferred to the inserted metal. Small fragments of the tool become attached to the surface of the orthopædic appliance and are buried with it in the body. It has been pointed out that although these amounts are very small (about 10–100 μgm.) the adherent particles may form corrosion centres on the surface of the buried metal. This could cause metal ions to pass into the surrounding tissue and produce a reaction which may interfere with normal physiology. Photomicrographic examination of the tissue surrounding those parts of buried metal which had been handled heavily with tools during insertion has demonstrated that such a reaction does in fact occur, even though there may be no evidence of gross corrosion.

Recent experiments have indicated that, in orthopædic operations involving the drilling of pilot-holes

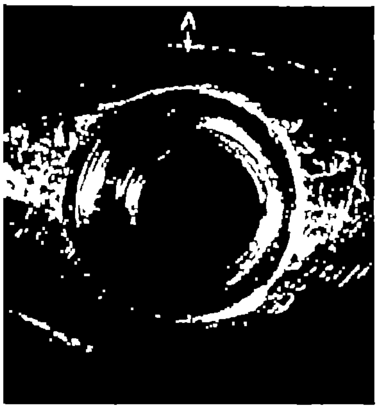

Fig. 1

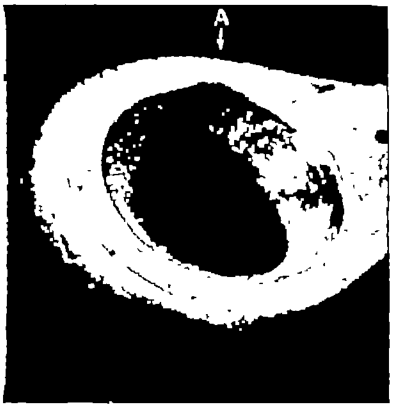

Fig. 2

Fig. 1. Hole in orthopædic plate removed from patient because of persistent sepsis; the drill had rubbed against the metal at *A*

Fig. 2. Hole in orthopædic plate; the drill has rubbed against the metal at *A*. Metal transferred from the drill to the plate at *A* may be as much as 2 mgm.

in bone the amounts of metal transferred may be very much greater than that occurring during screwing and bolting. It is usual to prepare pilot-holes in the bone to receive the screws which secure an orthopædic plate. A countersunk hole already exists in the plate, since this is prepared during its manufacture. Either engineers' twist-drills or special stainless-steel drills are commonly used for preparing the bone. Frequently such holes are drilled after a plate has already been fixed in place by two or more screws; the remaining holes of the plate are used to guide the twist-drill. Owing to the convex and wet surface of the bone, it sometimes happens that the twist-drill comes into contact with the edges of the plate-hole, and considerable friction may occur between them. Often it is desirable to insert a screw obliquely into the bone: if the pilot-hole in the bone is drilled through a plate-hole, the resulting friction may be severe. Fig. 1 shows a typical hole in an orthopædic plate which was removed because of persistent sepsis after being attached to the right tibia of a patient for five months. It is clear that the twist-drill has ground away the rim of the hole at *A*.

The transfer of metal to a plate when a pilot-hole is drilled has been measured. In the first experiment, the drills were merely allowed to touch the edges of the plates occasionally during the drilling process; in the second, oblique holes were drilled and the shoulders of the plate-holes were deliberately ground away until the damage appeared similar to that occasionally observed in plates removed from patients. Fig. 2 shows a typical experimental plate drilled in this way (compare Figs. 1 and 2).

Table 1. TRANSFER FROM TWIST-DRILL TO PLATE DURING DRILLING OF PILOT-HOLE FOR SCREW
(in micrograms)

| | Stainless steel plate | | Vitallium plate | |
|---|---|---|---|---|
| | Engineers' drill | Stainless steel drill | Engineers' drill | Stainless steel drill |
| Drill passing freely through hole in plate, touching it occasionally | 2·3 | 18 | 0·55 | 1·8 |
| Drill allowed to grind against edge of plate-hole | 3·0 | 1,500 | 1·2 | 2,000 |

HARDNESS OF THE METALS
(Diamond pyramid hardness in kgm./mm.$^2$)

| | |
|---|---|
| Stainless steel drill | 400 |
| Engineers' drill | 860 |
| Stainless steel plates | 300–350 |
| Vitallium plates | 400 |

Table 1 shows typical amounts measured when both stainless steel and engineers' drills were used to make pilot-holes in bone through stainless steel and vitallium plates. The hardness of these metals are also given. The extremely large amounts of transfer observed with stainless steel twist-drills are probably due to the fact that the plates are as hard as the drills. When engineers' drills are used, the corresponding increase in the amount of transfer is much smaller; however, these drills are more liable to break off in the bone, thus increasing the difficulty of the operation.

It is clear that the amount of transfer occurring from the drill to the plate when a pilot-hole is drilled into bone through a plate-hole can be large: it is very much greater than that observed in screwing or bolting operations. If the twist-drill is allowed to rub against the side of the plate-hole while the pilot-hole is being drilled, the transfer can be as much as 1 or 2 mgm. The surfaces of the shoulder of the plate-hole and of the screw neck are particularly vulnerable to the onset of corrosion, for when the screw-head is seated in a countersunk hole any corrosion pores which may develop in the oxide layer will not readily be sealed by dissolved oxygen carried to the site; the close fitting of the screw-head and the countersink does not permit easy access of oxygen to these surfaces. These very large amounts of transfer, together with the subsequent differential aeration of the region, may be a cause of the gross corrosion which is occasionally observed at such points[5]. The danger of this could be diminished if drill-sleeves were used when drilling through plate-holes. Other experiments show that the amount of metal transferred from the drill to the bone itself is small.

Earlier work has shown that tiny adherent fragments of foreign metal may exert a profound influence on the surface properties of the metal to which they are attached. While they are not the only cause of the corrosion of orthopædic components, they may nevertheless be an important one and merit careful consideration. These recent observations suggest that such metallic transfer may occur in particularly large amounts when pilot-holes are drilled. The properties of the buried metal are not the only points to be considered. Attention should be given to the particular combination of the tools and the metal used, and also to the care with which the tools are handled. A full account of these investigations will appear shortly[6].

We thank Colonel J. Hickman, Department of Veterinary Clinical Studies, Cambridge, for help, and the Royal Society for a grant for equipment.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Modification of X-Ray Sensitivity of Bean Roots by Hydrogen Gas

THE presence of molecular hydrogen during irradiation is known to affect radiation chemical reactions. Its influence is ascribed to the reaction $H_2 + OH \rightarrow H + H_2O$ [1], in which the very active oxidizing hydroxyl radicals disappear and hydrogen atoms arise. If hydrogen were to affect biological response to radiation, hydroxyl radicals would be strongly implicated as being responsible for part of the damage. Read[2] found no difference in the effect of radiation on growth of bean roots exposed in 14 atm. of hydrogen, or in 14 atm. of nitrogen. We have found that when gases are applied at 50 atm., hydrogen influences radiation damage differently from nitrogen.

Seedlings of *Vicia faba*[3] (Sutton's Prolific Longpod) were grown as described by Gray and Scholes. Root meristems were irradiated at 63 r. per min. with a Phillips 'Metallix' X-ray tube run at 190 kV. Reduction in growth-rate is known to be due to damage to the dividing cells of the meristem[3].

We have found that hydrogen at 50 atm. exerts a protective effect both in the presence and in the absence of oxygen. When 420 r. was given to root meristems in 50 atm. of pure hydrogen, significantly less ($P < 0{\cdot}01$) mortality was caused (fifteen survivors out of fifteen) than when given in 50 atm. of pure nitrogen (six survivors out of fifteen). 125 r. in 1 atm. of air plus 50 atm. hydrogen caused less mortality (thirteen survivors out of sixteen) and less reduction in growth than the same dose given in gas mixtures which contained 2 atm. hydrogen or less (thirty-eight survivors out of seventy-eight; see Fig. 1). Controls showed that the difference between the treatments was due to the presence of 50 atm. hydrogen during irradiation, and not to pressure or to the gas mixtures applied either before or after the irradiation. The depression of growth-rate six to eight days after irradiation gives a measure of radiation damage. Using Gray's data[4], we estimate the dose reduction factor for hydrogen at 50 atm. in the absence of oxygen, compared with that for nitrogen, to lie between 0·7 and 0·9. Further work is planned to obtain a more accurate value.

We interpret our results to mean that hydrogen molecules, when present in sufficiently high concentration inside the cell, alter the radiation effect by reacting with hydroxyl radicals. The hydrogen concentration must be high enough to allow hydrogen molecules to compete successfully for hydroxyl radicals with organic molecules present. This level is reached in bean roots between 14 and 50 atm. of hydrogen. Gray[4] found that the modification of radiation sensitivity in bean roots by carbon monoxide, ascribed mainly to a radical reaction, became apparent also at 40–60 atm. of the gas.

Some deductions can be made as to the damaging capacity of different radicals. Since in our experiments radiation in the presence of hydrogen results in less biological damage, we conclude that the oxidizing action of hydroxyl radicals is responsible for part of the damage caused by radiation in the bean root. If irradiation is carried out in pure nitrogen, hydrogen and hydroxyl radicals are formed from water molecules. If hydrogen is present, the concentration of hydroxyl radicals is reduced, and that of the hydrogen radicals correspondingly increased. Since biological damage is less in hydrogen than in nitrogen, it follows that hydroxyl radicals are more damaging than hydrogen radicals. If oxygen is present during irradiation, $HO_2$ radicals are formed by the reaction $H + O_2 \rightarrow HO_2$. The presence of oxygen during irradiation increases biological damage, indicating that $HO_2$ radicals are more damaging than hydrogen radicals. When hydrogen under pressure is present as well as oxygen, the number of $HO_2$ radicals would be expected to be larger than under any of the other conditions. Since $HO_2$ radicals are generally assumed to be more damaging in biological systems than hydroxyl radicals, the radiation effect would be expected to be greater when their number is increased. The contrary is, however, observed. We have no explanation to offer for this result at present.

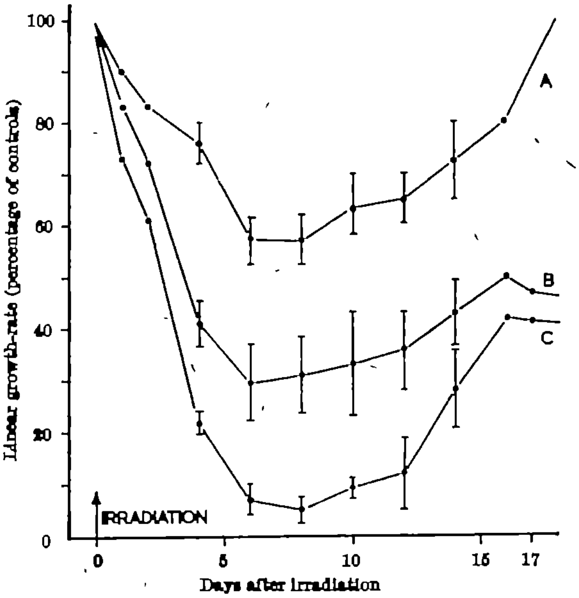

Fig. 1. Linear growth-rate of *Vicia faba* roots after exposure to 125 r. of 190 kV. X-rays plotted as per cent of growth-rate of control roots. Standard errors are shown. Curve *A*: exposure given under 50 atm. of hydrogen free of oxygen. Curve *B*: exposure given under 1 atm. of air plus 50 atm. hydrogen. Curve *C*: combined results of five groups exposed under (1) 1 atm. air; (2) 1 atm. oxygen; (3) 50 atm. oxygen; (4) 0·9 atm. oxygen plus 0·1 atm. hydrogen; (5) 48 atm. oxygen plus 2 atm. hydrogen. No differences were observed between these five groups

It is probable that the reduction of growth-rate in bean roots is due in part to 'direct action' of radiation, that is, to direct energy transfer to vital non-aqueous molecules, and in part to 'indirect action', that is, to energy absorbed in water molecules which exerts its influence via chemical intermediates. On the assumption that the 'direct' effect is not altered by dissolved gases within the cells, it is possible to ascribe an upper limit to that proportion of radiation damage which is due to the 'direct' effect. If damage in the presence of pure nitrogen is taken as 1, that in air has been measured as 2·8[4], and that in hydrogen may be taken as 0·8. The latter is an upper limit for the contribution of the 'direct' effect. If bean roots are irradiated in air, not more than one-third of the damage can be ascribed to the 'direct' effect.

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## Deoxyribonucleic Acid Content of Marsupial Nuclei

THE deoxyribonucleic acid content of nuclei of different species of animals has been listed[1]; there appears to be a fairly regular increase from the sponges to the mammals. In the sponges the amount is about $0\cdot1 \times 10^{-12}$ gm. per diploid nucleus, in mammals it is about $6\cdot0 \times 10^{-12}$ gm. In birds the amount is only a little more than a third of that found in mammals, being about $2\cdot3 \times 10^{-12}$ gm. As pointed out by White[2], there is a distinct break in the distribution of chromosome numbers of the mammals, the Eutherian mammals with few exceptions having a haploid number of the order of 20–30, the marsupials of the order of 6–12. The birds and monotremes both have considerably larger numbers, and resemble the reptiles in this respect. There are, then, at least two major characters by which the higher vertebrates differ: first, the deoxyribonucleic acid content of the nucleus, and secondly, the number of chromosomes. The two do not necessarily parallel one another; but there seems to be a tendency for the groups with many chromosomes to have less deoxyribonucleic acid. The deoxyribonucleic acid content of marsupial nuclei has not heretofore been measured, and investigations of this group are reported here.

Three species of marsupial were investigated. Fresh testes of *Macropus rufus* (kangaroo) were kindly provided by Mr. Edgell, of Sydney, who removed them from three specimens, sliced them into two or three pieces and shook them in saline. Formaldehyde to a final concentration of 4 per cent was then added for preservation. Sperm were separated from this material by low-speed centrifugation and washed. The final preparations contained less than 10 per cent of other nuclei as judged by Feulgen-stained smears. The number of extra nuclei was estimated from the smears and included in the final count. Liver, gut mucosa, kidney and spleen nuclei were isolated from young *Trichosurus vulpecula* (possum) and *Perameles nasuta* (bandicoot) by the method of Marshak[3] and counted. Deoxyribonucleic acid was estimated by the method of Davidson, Frazer and Hutchison[4]. The results are shown in Table 1, with chromosome numbers (Sharman, G. B., personal communication).

Table 1

| Species | Tissue | Deoxyribonucleic acid per nucleus (gm. × $10^{-12}$) | Diploid chromosome number |
|---|---|---|---|
| *Macropus rufus* | Sperm | 2·9<br>3·1<br>3·4 | 18 + *XY* |
| *Trichosurus vulpecula* | Kidney<br>Spleen<br>Intestine<br>Liver | 6·6<br>6·0<br>6·4<br>5·0 | 18 + *XY* |
| *Perameles nasuta* | Kidney<br>Spleen<br>Intestine<br>Liver | 8·9<br>9·9<br>8·8<br>9·4 | 12 + *XX* |

The deoxyribonucleic acid content of marsupial nuclei is very similar to that of Eutherian mammals and different from that of birds. We cannot account for the rather high amount found in the nuclei of *Perameles*; it is certainly not less than in Eutherian mammals. We may conclude that the big increase in nucleic acid content of the nucleus which differentiates birds and mammals and appears to accompany a difference in chromosome number took place before mammals were differentiated into Eutherian and Marsupial forms.

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## Crystalline Cytochrome c from the King Penguin

CYTOCHROME *c* was prepared from skeletal (mainly pectoral) muscle of the king penguin (*Aptenodytes patagonica*) by the method of Keilin and Hartree[1,2] and further purified with the aid of the ion-exchange resin 'Amberlite *XE*-64', by the method of Margoliash[3].

Attempts were made to crystallize the protein by saturating 1–2 per cent aqueous solutions with ammonium sulphate at various *p*H's. From solutions of ferri-cytochrome only spherulitic globules were obtained, which did, however, exhibit birefringence between crossed nicols. But if a neutral solution of cytochrome, almost saturated with ammonium sulphate, was reduced by adding a trace of sodium dithionite, the reduced cytochrome was precipitated slowly in the form of true crystals possessing flat faces and exhibiting straight extinction between crossed nicols. The crystals have the form of thin plates, as shown in Fig. 1. Crystalline preparations of cytochrome *c* have not hitherto been reported in the literature.

The precipitate, which was almost completely crystalline, was centrifuged off and its enzymatic activity compared with that of purified horse cytochrome *c*. Two methods were used: (*a*) the cytochrome oxidase system with ascorbic acid as reducing

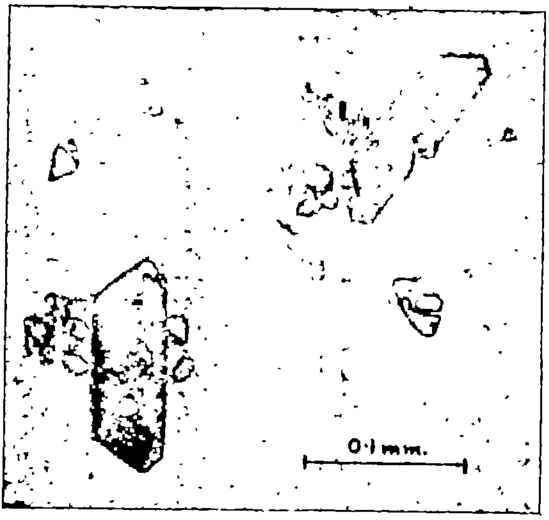

Fig. 1. Two crystals of cytochrome c (lower left and upper right)

agent, and (b) the succinic oxidase system (Keilin and Hartree[3,4], Slater[5]), using excess of heart muscle preparations deficient in cytochrome c (Tsou[6]) and limiting amounts of cytochrome c. By each method the activity of the crystalline king penguin cytochrome c was found to be, within the limits of error, identical with that of horse cytochrome c.

Measurements of the iron content and absorption spectrum of king penguin cytochrome c were made using purified stock solutions. The iron content was found to be 0·430 and 0·444 per cent in two separate preparations (for the horse heart pigment the standard figures range from 0·43 to 0·46 per cent iron). The absorption spectra of ferri- and ferro-cytochrome c of the king penguin were found to be identical with those of horse and beef cytochrome c within the limits of error. Thus the extinction coefficients of the α-, β- and Soret bands correspond within 3 per cent to the values given for beef cytochrome c by Theorell[7]. The ratio of the extinction coefficients of the reduced form at 550 mμ to that of the oxidized form at 280 mμ was found to be 1·15, as compared with 1·17 for beef (Paleus[8]).

I thank the Director of the Zoological Society of London for providing the king penguin muscle, and Prof. D. Keilin, Dr. E. F. Hartree and Dr. A. Tissières of the Molteno Institute, University of Cambridge, for the sample of purified horse cytochrome c, for the heart-muscle succinic oxidase preparation and for providing facilities and help in carrying out the determination of enzymatic activity.

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## Enzymatic Conversion of Alpha-Formamidinoglutaric Acid to Glutamic Acid by Rat Liver

A previous report from this laboratory[1] gave evidence that histidine is converted to glutamic acid *in vivo* and *in vitro*. The *in vitro* experiment, done with guinea pig-liver slices, is subject to the criticism that degradation of α-formamidinoglutaric acid, the principal conversion product, may have occurred non-enzymatically. Direct evidence for such a conversion has been found so far only in micro-organisms adapted to histidine[2]. I have now shown the presence in rat liver of an enzyme which degrades α-formamidinoglutaric acid (N-formiminoglutamic acid) to glutamic acid.

Radioactive α-formamidinoglutaric acid was prepared by incubating homogenized rat liver with L-histidine-$^{14}$COOH (20,000 counts/min. per mgm. or 3,100 counts/min. per μmole) at 37° C. for 18 hr., precipitating the proteins with trichloracetic acid and separating the radioactive products by elution with hydrochloric acid from a column of 'Dowex-50' resin. The fraction containing α-formamidinoglutaric acid (200–280 ml. of 1·5 $N$ hydrochloric acid) was lyophilized and stored in aqueous solution at $p$H 2–3. The radioactive α-formamidinoglutaric acid had an $R_F$ on paper of 0·28 with 3 parts $n$-propanol/1 part 1·0 $N$ acetic acid as solvent. It gave a delayed ninhydrin reaction (purple) and an immediately positive alkaline ferricyanide–nitroprusside reaction (pink)[3]. Synthetic α-formamidinoglutaric acid, kindly supplied by Dr. Alexander Miller[4], had identical $R_F$ and colour reactions. α-Formamidinoglutaric acid is unstable in the presence of 1·0 $N$ sodium hydroxide and is converted to a compound identical, by the above column and paper chromatographic procedures, with glutamic acid.

α-Formamidinoglutaric acid so prepared was converted to glutamic acid enzymatically by a soluble rat-liver preparation. A rat liver was homogenized at 0–4° C. in 20 ml. of 0·1 $M$ potassium phosphate buffer, $p$H 7·8, and centrifuged at 100,000 $g$ for 1 hr. The clear supernatant (protein nitrogen = 2·0–3·5 mgm./ml.) was incubated at 37° C. for 2 hr. in varying concentrations in a total volume of 1·0 ml. (0·1 $M$ in potassium phosphate buffer, $p$H 7·8) with 2,000 counts/min. (= 0·65 μmole) α-formamidinoglutaric acid. The reaction was stopped with trichloracetic acid, and the filtrate put on a small column (0·3 cm. × 55 cm.) of 'Dowex-50'. The column was eluted with 1·5 $N$ hydrochloric acid, and fractions of 0·5 ml. were collected. These were evaporated to dryness and tested for radioactivity. Unaltered α-formamidinoglutaric acid was recovered in fractions 18–25. A radioactive peak in fractions 11–15 was identical on paper chromatography with glutamic acid, giving an immediate ninhydrin colour (purple) and no colour with alkaline ferricyanide – nitroprusside. No other radioactive peaks were obtained.

Enzyme activity was measured with enzyme (1) unmodified, in varying concentrations, (2) boiled for 10 min., (3) incubated in the presence of 0·01 $M$ glutathione, (4) incubated in the presence of 0·0025 $M$ $p$-chloromercurobenzoate, (5) pre-incubated 2 hr. at 37° C. with and without glutathione, and (6) incubated in the presence of folic acid ($1 \times 10^{-4}$ to $5 \times 10^{-3}$ $M$) with glutathione. The percentage conversions to glutamic acid (calculated from amounts formed and α-formamidinoglutaric acid remaining) under various conditions are shown in Table 1.

able 1. CONVERSION OF α-FORMAMIDINOGLUTARIC ACID TO GLUTAMIC ACID

| Enzyme | Protein nitrogen (mgm.) | Percentage conversion to glutamic acid |
|---|---|---|
| None | 0 | 0 |
| Boiled | 0 | 0 |
| Unmodified | 1·0 | 100 |
| Unmodified | 0·6 | 88 |
| Unmodified | 0·5 | 66 |
| Unmodified | 0·3 | 36 |
| Unmodified | 0·2 | 20 |
| Glutathione added | 0·3 | 74 |
| Folic acid + glutathione | 0·3 | 0 |
| p-Chloromercuribenzoate | 1·0 | 22 |
| Preincubated | 1·0 | 83 |
| Preincubated + glutathione | 1·0 | 85 |

It is concluded that rat liver contains an enzyme, rhich can be solubilized, and which catalyses the deradation of α-formamidinoglutaric acid to glutamic oid, without the accumulation of any intermediate. imilar homogenates degrade histidine to α-formmidinoglutaric acid much more rapidly. The nzyme which degrades α-formamidinoglutaric acid s unstable, but less so in the presence of glutathione. ow activity and instability of this enzyme probably ccount for the accumulation of the acid when istidine is incubated with liver homogenate. Folic cid inhibits the enzyme, thereby raising the question rhether it is acting as an analogue of a coenzyme uch as tetrahydrofolic acid.

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## Benzene-$^{14}C_1$ from the Neutron Irradiation of the Clathrate with Ammoniacal Nickel Cyanide

THE use of *in situ* production of compounds ontaining carbon-14 by the neutron irradiation of itrogen-containing organic compounds or mixtures f nitrogen-containing compounds with organic comounds for the synthesis of labelled organic comounds has been suggested by recent work on this ubject[1,2]. The neutron irradiation of the clathrate f ammoniacal nickel cyanide and benzene was ported on by M. Zifferero[3] in Genoa last year. We ave carried out an irradiation of this compound to rovide data for comparison and to test a purificaion method for labelled compounds produced in this ay.

Pile irradiation conditions with regard to the ratio f fast to slow neutrons and the intensity of the amma-field vary from one installation to another. rrangement of the sample in the lattice of a pile ith regard to proximity of the fuel rods and quantity of absorber surrounding the sample will also affect the exact irradiation conditions.

A 21·4-gm. sample of clathrate prepared by the method of Hofmann and Hochtlen[4] was irradiated in the Brookhaven pile for thirteen days at a sample temperature of 30° C. The thermal neutron flux was about $4 \times 10^{12}$ neutrons/cm.$^2$ sec., the fast neutron flux about $10^{11}$, and the gamma flux was equivalent to about $5 \times 10^6$ r./hr. The irradiated sample proved to be quite γ-active. This activity was identified as cobalt-58 by Dr. M. L. Perlman of this Laboratory. The probable source is the $^{58}$Ni($n,p$)$^{58}$Co reaction. The clathrate was decomposed by the method of Turner and Warne[5] with some modification of the collection system. The benzene was dried and distilled from sodium. To allow greater ease in manipulation, distilled active benzene was diluted with inactive benzene and the dilute sample fractionated twice in a 50-plate (*n*-heptane, methyl *cyclo*hexane calibration) concentric tube column.

*Ortho*-benzoylbenzoic acid was prepared from the benzene, and anthraquinone was then made from this derivative. Careful purification of each derivative showed no change in specific activity relative to the parent benzene when corrected for the introduction of inactive carbons. Our results are presented in Table 1.

Table 1

| Sample | Carbon-14 activity (mμc./mgm. carbon) |
|---|---|
| Irradiated clathrate | 29·6 |
| Recovered benzene distilled from sodium | 0·835 |
| Fractionation No. 1 of diluted benzene | |
| Head cut[a] | 0·068 |
| Centre cut | 0·065 |
| Tail cut | 0·064 |
| Fractionation No. 2 of diluted benzene[b] | |
| Head cut[c] | 0·066 |
| Tail cut | 0·062 |
| o-Benzoyl benzoic acid | 0·061[d] |
| Anthraquinone | 0·063[d] |
| Corrected value for recovered benzene[e] | 0·630 |

[a] These fractions were taken from a boiling plateau with a 0·2 deg. range.

[b] Three cuts from previous fractionation combined.

[c] Boiling points of cuts within 0·05 deg. of each other.

[d] Corrected for dilution by eight additional carbons.

[e] Using 0·062 as the value for diluted benzene at constant specific activity.

Quantitative recovery of benzene was not attempted; however, very little is lost by radiation damage. Difficulty in obtaining precise carbon values for the clathrate made it necessary to rely on the nickel and nitrogen values in order to calculate the total amount of benzene present. The carbon-14 activity as benzene represents 1·44 ± 0·13 per cent of the total carbon-14 activity produced. The stated error is exclusive of any error introduced in the radioactive assay. The percentage is calculated by simply using the following formula:

$$\frac{\text{Benzene activity (m}\mu\text{c./mgm. carbon)}}{\text{Clathrate activity (m}\mu\text{c./mgm. carbon)}} \times \frac{\text{total mgm. carbon due to benzene}}{\text{total mgm. carbon in sample used}} \times 100 = \%\text{ of total activity}$$

Had the analysis been ideal, the carbon-14 activity in benzene would have been 1·59 per cent.

The value reported by M. Zifferero[3] was 4 per cent. The method of calculation was not stated.

The actual levels of activity produced in recognizable compounds is still rather lower than one might desire for labelled compounds. In a system where a carbon analogue is produced, such as the acridine to anthracene sequence[6], it may in the future be possible to isolate the analogue free from carrier. It must be borne in mind, however, that at the present time these compounds are formed in quantities too small for practicable separation.

Investigations on the chemical fate of a recoiling carbon-14 atom are being carried out. It is hoped that the increasing amount of research in this field will provide accurate data for the correlation of re-entry versus total carbon-14 production in a given system. In addition, the method may become a valuable synthetic tool for the organic chemist.

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## Steric Effects in the Formation of Copper and Cobalt Complexes with the Epimeric Salicylidenementhylamines

In a previous communication[1], it was reported that cobaltous ions do not react readily with salicylidene-aniline bases bearing ortho substituents on the aniline ring. In the present communication are reported some further attempts to prepare similar complexes of cobalt and copper, using as the amine components of the salicylidene bases four epimeric forms of menthylamine which, with bulky *iso*propyl substituents and nonplanar ring forms, may be expected to exert considerable steric resistance to a tetrahedral grouping of ligands about cobalt ions. The complexes were prepared by mixing aqueous solutions of the metal acetates with an alcoholic solution of the salicylidene base[2]. The results of this work are indicated in Table 1, the complexes isolated being of the form *bis* (salicylidenementhylamine) cobalt (copper).

Table 1

| Amine component | Co | Cu |
|---|---|---|
| Cyclohexylamine | + | + |
| (−)-Menthylamine | + | + |
| (+)-*neo*Menthylamine | − | − |
| (+)-*iso*Menthylamine | 0 | + |
| (±)-*neoiso*Menthylamine | 0 | + |

+ = isolation of the complex *bis* (salicylideneamine) *M*.
− = no reaction: formation of metal hydroxide and unchanged Schiff's base.
0 = formation of oils or tar and unchanged Schiff's base.

The inability of salicylidene-(+)-*neo*menthylamine to form complexes with either cobalt or copper points to a strong steric hindrance with respect to both the nitrogen atom and the phenolic hydroxyl in this case. (−)-Menthylamine and (+)-*neo*menthylamine differ only in the configuration of the amino-group at $C_{(3)}$, and the ready formation of complexes with (−)-menthylamine (with both copper and cobalt) is explainable on the basis of this relationship. A consideration of the probable conformations of strainless rings for the amines[3,4] suggests that the *cyclo*hexane ring contributes considerably to the steric hindrance preventing complex formation with (+)-*neo*menthylamine, in which the amino-group occupies an axial position, whereas no such effect impedes complex formation with (−)-menthylamine, which has an equatorial amino-group.

With copper and salicylidene-(+)-*iso*menthylamine the expected complex was isolated as readily as in the case of (−)-menthylamine; but with cobalt the reaction produced only a reddish tar together with unchanged base, and no solid complex could be isolated from the mixture. It is not immediately obvious why cobalt does not form a derivative with the (+)-*iso*menthylamine base while copper does, even on the assumption of a tetrahedral arrangement for the expected cobalt complex. This difference observed between the behaviour of salicylidene-(−)-menthylamine and that of salicylidene-(+)-*iso*menthylamine towards cobalt ions was not expected, as the difference between the two amines is believed to be only in the position of the methyl group (1*e* in the case of menthylamine and 1*p* in *iso*menthylamine[4]).

Although no complex could be obtained with cobalt and salicylidene-(±)-*neoiso*menthylamine, but only a reddish tar and unchanged Schiff's base, the copper derivative, on the other hand, was readily isolated. The lesser hindrance towards complex formation of (±)-*neoiso*menthylamine compared with that of (+)-*neo*menthylamine is in agreement with the greater reactivity of *neoiso*menthol over that of *neo*menthol towards acid chlorides[5]. If the inability of salicylidene-(+)-*neo*menthylamine to form complexes with both copper and cobalt ions is due chiefly to the spatial arrangement of the *iso*propyl and amino-groups, it seems unlikely that *neoiso*menthylamine has, in these reactions at least, a conformation in which the amino-group occupies an axial position. Rather, our results tend to support the view that *neoiso*menthyl derivatives are examples of conformational instability (Mills, J. A., private communication), and that it is possible for the amino-group in *neoiso*menthylamine to adopt an equatorial position[6].

Relative $pK_a$ values have been determined for the four menthylamine epimers by potentiometric titration in 50 per cent aqueous ethanol against hydrochloric acid. As can be seen from Table 2, the order of decreasing basic strength is *iso*menthylamine, menthylamine, *neo*menthylamine, and *neoiso*menthylamine.

The apparent non-reactivity of several of the salicylidene-menthylamine bases with cobalt, and of the *neo*menthylamine derivative with copper and cobalt cannot be ascribed to differences in the basicities of the amines. They are all comparably strong bases, and the electron density on the nitrogen atom in each case should not differ greatly throughout the series. Steric effects related to the tendency to form planar (copper) or tetrahedral (cobalt) derivatives as outlined above seem to provide the only

Table 2. $pK_a$ Values of Four Epimeric Menthylamines determined in 50 per cent Aqueous Ethanol at 20°

| | $pK_a$ |
|---|---|
| (+)-*iso*Menthylamine | 9·93 |
| (−)-Menthylamine | 9·78 |
| (+)-*neo*Menthylamine | 9·69 |
| (−)-*neoiso*Menthylamine | 9·47 |

other explanation of the difference in reactivity between copper and cobalt with the various bases studied.

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## Crystallization of Silver Chromate

The precipitation of silver chromate from its supersaturated solutions has been studied by van Hook[1], who concluded that crystallization could be represented as a two-step process: first, an induction period varying inversely with the volume of seed suspension used, during which the principal action was the generation of crystal nuclei; secondly, a bimolecular growth of these nuclei.

It is well known that the inoculation of supersaturated solutions with seed crystals results in the growth of these added crystals rather than the formation of crystal nuclei[2]. Crystallization of silver chloride begins immediately on seeding a supersaturated solution. Delayed crystallization, however, similar to that reported by van Hook, is encountered when seed suspensions are aged before use in the presence of suitable poisoning substances such as eosine[3]. The observed inverse relationship between the duration of these induction periods and the volumes of poisoned suspension used suggests that the results of van Hook were due to the presence of adsorbed contaminant at the surface of aged silver chromate crystals. The present work was designed to test this suggestion.

Preliminary experiments confirmed the existence of a well-defined critical supersaturation: it was possible to prepare stable solutions of silver chromate in which the molar concentration product $[Ag^+]^2[CrO_4^{=}]$ exceeded the solubility value by more than 300 per cent. The solubility of silver chromate at 25° was determined by the equilibration (*a*) of pure solid with conductivity water ($0{\cdot}923 \times 10^{-4}$ moles/l.), and (*b*) of highly supersaturated solutions ($0{\cdot}931 \times 10^{-4}$ moles/l.).

Crystallization experiments were carried out at 25° using the conductivity technique described elsewhere[2]. Supersaturated solutions of silver chromate were prepared in a stirred conductivity cell by mixing silver nitrate and potassium chromate solutions, and crystallization was induced by the addition of a small volume, usually 5 ml., of the appropriate seed suspension. Some typical results are shown in Fig. 1, in which the reciprocal of the resistance of the solution (a measure of the extent of crystallization) is plotted against time.

Solubility product = $3{\cdot}186 \times 10^{-12}$

| Experiment | Initial concentrations moles/l. × $10^4$ $[Ag^+]$ | Initial concentrations moles/l. × $10^4$ $[CrO_4^{=}]$ | $[Ag^+]^2[CrO_4^{=}]$ × $10^{12}$ |
|---|---|---|---|
| 15 | 2·234 | 1·129 | 5·635 |
| 17 | 2·250 | 1·130 | 5·720 |
| 23 | 2·254 | 1·127 | 5·726 |
| 24 | 3·580 | 0·448 | 5·725 |
| 26 | 1·420 | 2·840 | 5·727 |

An aged seed suspension, prepared by crystallization from boiling saturated silver chromate solution, was used in Exp. 17 and no change in conductivity was detected for at least four hours, even though a sensible supersaturation persisted. Thorough washing of this aged suspension with boiling conductivity water before use in Exp. 15 resulted in a substantial reduction in the time of induction. In Exps. 23, 24 and 26, the use of freshly precipitated seed suspension of available growth area less than half that of the aged suspension enabled crystallization to start immediately on seeding. These results provide conclusive evidence that any induction effect is due to contamination of the surface of aged crystals. Hydrolysis products, the most likely contaminants, might include any or all of the species $HCrO_4^-$, $AgOH$, $Ag_2OH^+$.

It is seen from Fig. 2 that the rate of crystallization, $-dm/dt$ (moles.l.$^{-1}$min.$^{-1}$), obtained from the curves in Fig. 1, is best interpreted in terms of third-order

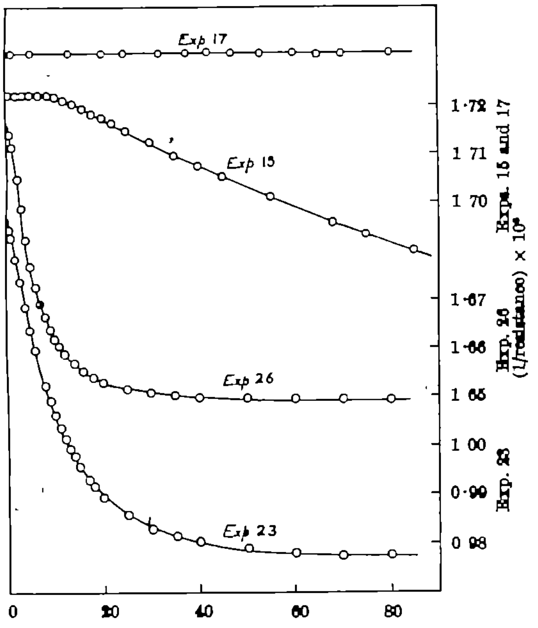

Fig. 1. Time plots of the reciprocal of the resistance of the solution

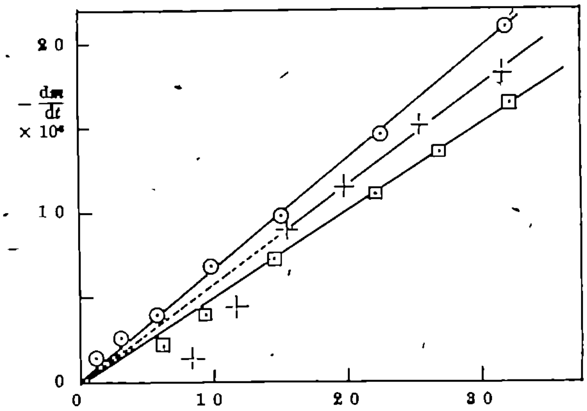

Fig. 2. Third-order kinetic plot. Exp. 23, ○; exp. 26, +; exp. 24, ⊡

kinetics: $-\mathrm{d}m/\mathrm{d}t = k(P - P_s)^2$, where $k$ is a constant, $P = \{[\mathrm{Ag^+}]^2[\mathrm{CrO_4^-}]\}^{1/3}$ at any instant, and $P_s$ is its solubility value. By analogy with the observed second-order kinetics for crystallization of silver chloride[3], these results may be interpreted in terms of the simultaneous arrival of two silver ions and one chromate ion at the hydrated monolayer assumed to be adsorbed at the surface of the crystals.

At non-equivalent ionic concentrations of silver and chromate, the presence of an excess of chromate ions (Exp. 26) produces a greater reduction in the rate of crystallization in the later stages than is to be expected for a termolecular process. This may be due to the adsorption at the growing surface of $\mathrm{HCrO_4^-}$ ions, formed by hydrolysis of chromate ions, effectively reducing the number of available growth sites.

Studies of both crystallization and dissolution processes are being continued.

We thank Prof. C. W. Davies for his interest in the work.

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## Radioactivity of Zircons

Mügge[1] recorded the α-particle emission of zircons by sprinkling them on a photographic plate and, more recently, Tyler and Marais[2] have used a similar technique for determining the relative radioactivities of mineral grains. In both experiments, the mineral grains were mounted on the surface of the photographic emulsion.

We have attempted quantitative measurement and comparison of the α-activities of zircons by embedding them completely in 'Nuclear Research' photographic emulsions, using a method very similar to that used by King, Traczyk and Harris[3] in the study of Protozoa by electron-track radiography.

Zircons obtained from a Triassic sandstone of the Bristol district were sprinkled evenly on the emulsion surface of Ilford *C2*, 50μ, 'Nuclear Research' plates, and some *C2* gel was liquefied and poured over them, so that the grains were completely surrounded by photographic emulsion. The plates were dried in a current of filtered air for two hours at room temperature, and then left to 'expose' for 20 days at 2–3° C. in a light-tight box in a refrigerator. Processing revealed α-particle tracks surrounding, and in contact with, the zircons.

Preliminary examination showed that the zircons could be divided into a strongly radioactive group (Fig. 1) and a weakly radioactive group (Fig. 2).

More precise information was obtained by dividing the estimated total surface area of each grain by the total number of α-tracks associated with it. When this was done, it was seen that zircons of four activities were present with mean area/emission ratios of 18, 40, 85 and 250.

Zircon is probably one of the first minerals to crystallize from a rock melt, and since uranium and thorium can substitute for zirconium in the zirconium silicate structure[4], the specific activity of a zircon can be considered as a function of the uranium–thorium concentration in the parent rock magma.

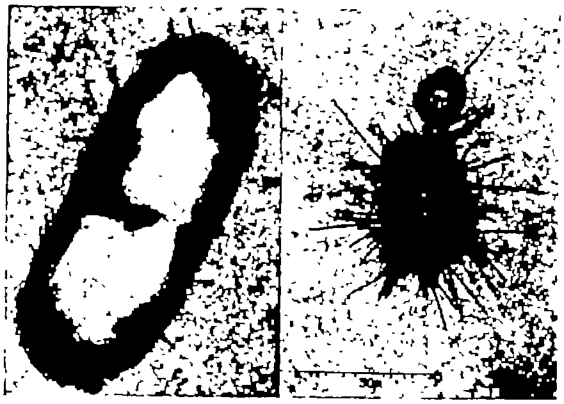

Fig. 1. Zircon grain of low activity from Triassic sandstone, Bristol
Fig. 2. Zircon grain of high activity from Triassic sandstone, Bristol

Zircon is therefore 'labelled', and, we suggest, can be used as a natural radioactive tracer. Since it is an extremely durable mineral[5], the technique described should prove useful in many petrological problems, particularly those of provenance in sedimentary petrology.

A more detailed account of this work will be published elsewhere.

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June 15.

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## The Graphite–Diamond Equilibrium

There have very recently been two recalculations of the graphite–diamond equilibrium, one by Liljeblad[1] and the other by Berman and Simon[2], who also included a brief historical survey. Liljeblad did not make use of the most recent experimental data, whereas in the second paper the latest published material was incorporated as well as new measurements of the expansion coefficient of diamond, made by one of us (J. T.). Fig. 1 shows the two calculated equilibrium curves; while Liljeblad's curve goes through a maximum of about 62,000 atm. near 3,000° K., Berman and Simon arrived at a linear extrapolation above 1,200° K., which follows the equation:

$$P_{(\mathrm{atm.})} = 7{,}000 + 27\,T_{(°\mathrm{K.})}$$

The technical difficulty in synthesizing diamond is that of achieving, simultaneously, the high temperature at which the reaction velocity will be appreciable and the high pressure under which diamond is stable at such a temperature. If the equilibrium curve is linear at high temperatures, there is no escape from this difficulty in an equilibrium synthesis. If Liljeblad is correct, the obvious solution would be to work at very high temperatures and so combine the great reaction velocity with a smaller pressure. In view of the increased interest in this problem, associated with the recent successful synthesis of diamond[3], it seems appropriate to consider the reason for the discrepancy between the calculations.

New values of the densities and of the low-temperature specific heats of diamond and graphite introduce only slight changes, and the difference between the two curves is almost entirely due to the different values of the expansion coefficient of diamond used in the calculations. This coefficient is important because it affects the difference of the specific heats,

$$C_p - C_v = \frac{(3\alpha)^2 TV}{K}$$

where $\alpha$ is coefficient of linear expansion, $V$ is atomic volume and $K$ is compressibility. Although $C_v$ for diamond and graphite may be equal at high temperatures, a large expansion coefficient, combined with low compressibility, would make $C_p$ for diamond much bigger than for graphite.

High-temperature determinations of the coefficient of expansion of diamond have been made by Joly[4], using an optical method, and by Krishnan[5], using X-rays. The results are shown in Fig. 2, together with the low-temperature measurements of Dembowska (quoted by Röntgen[6]). If Joly's values were correct we should have a very severe violation of Grüneisen's law of the proportionality of thermal expansion coefficient to specific heat. It is true that slight deviations from this law have recently been observed at low temperatures[7]; but it is difficult to see how a serious departure could occur at high temperatures. As a further check, the Grüneisen constant, $\gamma$, can be calculated from the relation, [illegible] $= b\gamma C_v/V$, and for most substances $\gamma$ is found [illegible] lie between 1 and 2. Grüneisen[8] had derived [illegible]es of 1·1–1·2 from Dembowska's measurements, [illegible] Krishnan showed that his results satisfied the [illegible] relation with $\gamma$ about 1·3. According to [illegible]s, $\gamma$ would increase rapidly to more than 3. [illegible]epting such a departure from Grüneisen's [illegible]t be convinced of the reliability of the measurements involved. A consideration of Joly's apparatus, however, led us to doubt his accuracy and to undertake a new X-ray determination of the lattice constant up to about 1,200° K. Fuller details of these experiments will be published later, and in Fig. 2 we only show the high-temperature end. At 1,200° K., we find $\gamma$ to be 1·3, in agreement with Krishnan's value for lower temperatures. To show more fully how well the expansion, according to the new measurements, obeys Grüneisen's law, we give in Table 1 the ratio of the change of lattice constant to the change of heat content, over several temperature intervals. It can be seen that, apart from a suggestion of a very slight anomaly between 400° and 600° K., the ratio of these two quantities remains sensibly constant. The thermal expansion of diamond is therefore quite normal, and the only justifiable extrapolation to higher temperatures should follow Grüneisen's law.

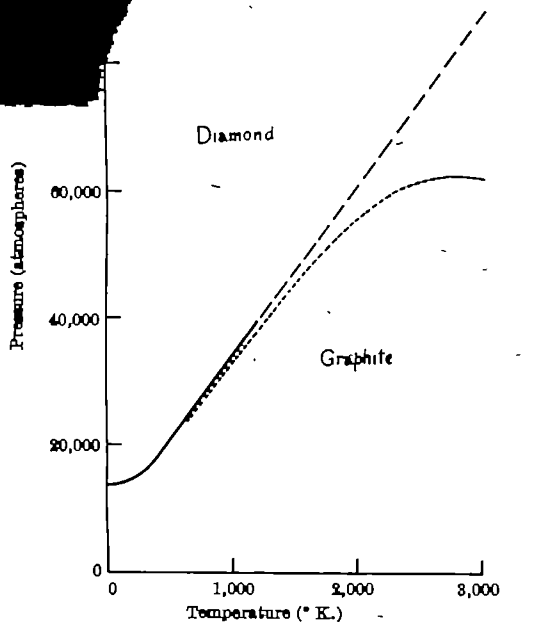

Fig. 1. Calculated graphite-diamond equilibrium curve. Berman and Simon, ———, calculated to 1,200° K.; — —, linear extrapolation. Liljeblad, ———

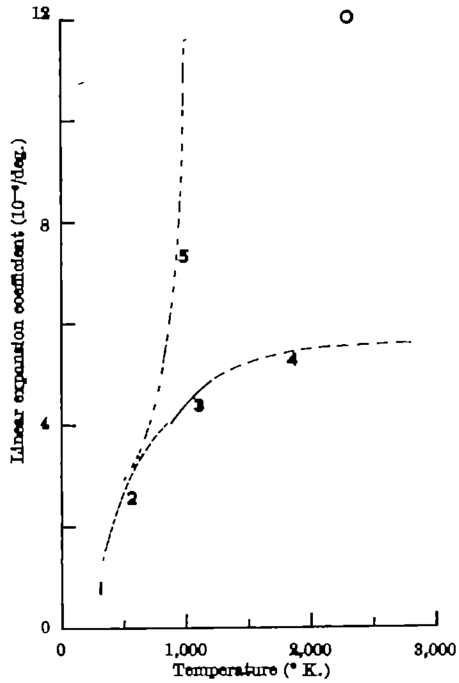

Fig. 2. Coefficient of linear thermal expansion of diamond. (1) Dembowska, ······; (2) Krishnan, – – – – – –; (3) Thewlis (only the high temperature end is shown), ———; (4) Extrapolation according to Grüneisen relation, —·—·—; (5) Joly, —··—··—. Value quoted by Liljeblad, ○

Thus Joly's results are certainly in error. Liljeblad only states the value he has assumed for $3\alpha$ at 2,300° K. ($\alpha$ is plotted in Fig. 2), without giving his sources. This unjustifiably high value would increase $C_p - C_v$ of diamond to 2 cal./mol.-deg. and is

Table 1. COMPARISON OF CHANGES IN LATTICE CONSTANT ($\Delta a$) AND CHANGES OF HEAT CONTENT ($\Delta H$) WITH TEMPERATURE, FOR GEM QUALITY AND FOR INDUSTRIAL DIAMONDS

| Temp. interval (°K.) | $\Delta a$ ($10^{-6}$ A.) Gem stones | $\Delta a$ ($10^{-6}$ A.) Industrial stones | $\Delta H$ (cal./mol.) | $\Delta a/\Delta H$ ($10^{-6}$ A. mol./cal.) Gem stones | $\Delta a/\Delta H$ ($10^{-6}$ A. mol./cal.) Industrial stones |
|---|---|---|---|---|---|
| 300–400 | 55 | 50 | 200 | 0·28 | 0·25 |
| 400–500 | 85 | 90 | 265 | 0·32 | 0·34 |
| 500–600 | 111 | 104 | 345 | 0·32 | 0·30 |
| 600–700 | 117 | 110 | 415 | 0·28 | 0·27 |
| 700–800 | 131 | 131 | 450 | 0·29 | 0·29 |
| 800–900 | 138 | 143 | 475 | 0·29 | 0·30 |
| 900–1,000 | 148 | 150 | 495 | 0·30 | 0·30 |
| 1,000–1,100 | 158 | 159 | 510 | 0·31 | 0·31 |

responsible for the maximum in Liljeblad's equilibrium curve between 2,500° and 3,000° K. With the Grüneisen extrapolation of α, $C_p - C_v$ of diamond is only 0·2 cal./mol.-deg. at 2,300° K., which is little greater than the value for graphite. Up to the highest temperatures considered, $C_{p(\text{diamond})} - C_{p(\text{graphite})}$ is therefore sufficiently near zero so that, with the other uncertainties, of a similar order of magnitude, which were discussed in Berman and Simon's paper, a linear extrapolation of the equilibrium curve is as accurate as the existing data warrant.

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July 27.

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## Location on Jupiter of a Source of Radio Noise

A search of old records of cosmic noise, taken in the Radiophysics Laboratory at 18·3 Mc./s., has confirmed the discovery, by Burke and Franklin[1], of radio radiation from Jupiter, and has further shown that in 1951 the radio radiation came from a very localized region of the planet.

The records studied fall into two series. The first series comprised records, using an aerial with beamwidth 17°, taken at intervals during the period October 1950–April 1951. Radiation from Jupiter appeared on about one-half of the days on which records were suitable (correct aerial direction, no obvious interference, etc.), and it was clear that the right ascension of the source changed with that of Jupiter. For some of these records more accurate direction-finding was possible using a split-beam technique, and these records proved that the position of the source was within ± 1° of Jupiter.

The second series of records had been taken with the aerial modified in such a way that the beam was still narrow in declination but was very broad in hour angle. Because of its broad beam it was capable of receiving signals from an extra-terrestrial source for nearly eight hours per day—a time which would cover nearly one complete rotation of Jupiter. This series of records, from August 15 to October 2, 1951, revealed Jupiter radiation on twenty-seven out of the thirty days on which there were suitable records, although on all days the bursts of radiation came in groups only an hour or two in duration.

A most interesting new fact coming out of the examination of these records was the very close relation between the times of occurrence of bursts and the rotation of Jupiter. For each record the times of activity were noted. Fig. 1 shows the longitudes of the central meridian during the times when bursts were received. The equatorial regions of the visible surface of Jupiter rotate more rapidly than the remainder of the planet and two conventional systems of zenocentric longitude are used. System I, which applies to the equatorial regions, is based on a rotation period of about 9h. 50m.; system II on a rotation period of about 9h. 55m. It will be seen that the lines indicating times of occurrence of bursts are almost directly under one another when plotted against system II longitudes and show a steady drift towards increasing longitudes in system I. Closer examination shows that there is actually a small negative drift in the system II diagram. These drifts imply that the source of radiation had a rotation period slightly shorter than that adopted for the calculation of system II longitudes; the period of rotation is found to be 9h. 55m. 13s., with an estimated probable error of ± 5s.

After allowing for the slight drift in longitudes, all the lines in Fig. 1 were superimposed to give a histogram of the frequency of occurrence of the noise for 5° intervals of central meridian longitude. This is shown in Fig. 2, the longitudes being system *II* longitudes on August 14. This figure shows that for a band of longitudes centred on 67° and extending from about 0° to 135°, the frequency of occurrence was much greater than outside this band. This suggests an origin in a very localized source Jupiter. Since there were about 120 rotations Jupiter during the period of the observations which the figure is based, the probability tha effect observed is due to chance is extremel

Fox[3] has given a summary of the obs Jupiter at this time which were comm the Jupiter Section of the British Association. A disturbance at the bou the South Temperate Zone and the So Belt, which was observed for several observed rotation period of 9h. 55 the radio source. All the other belt with system II were either faint, wi markings, or moved slightly more system II. Fox gave a sketch by E. J. depicted the most visually active region Temperate Belt at the end of November radio observations ceased on Octob allowing for a continuing drift in l longitude of the radio source on Nove have crossed the middle of one of white markings in Reese's sketch although the identification is not prov doubt, it seems very probable that thi

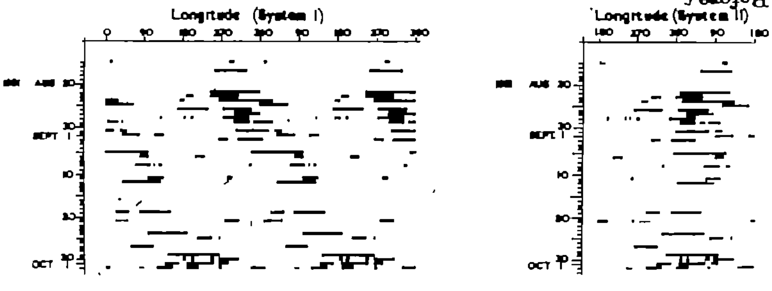

Fig. 1. Periods of occurrence of 18·3 Mc./s. radiation from Jupiter plotted against longitude of the central meridian at the time of observation

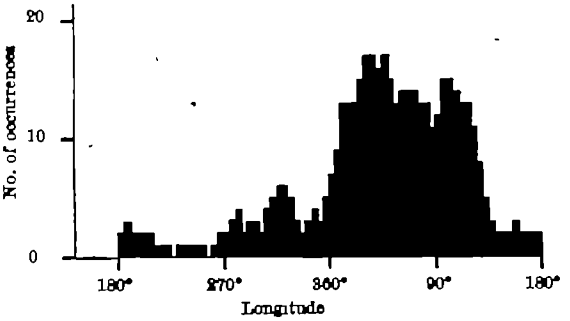

Fig. 2. Frequency of occurrence of 18 3 Mc./s. radiation from Jupiter for intervals of 5° in longitude (based on a rotation period of 9h 55m. 13s.). The longitudes are system II longitudes on August 14, 1951

turbed region was responsible for the radio radiation, the most intense source lying in one of the white spots at the southern edge of the South Temperate Belt.

The mechanism of origin of the radiation is still unknown. Observations during the past few months have confirmed a result suggested by the 1950–51 observations that the individual bursts have durations ranging from fractions of a second to many seconds. An origin in electrical discharges analogous to terrestrial atmospherics is not unlikely. The recent observations are also consistent with the hypothesis of a localized source of the radiation.

A full discussion of the 1950–51 observations will be given in a paper submitted to the *Australian Journal of Physics*.

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Aug. 19.

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## Mechanism of Uniform Field Breakdown in Hydrogen

Any assessment of the validity of theories of electrical breakdown of gases in uniform fields requires an accurate knowledge of breakdown potentials and of the magnitudes of the fundamental ionization processes involved. Preferably these quantities should be determined under the same experimental conditions.

Some years ago, experiments were started in this laboratory to carry out such measurements with the object of checking the streamer theory[1] over a wide range of values of $pd$, the product of gas-pressure and gap-length. Since that time, the results of experiments of F. Llewellyn-Jones and his co-workers[2,3] have been published. Their results demonstrate that the Townsend theory of breakdown, involving (i) a primary ionization process in the gas denoted by the Townsend coefficient $\alpha$, and (ii) a secondary process here denoted by $\gamma$ probably taking place at the cathode, is adequate to explain the initiation of breakdown in both air and nitrogen up to a value of $pd$ of about 1,000 cm. mm. mercury. Our results in air lend support to this view, and it is the purpose of this communication to report the results of similar experiments in hydrogen.

Determinations have been made, at a number of values of the ratio of electric field-strength to pressure, $E/p$, of the growth of current as the gap-length, and consequently $pd$, is increased to within a few per cent of the breakdown value. A plot of ln $i$ against gap-length $d$ has a form similar to that obtained for air, having an initial linear region from which a value of the Townsend coefficient $\alpha$ can be obtained, followed by a region of increasing gradient indicating the presence of a secondary ionization process. A typical series of curves obtained at 700 mm. mercury pressure is shown in Fig. 1, and similar curves have been obtained at 300 mm. and 100 mm. mercury pressure.

The values of $\alpha/p$ obtained from the curves are shown in Fig. 2, together with the results in hydrogen of previous workers. It has been found that in the range of $E/p$ where the results obtained at different pressures overlap, there is agreement in the values of $\alpha/p$ within the limits of experimental error. The fact that $\alpha/p$ is truly a function of $E/p$ has not previously been experimentally demonstrated over a wide pressure range.

There is general agreement in the values of $\alpha/p$ obtained by all workers when $E/p > 25$ volts/cm./mm. mercury; but for $E/p < 22$ the results of this work show considerable divergence from those of Ayres[4] and the microwave measurements of Brown[6] *et al.* The value of $\alpha/p$ at $E/p = 15$ V./cm./mm. mercury is almost two orders of magnitude smaller than that obtained by Ayres. It should be pointed out, however, that the measurements of Ayres[4] in nitrogen are greater by a number of orders of magnitude at low $E/p$ than the more recent results of Masch[7], Posin[8] and Dutton *et al.*[3].

It is of particular interest that, over the range of $E/p$ studied, the results are in very good agreement with the calculations of Emeléus, Lunt and Meek[9], which are based on the assumption of a Maxwellian distribution of electron energies.

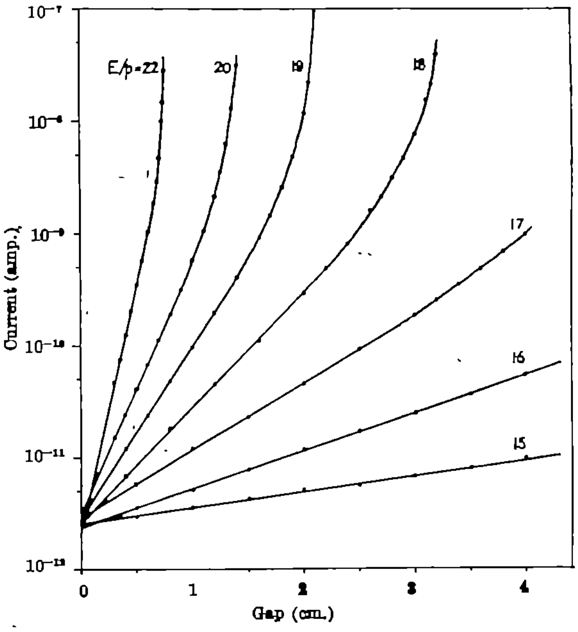

Fig 1. Hydrogen at pressure of 700 mm. of mercury and temperature of 20° C.

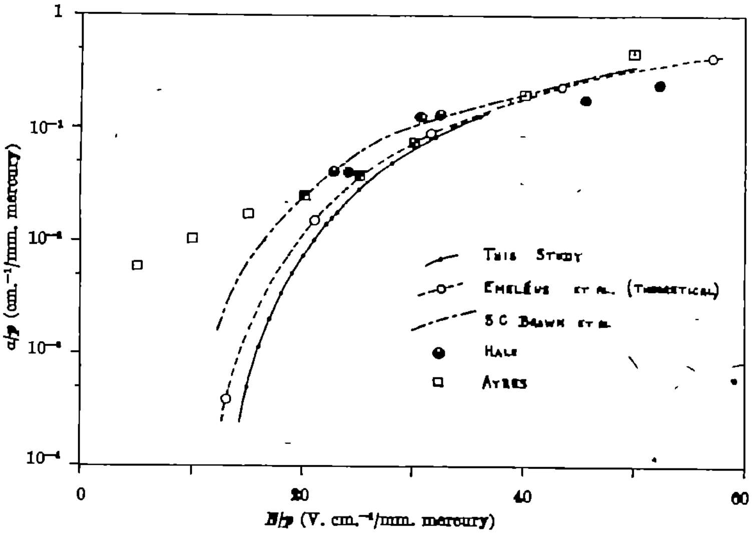

Fig. 2

Assuming the Townsend-type equation

$$i = i_0 \frac{\exp \alpha d}{1 - \gamma (\exp \alpha d - 1)}$$

to describe the form of the $d$ — ln $i$ plots, values of $\gamma$ have been evaluated for each experimental point on the non-linear part of the curve, and reasonably consistent values are obtained for all points on any one given curve. When these values of $\gamma$, together with the measured values of $\alpha/p$, are substituted into the Townsend equation, values of $pd$ at breakdown in good agreement with measured values are obtained.

If the measured values of $\alpha/p$ are substituted into the streamer equation in order to calculate breakdown voltages, it is found that the streamer criterion is considerably in error, and that in fact the criterion is only satisfied when over-voltages of the order of 10 per cent are applied.

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## Variation of Flow Birefringence with Stress

In flowing liquids in which the same mechanism (for example, network deformation in a polymer solution) gives rise to birefringence and to stress, it is reasonable to expect these to vary together when factors such as rate of shear and concentration of solute are altered. Birefringence and stress require, for their complete description, ellipsoids, and the question arises as to how these are to be compared. According to the simplest possible relation (in which the stress tensor is equal to a constant multiple of the refractive index tensor plus an isotropic tensor) the optic and stress ellipsoids have the same orientation, and the differences of principal axes of either ellipsoid are proportional to the differences of the corresponding principal axes of the other ellipsoid. Thus for coaxial ellipsoids, which we shall consider here, it seems natural to compare differences of principal axes.

In stationary laminar shear flow, the symmetry of flow ensures that two principal axes of each ellipsoid lie in a plane containing the direction of flow and the velocity gradient (Fig. 1). Using light rays normal to this plane, the difference, $\Delta n$, of principal semi-axes and the orientation, $\chi$, of the optic ellipsoid can be measured directly. A recently developed technique[1] enables one to measure the corresponding quantities $\Delta p$, $\chi$ for the stress ellipsoid in solutions of suitable consistency. Such optical and stress measurements have not yet been made on the same liquid, so for the present we shall use the assumption of coaxiality of the ellipsoids to calculate $\Delta p$, the difference of principal stresses, from the measured shear stress $\tau$ and the optical extinction angle $\chi$, using the relation

$$\Delta p = 2\tau \operatorname{cosec} 2\chi \tag{1}$$

known from plane stress analysis[2].

It is therefore to be expected that the ratio

$$\frac{\Delta n}{\Delta p} = \frac{\Delta n \sin 2\chi}{2\tau} \tag{2}$$

will have simple properties.

For Newtonian liquids, $\chi = 45°$ for the stress ellipsoid; hence $\sin 2\chi = 1$ and $2\Delta n/\Delta p = \Delta n/\tau$, which is the 'Maxwell constant' introduced in the early theory of Raman and Krishnan[3] for this case. Optical measurements also give $\chi = 45°$ for most liquids at low shear rates, but values less than 45° at higher shear rates. Similar results for the stress have been found recently[1] for various polymer solutions. This is consistent with the assumption of coaxiality.

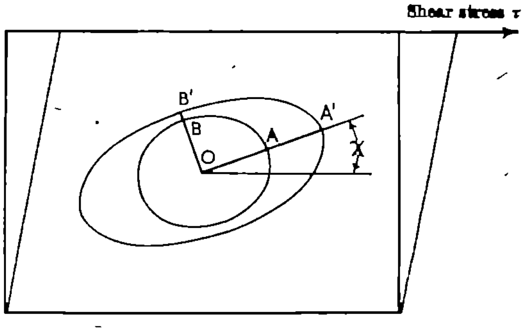

Fig. 1. Sections of coaxial optic ($AB$) and stress ($A'B'$) ellipsoids in shear flow. $OA - OB = \Delta n$; $OA' - OB' = \Delta p$

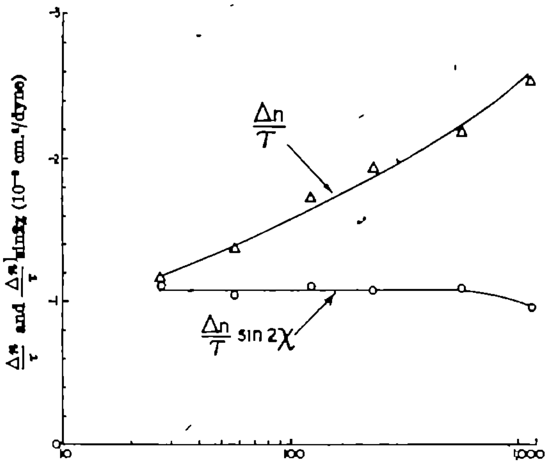

Fig. 2. Flow birefringence of polystyrene ('viscosity average' mol. weight, 200,000) in benzene; 6 per cent solution at 20° C. (Data of Signer, ref. 4)

Measurements of birefringence and shear stress have often been used[4] for calculating the ratio $\Delta n/\tau$ even when $\chi$ differs from 45°; but the ratio $\Delta n \sin 2\chi/\tau$ does not appear to have been calculated, despite the strong hint in this direction given by Buchheim and Philippoff[5]. Using published data[4,6] on moderately concentrated polystyrene solutions in various solvents, I have calculated this ratio and find that it is independent of shear rate, polymer concentration, and distribution of chain-length over considerable ranges of these variables. Moreover, the effect of omitting the factor $\sin 2\chi$, when significant, is deleterious: a striking example of this is given in Fig. 2. In these examples, the birefringence of the solvent is negligible in comparison with that of the polymer, so we take $\tau = G(\eta - \eta_s)$, the shear stress due to the polymer, where $G$ denotes shear rate and $\eta$, $\eta_s$ the solution and solvent viscosities.

Thus the data on certain polystyrene solutions are consistent with the view that the stress and optic ellipsoids are coaxial, that their orientation increases with shear rate, and that the difference of principal axes of the optic ellipsoid increases in proportion to the difference of the corresponding principal axes of the stress ellipsoid.

These results agree with a recent 'molecular' theory[7] in which stress and birefringence in a moderately concentrated flowing polymer solution are assumed to arise from network deformation; this theory leads to the results that the stress and optic ellipsoids are coaxial for any flow history at constant temperature, and that, in shear flow,

$$\frac{\Delta n}{\Delta p} = \frac{\Delta n \sin 2\chi}{2G\,(\eta-\eta_s)} = \frac{2\pi}{45}\,\frac{(n^2+2)^2}{n}\,\frac{\alpha_1-\alpha_2}{kT} \tag{3}$$

where $n$ denotes the mean refractive index of the solution, $k$ Boltzmann's constant, $T$ the absolute temperature, $\alpha_1$ and $\alpha_2$ the longitudinal and transverse principal polarizabilities of an 'equivalent random link' of the polymer chain. Kuhn and Kuhn have developed a theory for very dilute polymer solutions in which the deformation and orientation of polymer molecules are caused by hydrodynamic forces; using their expressions[8] for $\Delta n$, $\chi$ and $\eta$ for flexible molecules to calculate $\Delta n/\Delta p$, I find exactly the same equation (3).

This work forms part of the programme of fundamental research undertaken by the British Rayon Research Association.

A. S. LODGE

British Rayon Research Association,
Heald Green Laboratories,
Wythenshawe, Manchester.
June 16.

[1] Roberts, J. E., Proc. Second Int. Congress Rheol., 91 (Butterworth, 1954).

[2] Southwell, R. V., "Theory of Elasticity" (2nd edit., Oxford Univ. Press, 1941); cf. equations (27), (29), p. 136.

[3] Raman, C. V., and Krishnan, K. S., *Phil. Mag.*, **5**, 769 (1928).

[4] Signer, R., *Z. phys. Chemie*, A, **150**, 257 (1930).

[5] Buchheim, W., and Philippoff, W., *Naturwiss.*, **26**, 694 (1938).

[6] Schmidli, B., Diss., Tech. Hochsch. Zurich (1952).

[7] Lodge, A. S., Proc. Second Int. Congress Rheol., 229 (Butterworth, 1954); cf. equations (7), (9), with $\eta$ replaced by $\eta-\eta_s$.

[8] Kuhn, W., and Kuhn, H., *Helv. Chim. Acta*, **28**, 1533 (1945); **29**, 71 (1946); cf. equations (4.19), (5.4) and (5.7).

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## Oscillating Droplets and Spontaneous Emulsification

THE observations of Lewis and Pratt[1] and later of Lewis[2] on mass transfer and interfacial stability have led, at these authors' instigation, to our investigating the phenomena in greater detail.

We were able to produce an oscillation in a pendent drop of water in toluene by squirting acetone from a capillary at one side only of the drop. The arrival of the acetone at the interface immediately caused the drop to kick violently towards the capillary. This experiment was repeated with an air bubble in toluene and gave similar results. If, on the other hand, both water droplets and air bubbles are surrounded by a homogeneous solution of acetone in toluene, the water droplets oscillate; but the air bubbles show no movement whatever. An essential condition for oscillations thus appears to be a non-uniform distribution of solute around the drop; this may either be induced by squirting, as above, or by non-uniform diffusion across the interface. The effect of localized changes of interfacial tension resulting from variations of solute concentration around the drop can be deduced from the equation:

$$p = 2\gamma/r \tag{1}$$

where $p$ is excess pressure inside the drop, $\gamma$ is the interfacial tension and $r$ is the curvature of the surface of the drop. The equation shows that a sudden decrease in $\gamma$ over a given area will produce either an impulse outward through this area, or a decrease in $r$ for the same area. These expectations are in agreement with our experimental observations, and also those of Garner, Nutt and Mohtadi[3].

In an attempt to consider this phenomenon quantitatively, we have equated the localized interfacial energy changes to the potential energy of the pendent drop in its displaced position, and on this basis have derived the equation

$$M^*\left(\frac{dc}{d\gamma}\right)^* = \frac{A}{gh}\cdot\frac{c^*}{(1+\alpha)} \tag{2}$$

where $h$ is the height through which the centre of gravity of the drop rises during a kick and $c$ is the initial solute concentration in the phase from which diffusion occurs; $(dc/d\gamma)^*$ is the gradient of the (solute concentration)–(interfacial tension) curve at the point $c^*$. (The asterisks imply that the quantities correspond to a kick of size $h$.) Further, $M^*$ is the relative mass of the drop; $\alpha$ is the distribution

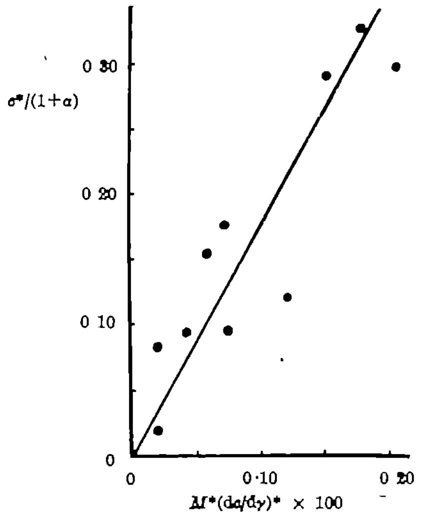

Fig. 1. Plot of $c^*/(1 + \alpha)$ against $M^*(dc/d\gamma)^* \times 100$ for various systems, each consisting of two phases with a third component soluble in both. All experiments were carried out at 20° C.

coefficient for the solute between the two phases and $A$ is the area over which a local change in $\gamma$ occurs.

By projecting the magnified image of the drop on to a screen, its oscillations were more easily studied and it was found possible to keep $h$ the same (and small) for each system. The factors $M^*$, $(dc/d\gamma)^*$, and $c^*/(1 + \alpha)$ were determined for each of ten different solute–solvent systems and $c^*/(1 + \alpha)$ plotted against $M^*(dc/d\gamma)^*$ (Fig. 1). Since the line is approximately linear, $A$ can vary very little from system to system. The presence of a detergent in the aqueous phase was found by Lewis greatly to reduce the violence of the oscillations, and in the present work 0·49 m$M$ sodium dodecyl sulphate increased $c^*$ considerably for the acetone-toluene/water system. The point $M^*(dc/d\gamma)^*$, $c^*/(1 + \alpha)$, for this case, however, did not lie on the line of the other results. A probable explanation is that the area $A$ over which the excesses of acetone spread was largely confined by the pressure of the detergent film. This aspect is being investigated.

Since increased transference-rates were observed by Lewis[2] for systems showing interfacial turbulence, investigations have been made on the basis of a suggestion by Quincke[4] that interfacial turbulence is the cause of spontaneous emulsification. If an emulsion were formed at the interface, the surface area would be increased and an increased rate of transference would be expected. Of the systems examined, only those containing alcohol visibly produced emulsions together with kicking of the interface. It is possible, however, to prevent the kicking by the addition of small amounts of protein or detergents without preventing the spontaneous emulsification. The conclusion is, therefore, that spontaneous emulsification is not related to kicking and proceeds according to the mechanism proposed by McBain and Woo[5]. This involves the idea of a column o diffusing alcohol carrying with it some oil int the water and there stranding it in the form o small droplets. Retardation of the diffusion-rate b the addition of sodium chloride to the aqueous phas confirms this, in that much less emulsion is formed Photographs and slow-motion ciné-films are bein taken demonstrating these effects.

Thanks are due to the Atomic Energy Authorit for financing the work and to Dr. J. T. Davies Mr. T. V. Davies, Mr. J. B. Lewis and Sir Eric Rideal for helpful discussions.

D. A. HAYDON

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June 29.

[1] Lewis, J. B., and Pratt, H. R. C., *Nature*, 171, 1155 (1953).
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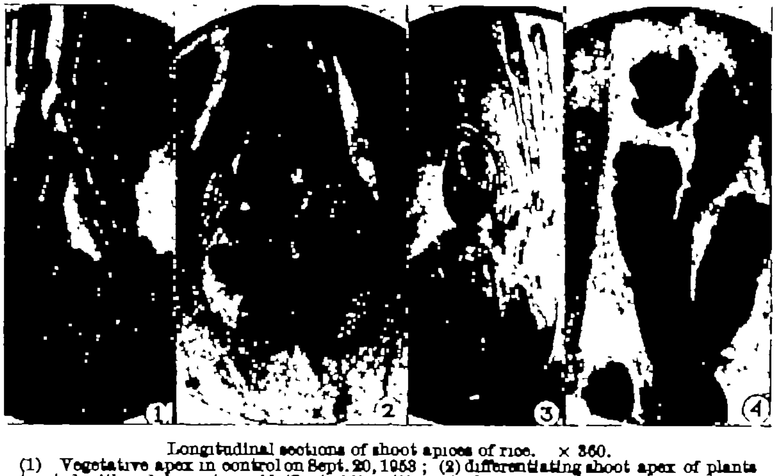
## Effect of Auxins on the Flowering Behaviour of Rice

IN a recent paper, Hussey and Gregory[1] reported that in two experiments out of four carried out, low concentration of auxin increased the number of flower primordia, while high concentration decreased it in winter barley. These results confirm the findings of Leopold and Thimann[2] in winter barley; but in petkus rye the flowering behaviour was not affected by the auxin treatment. In discussing these results, Hussey and Gregory defined the meaning of flower initiation and promotion of flowering, and expressed the opinion that auxin had no effect on the initiation of flowering, as auxin injection in an unfavourable photoperiod did not show initiation of flower primordia.

In rice, a different picture is obtained. Rice seeds, var. Rupsail, were sown on July 13, 1953, and 500 p.p.m. indole acetic acid and 300 p.p.m. α-naphthalene acetic acid were sprayed to the plants daily for one week from September 10. At the end of the treatment, the plants were allowed to continue



Longitudinal sections of shoot apices of rice. × 360.
(1) Vegetative apex in control on Sept. 20, 1953; (2) differentiating shoot apex of plants treated with indole acetic acid (Sept. 21); (3) control on Sept 25; (4) differentiation (Sept. 25) of flower initials of plants treated with indole acetic acid

e 1. Effect of Auxins on Leaf Number, Ear-Emergence, Ear-length and Number of Spikelets on the Main Shoot. Sowing Date, July 13, 1953. Replications, 15

| Treatment | No. of leaves | No. of days from sowing to ear-emergence | Ear-length (cm.) | Total No. of spikelets | No. of empty spikelets | No. of grains set per ear |
|---|---|---|---|---|---|---|
| ndole acetic acid (500 p.p.m.) | 15·2 ± 0·33 | 95·9 ± 2·72 | 6·76 ± 0·53 | 65·1 ± 2·25 | 34·3 ± 2·88 | 29·4 ± 1·52 |
| Naphthalene acetic acid (900 p.p.m.) | 15·6 ± 0·36 | 104·6 ± 2·80 | 5·90 ± 0·48 | 54·9 ± 2·18 | 36·0 ± 1·95 | 19·4 ± 1·66 |
| ontrol | 17·4 ± 0·37 | 123·0 ± 1·60 | 6·95 ± 0·30 | 90·2 ± 1·88 | 22·2 ± 0·64 | 68 0 ± 1 62 |

der natural day-length, which is unfavourable to wering. Microtome sections were prepared to udy daily changes in the development of the shoot ex, the details of which have been described elsehere[3]. Up to the time of the hormone spray, the oot apices in all the cases were vegetative. On ptember 13 the first sign of a transitional stage egan to appear in the plants treated with indole cetic acid. The full differentiation of the apex in lants treated with auxin took place much earlier han those of the control (Figs. 1–4).

Table 1 shows that plants treated with indole cetic acid flowered an average of 27·1 days earlier, nd plants treated with naphthalene acetic acid re earlier by 18·4 days. The total number of pikelets was rather adversely affected by the treatent, while the differences in ear-length are not ignificant. It is evident that the treatment caused significant reduction in the percentage of grain etting.

Preliminary experiments with only one concentration, fairly high, show that flower primordia are initiated earlier; but the promotion of flowering as visualized by Leopold and Thimann in the formation of an increased number of flowers was not seen. An after-effect of auxin is increased sterility in the spikelets.

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Maya Kundu

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[2] Leopold, A. C., and Thimann, K. V., *Amer. J. Bot.*, 36, 342 (1949).

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## Gene Control of Copper-Sensitivity in *Saccharomyces*

An extensive study of the adaptation of yeasts to copper by Prof. Joji Ashida and his associates[1] revealed that yeasts are trained to high concentrations of copper by a two-step process. On agar containing copper, they found that copper-sensitive yeast cells grew as a thin film which became spotted with brown colonies of copper-resistant cells. Cells which they selected from the brown colonies proliferated rapidly on transfer to a copper medium, producing dense brown subcultures. Studies by the Ashida group indicated that many factors affect pigmentation of the copper-resistant cells. They inferred that the ability to resist copper-poisoning could be transferred to sensitive cells by ribonucleic acid extracted from closely related resistant organisms, but not by ribonucleic acid from sensitive organisms. They showed that the difference between resistant and sensitive cells was clearly expressed in medium containing 1 m*M*/l. of copper sulphate. In the cultures of *Saccharomyces* tested by Ashida and his group copper-resistant variants did not arise without training; none grew rapidly on a copper medium without previous selection by the two-step process described above.

Eighteen cultures of the Carbondale breeding stock (a stock developed by the hybridization of six different species of *Saccharomyces*) were tested for resistance to copper in broth cultures. All but one were resistant. The medium was supplemented with 1 m*M*/l. of copper sulphate and contained 4 ml. of liquid yeast extract (Anheuser–Busch), 3·5 gm. of peptone, 1·0 gm. of magnesium sulphate, 2·0 gm. of potassium dihydrogen phosphate, 40·0 gm. of dextrose, 1,000 ml. of distilled water. The *p*H was adjusted to 5·5 in a Beckman *p*H meter. The conclusions of the Ashida group that 1 m*M*/l. is a satisfactory concentration for distinguishing copper-resistant from copper-sensitive cultures were confirmed. 4 ml. of broth containing copper was inoculated with 300–500 cells from a 24-hr. copper-free slant. The resistant cultures grew rapidly in the copper-broth, whereas the sensitives failed to produce perceptible growth in 24 hr. Stock cultures were maintained on copper-free medium, and transfers from the copper-containing medium were never used in the hybridization programme. Genetical analysis was confined to the single original gene-pair controlling copper-resistance and copper-sensitivity, and no attempt was made to discover if other gene pairs were involved in the control of copper-sensitivity, since more than one gene controlling the same phenotype cannot be used in a programme aimed at chromosome mapping.

The original sensitive culture was mated to a resistant culture and eleven asci were dissected and tested for sensitivity to copper. Two sensitive and two resistant cultures were obtained from each ascus, indicating that the character is gene-controlled. The hybrid (family I) was heterozygous for genes controlling mating type and galactose fermentation. Four families heterozygous for the gene-pair controlling resistance and sensitivity to copper, as well as for genes controlling mating-type, fermentation of galactose, sucrose and melibiose, and synthesis of proline, *iso*leucine, uracil and lysine, were analysed. The pedigree is shown in Fig. 1. No linkage between the gene-pair controlling sensitivity to copper and other genes was found. Regular segregation occurred in all asci for all the markers indicated except for one ascus in family III which produced three *iso*leucine-independent and one *iso*leucine-dependent clone, and one ascus in family IV which produced three uracil-dependent and one uracil-independent clone. In all, a total of fifty-seven asci were analysed. In eight asci only three spores survived and the composition of the missing spore was inferred. Hybrids homozygous for either sensitivity or resistance produce only progeny which resemble their parents in this respect.

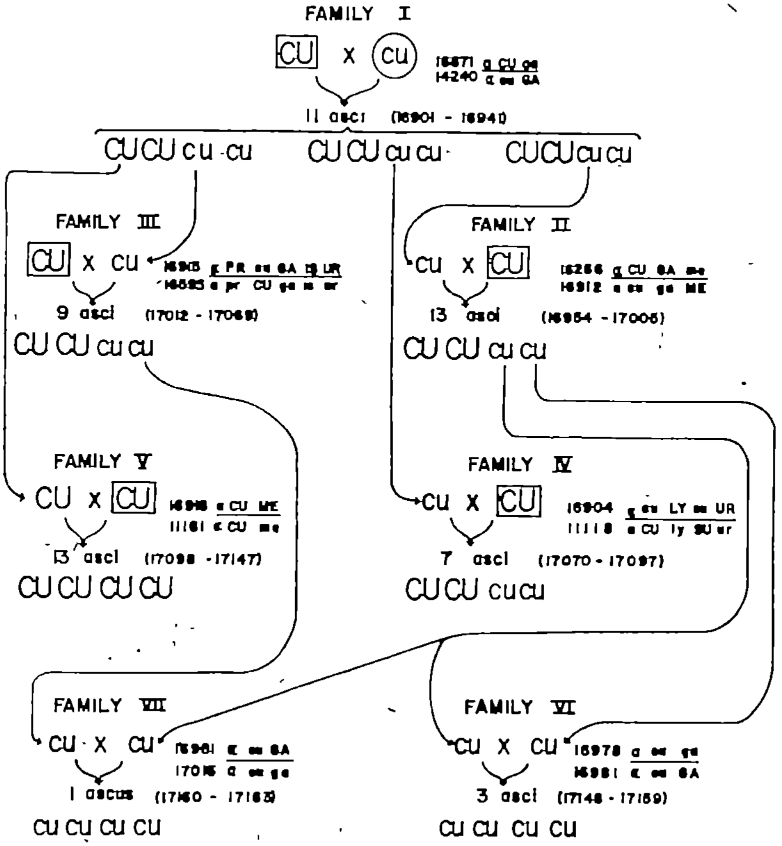

Fig. 1. PEDIGREES OF COPPER-RESISTANCE AND COPPER-SENSITIVITY
The designations enclosed in squares or circles indicate cultures selected by canvassing the breeding stocks. The genotypes of the hybrids and the serial numbers of the parent stocks are indicated to the right of each. The abbreviations are: *a/α*, mating type; *CU/cu*, copper sensitivity; *GA/ga*, galactose fermentation; *ME/me*, melibiose fermentation; *PR/pr*, proline requirement; *IS/is*, isoleucine *UR/ur*, uracil; *LY/ly*, lysine; *SU/su*, sucrose. The number of asci isolated from each hybrid and their serial numbers are indicated. Three asci from family I provided parent cultures for families II, III, IV and V as indicated by the arrows

This work has been supported by a research grant from the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service, C-2140.

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CARL C. LINDEGREN
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June 9.

[1] Minagawa, T., Yanagishima, N., Arakatsu, Y., Nagasaki, S., and Ashida, J., *Bot. Mag. Tokyo*, **64**, 753 (1951); **65**, 771 (1952); **66**, 775 (1953). Naiki, N., Minagawa, T., Arakatsu, Y., and Ashida, J., *Mem. Coll. Science, Univ. Kyoto*, B, **21**, 87 (1954). Arakatsu, Y., Yanagishima, N., Minagawa, T., Naiki, N., and Ashida, J., *Mem. Coll. Sci., Univ. Kyoto*, B, **21**, 97 (1954).

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## An Electrified Barrier for Caterpillars

PLANT-FEEDING caterpillars are often difficult to rear in the laboratory owing to their wandering habits. Cages which will contain the caterpillars, particularly in the young stages, must be of such fine mesh that the whole environment is altered and becomes unsuitable for both plant and insect. The wandering propensities of the insects are often accentuated by the unsuitable conditions. These difficulties have been overcome, in the case of the cutworm *Persectania aversa*, by the development of an electrified barrier. This bar
may be only two inches high
makes little alteration to the
vironment while effectively preve
ing the escape of the caterpills

The main difficulty in making
electrified barrier to contain sm
insects lies in the need to have
very narrow gap between the t
conducting elements. A sin
electrified wire close to the grou
is unsuitable, since any slight u
evenness in the soil surface w
cause a short-circuit. Short-circu
can be avoided by placing tv
conducting elements on a vertic
wooden or metal frame.

Aluminium foil, which is che
and easy to handle, is used for t
conducting elements. A strip
foil 2–2½ in. wide is glued to thic
brown paper. When dry it is c
into two strips; a guillotine is be
for this as it ensures that the edg
of the foil and paper are flush wit
each other over their whole lengt
The two paper-backed strips a
then glued to a wider strip of brow
paper so that one overlaps th
other by ¼ in. The two strips ar
thus insulated from each other b
one thickness of brown paper, bu
provide a barrier 1¾ in. wide. Th
whole completed barrier is then
glued to a wooden or metal fram
which is embedded in the soil o
the rearing container. The brown paper provides a gap small enough to stop the smallest caterpillars, but with sufficient insulation for the low voltages used.

Owing to this narrow gap, high voltages cannot be used. It would be necessary to determine the minimum voltage for each individual insect. For *P. aversa*, 6 V. is the lowest voltage which will stop the insects without killing them. The barriers in use at the moment carry 12 V. a.c. obtained by the use of a radio transformer. Direct current is less satisfactory, for although it will stop the caterpillars there is a tendency for many to stick across the two elements and be killed.

A vertical barrier is preferable, for the caterpillars can recoil more easily after making contact. Many of them drop straight back to the ground. On a horizontal barrier they are more likely to be killed by their inability to recoil quickly.

In addition to its use for preventing the escape of caterpillars, this barrier might be used to prevent them entering a control plot. In this case the electrified elements would need to be placed on the outside of the frame.

This equipment has not yet been tried with other insects. This will be done shortly, and a full description, together with methods of testing the barrier, will be published later.

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June 13.

## FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

### Monday, October 31

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 2.30 p.m.—Mr. H. D. R. Shearman: "The Technique of Ionospheric Investigation using Ground Back-Scatter" and "A Study of Ionospheric Propagation by means of Ground Back-Scatter"; Mr. R. W. Meadows: "An Experiment to Test the Reciprocal Radio Transmission Conditions over an Ionospheric Path of 740 km."; Mr. J. F. M. Laver and Mr. C. Stanesby: "An Experimental Test of Reciprocal Transmission over Two Long-Distance High-Frequency Radio Circuits". At .30 p.m.—Mr. W. J. Bray, Dr. J. A. Saxton, Mr. R. W. White and Mr. G. W. Luscombe: "V.H.F. Propagation by Ionospheric Scattering and its Application to Long-Distance Communication".

### Monday, October 31—Thursday, November 3

Society of Chemical Industry, Pesticides Group (in collaboration with the Association of British Insecticide Manufacturers, the British Agricultural Contractors' Association, the National Association of Corn and Agricultural Merchants, and the National Farmers' Union, at Eastbourne)—National Crop Protection Conference—"Practical Aspects of the Use of Insecticides and Fungicides in Agriculture and Horticulture".

### Tuesday, November 1

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Hannah Steinberg: "Drugs and Psychological Time".*

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. M. M. Swann: "Physiology of Mitosis". (Second of fifteen Lectures on "The Scientific Basis of Medicine.")*

### Wednesday, November 2

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. D. V. Ager: "The Geographical Distribution of Brachiopods in the British Middle Lias"; Dr. J. H. James: "The Structure and Stratigraphy of Part of the Pre-Cambrian Outcrop between Church Stretton and Linley, Shropshire".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. F. N. David and Dr. N. L. Johnson: "Some Tests of Significance with Ordered Variables".

University of London (in the Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Sir David Brunt, F.R.S.: "Retrospect and Prospect in Meteorology" (Meteorological Office Centenary Lecture).*

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. T. M. Harris: "Mesozoic Plants". (Further Lectures on November 9 and 16.)*

Institution of Electrical Engineers, London Graduates and Students Section (at Savoy Place, London, W.C.2), at 6.30 p.m.—Dr. E. Colin Cherry: "Communication of Information—Human, Animal and Machine".

Society for Analytical Chemistry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Meeting on "The Evaluation of Anti-fungals".

British Psychological Society, Social Psychology Section (in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 7.30 p.m.—Symposium: "Who Doesn't Answer". A symposium on the problem of bias through non-return in questionnaire surveys and follow-up conducted by post.

### Wednesday, November 2—Friday, November 4

British Institute of Management (at Harrogate)—National Conference—"The Impact of Science on Management in the Future".

### Thursday, November 3

Royal Society (at Burlington House, Piccadilly, London, W.1, at 4.30 p.m.—Mr. H. G. Thornton, F.R.S.: "The Ecology of Micro-organisms in Soil" (Leeuwenhoek Lecture).

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. Graham Cannon, F.R.S.: "What Lamarck Really Said!".

Mineralogical Society (in the apartments of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

University of London (in the Barnes Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 5 p.m.—Lord Adrian, O.M., F.R.S.: "The Action of the Mammalian Olfactory Organ" (Semon Lecture).*

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Captain C. F. Booth and Mr. B. N. MacLarty: "The New High-Frequency Transmitting Station at Rugby".

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. H. G. Davies: "The Use of the Interference Microscope in Biological Research". (Third of fifteen Lectures on "The Scientific Basis of Medicine.")*

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

### Friday, November 4

Association of Applied Biologists (in the Meeting Room of the Royal Entomological Society of London, 41 Queen's Gate, South Kensington, London, S.W.7), at 11 a.m.—Meeting on "Some Recent Researches on Fruit Growing".

University of London (at Charing Cross Hospital Medical School London, W.C.2), at 5 p.m.—Dr. J. Hammond: "Growth in Animals".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Graham Sutton, F.R.S.: "Weather Forecasting—the Future Outlook".

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## APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Physical or Industrial Chemists or Chemical Engineers (with good honours degree or equivalent qualifications, preferably with experience), for research in the processing of coal and allied materials covering a wide field of physical chemistry and chemical engineering, including laboratory investigations into the surface characteristics and associated properties of coal and allied materials, and the design and operation of pilot plant—National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting 88/93 (November 4).

Biochemist, senior grade (with B.Sc. degree and/or A.R.I.C. and with wide general experience in medical biochemistry)—Group Secretary, Group 20 Hospital Management Committee, Stoney Stanton Road, Coventry (November 5).

Lecturer or Assistant Lecturer in Anatomy—Registrar, The University, Manchester 13 (November 7).

Senior Lecturer and Lecturer (with good honours degree and preferably with teaching experience) in Physics at the Nigerian College of Arts, Science and Technology—Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 7).

Research Assistant (with a good honours degree in biochemistry or in chemistry and physiology) in the Pharmacology Department—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 11).

Assistant (with interest in algology) in Botany—The Secretary, The University, Aberdeen (November 12).

Assistant Economist (with a university degree in economics, and preferably with postgraduate experience) at the Colonial Office, for duties including the review of economic trends and progress, economic analysis of colonial development plans, economic intelligence, research studies and to provide advice and assistance in economic fields to other departments of the Colonial Office—London Appointments Officer, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W.C.1, quoting AC.1218 (November 12).

Chair of Zoology—The Registrar, University College, Singleton Park, Swansea (November 12).

Computer (with at least G.C.E., including mathematics at advanced level) in Mathematical Statistics and some Applied Mathematics—The Registrar, King's College, Newcastle-upon-Tyne (November 12).

Engineering Assistant (graduate, with at least two years practical experience of civil engineering work) in the Highway Planning Section, for duties in connexion with the realignment of roads, preliminary reconnaissance of new major highway routes and the control of main roadside access—County Planning Officer, Litton Lodge, Clifton Road, Winchester (November 12).

Lecturer in Physiology—The Dean, St. Bartholomew's Hospital Medical College, West Smithfield, London, E.C.1 (November 12).

Lecturer in Psychology—The Secretary, The University, Aberdeen (November 14).

Scientific Officer (with first- or second-class honours degree in chemistry or chemical engineering, or equivalent qualification, with wide interest in the application of science rather than in academic research, a broad appreciation of the scientific aspects of industrial problems and an aptitude for dealing with people, preferably with industrial experience) at the Headquarters Intelligence Division, Directorate of Scientific and Industrial Research, London, to collect and collate information, both from literature and personal visits, on technical developments of current importance—Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.620/54 (November 14).

Aerodynamicists and Mathematicians, Scientific Officer grade (with first- or second-class honours degree or equivalent qualification, preferably with some research or development experience), at Ministry of Supply Experimental Establishments, mainly at Amesbury, Farnborough, Bedford and London Headquarters, for research and development work on aircraft projects, problems of auto-control, flight test and performance analysis, guided weapons and gas turbines—Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.753/5A (November 15).

Lecturer or Assistant Lecturer in Geography at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (November 15).

Lecturer in Pharmacology—The Registrar, King's College, Strand, London, W.C.2 (November 15).

Scientific Officer (with an honours degree in chemistry with postgraduate experience in agricultural chemistry or an honours degree in agricultural chemistry) in the Chemical Research Division, Ministry of Agriculture, Northern Ireland, to take part in research investigations and the general duties of the Division, and possibly to undertake teaching duties in the Faculty of Agriculture, The Queen's University—Director of Establishments, Ministry of Finance, Stormont, Belfast, N. Ireland (November 16).

Physiologist or Biochemist (with an honours degree in science or equivalent qualification with physiology or biochemistry as major subject and preferably with postgraduate research experience in the fractionation and biological assay of protein hormones) as Research Officer at the Sheep Biology Laboratory, Prospect, N.S.W., Australia, to undertake investigations on the endocrinology of wool growth—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 205/36 (November 19).

Plant Physiologist (with an honours degree and postgraduate training and experience in plant physiology)—The Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle, Ceylon (November 19).

Senior Lecturer or Lecturer in Bacteriology—The Registrar, The University, Manchester 13 (November 19).

Senior Lecturer in Physics at Victoria University College, Wellington, New Zealand—Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (November 21).

Research Officer (with a first- or good second-class honours degree with qualifications in agricultural chemistry and experience in field experimentation) at Dunholme Field Station, Lincoln, to organize a series of field experiments on the manuring of sugar beet—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (November 26).

Director of the West African Institute of Social and Economic Research, University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (November 30).

Fellow and Senior Research Fellow (to undertake research in mathematical statistics or its applications, including mathematical genetics) in the Department of Statistics, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (November 30).

Lecturer in Applied Mathematics at St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (November 30).

Lecturer (with an honours degree in geography and with special qualifications in physical and economic geography and geomorphology) in Geography, at St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (November 30).

Lecturer or Assistant Lecturer (preferably with special interest in petrology, mineragraphy or structural geology) in Geology, at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (November 30).

Reader in Geology—The Registrar, University of Dacca, Ramna, Dacca, East Bengal, Pakistan (November 30).

Demonstrator (graduate in chemistry) in Chemistry—The Registrar, College of Technology, Manchester 1 (December 1).

Senior Lecturer (with a degree in science or engineering with geology as a major subject, and with field experience in mining and/or engineering geology, preferably with experience in mineragraphy and/or geophysical exploration) in Geology, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 2).

Lecturer (with a research degree in organic chemistry and experience of teaching this subject) in Organic Chemistry at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 9).

Chair of Building Science—The Registrar, The University, Liverpool (December 10).

Chair of Geography at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 15).

Stanley Elmore Research Fellowship in Extraction Metallurgy, to undertake research in the Department of Metallurgy of a University or similar Institution in the United Kingdom—Stanley Elmore Trust, 175 Temple Chambers, Temple Avenue, London, E.C.4 (December 31).

Assistant Trials Officer (with a degree in botany or agriculture or equivalent qualification, and with practical experience in crop production) at the Seale-Hayne Agricultural College, Newton Abbot—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Chemical Engineer (with a degree in chemical engineering or equivalent qualifications) on the personal staff of the Chief Engineer, North Thames Gas Board, for duties including development work, particularly in relation to new and improved methods of production, refining and distribution of gas from gaseous and liquid hydrocarbons and coal—Staff Controller, North Thames Gas Board, 30 Kensington Church Street, London, W.8, quoting 666/282.

Editing Librarian to be responsible for the handling, cataloguing and storage of film material—Films Officer, British Transport Commission, 25 Savile Row, London, W.1.

Entomologists (with an honours degree in zoology and training in entomology) in the Department of Tsetse Control, Gold Coast, to investigate various aspects of the bionomics and ecology of tsetse flies in relation to man and animals, and to supervise control measures under the Director of Tsetse Control—Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.77/13/01.

Senior Experimental Officer or Experimental Officer (with at least H.S.C. Science or equivalent qualification, with a general scientific and engineering background and a working knowledge of radioactivity measuring apparatus, remote handling, health physics, machine shop and experimental construction of equipment) in the Isotopes Division, for duties including the preparation of materials and the arrangement of irradiations with Pile Groups, high-level remote handling and measurements, developments of techniques and mechanical, electrical and electronic equipments—Establishment Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/409.

Senior Instructor (with academic qualifications and sound workshop training and with teaching experience) at the Staff Training College, Derby, to prepare, supervise and take part in courses of instruction for various grades of staff who will be engaged in designing, maintaining and repairing locomotives and rail-cars having dies engine propulsion with hydraulic, mechanical, electrical or oth transmission and control—Manpower Adviser, British Transpo Commission, 222 Marylebone Road, London, N.W.1.

Senior Scientific Officer (honours graduate with a sound knov ledge of statistical methods and preferably with industrial and technic experience) for work including research into problems connected wit the coking industry, preparation of technical reports and possib participation in operational research in the provinces; Scientific Officer (graduate with some industrial and/or technical experienc for general technical duties and the preparation and editing of tech nical reports—The Secretary, British Coke Research Associatio 74 Grosvenor Street, London, W.1.

Training Manager (honours graduate with qualification in physic or chemistry or Associate Member of a senior Engineering Institutio for the United Kingdom Atomic Energy Authority, Industrial Grou Capenhurst Works, for training activities within the works with th assistance of a small staff, and to maintain close liaison with loc Education Authorities and Technical Colleges—Recruitment Office U.K. Atomic Energy Authority, Industrial Group Headquarter Risley, near Warrington, quoting 1,132.

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# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Committee on Air Pollution. Report. (Cmd. 9322.) Pp. 80 (London: H.M. Stationery Office, 1955.) 2s. 6d. net. [3

Clean Air Bill. (Bill 40.) Pp. iv+28. (London: H.M. Stationery Office, 1955.) 1s. net. [3

The Commonwealth and Nuclear Development. (Central Office o Information Reference Pamphlet—No. 2.) Pp. iv+52. (London H.M. Stationery Office, 1955.) 2s. net. [8

Education in 1954: being the Report of the Ministry of Educatio and the Statistics of Public Education for England and Wales. (Cmd. 9521.) Pp. viii+197. (London: H.M. Stationery Office, 1955. 7s. 6d. net. [88

The South-Eastern Naturalist and Antiquary. (Being the Fifty-ninth volume of transactions of the South-Eastern Union of Scientifi Societies, including the Proceedings at the Fifty-ninth Annual Congres held at Maidstone, 1954. Edited by L. R. A. Grove. Pp. xxvi+56. (Maidstone: Mr. L. R. A. Grove, Museum and Art Gallery, 1954. 6s. 6d. net. (Free to members.) [10

Ministry of Agriculture and Fisheries. Bulletin No. 56: Poultry Housing. Fifth edition. Pp. iv+56+4 plates. (London: H.M. Stationery Office, 1955.) 2s. 6d. net. [106

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1954. North Eastern Division. By C. W. Scott. Pp. ii+34+4 plates. (London: H.M. Stationery Office, 1955.) 2s. net. [108

Building Research Station Digest. No. 79 (July, 1955): Internal Corrosion of Concrete Sewer Pipes by Effluents Containing Sulphates. The Treatment of Walls Infected with Dry Rot. Repair to Mastic Asphalt and Felt Roof Coverings. Pp. 4. (London: H.M. Stationery Office, 1955.) 3d. net. [10

## Other Countries

Government of India: Meteorological Department. Report on the Administration of the Meteorological Department of the Government of India in 1951–1952. Pp. 62+8 plates. (Simla: Government of India Press, 1954.) [108

Museums Trustees of Kenya. Coryndon Memorial Museum, Nairobi. Annual Report for 1954—(1) Chairman's Report; (2) Curator's Report. Pp. 24+3 plates. (Nairobi: Coryndon Memorial Museum, 1955.) 1s. [108

Research Bulletin of the Panjab University. No. 63 (Zoology): A Preliminary Note on some Birds of the Hoshiarpur District, Panjab, (1). By G. P. Sharma and B. S. Lamba. Pp. 177–186. Rs. 1/2/–. No. 64 (Zoology): Spermatogenesis of a Digenetic Trematode (*Cotylophoron Elongatum*. By Om. Parkash Dhingra. Pp. 1–10. Rs. 1/10/–. No. 65 (Zoology): Spermatogenesis of a Digenetic Trematode *Gastrothylax Crumenifer*. By Om. Parkash Dhingra. Pp. 11–17. Rs. 1/4/–. No. 66 (Zoology): Gametogenesis, Fertilization and Cleavage in *Asymphylodora* SP. By Om. Parkash Dhingra. Pp. 19–29. Rs. 1/12/–. No. 67 (Mathematics): Partitions in General. By Hansraj Gupta. Pp. 31–38. Rs. 1/5/–. No. 68 (Zoology): Oogenesis of the Toad, *Bufo Stomaticus* Lutken, with observations under the Phase Contrast Microscope. By Vishwa Nath and S. K. Malhotra. Pp. 39–46. Rs. 3/–/–. No. 69 (Zoology): Studies on Insect Spermatogenesis of *Chrotogonus trachypterus* (Blanch) with observations under the Phase Contrast Microscope. By Sukhdev Raj Bawa. Pp. 47–54. Rs. 1/12/–. No. 70 (Zoology): Oogenesis of the Wall-Spider, *Crossopriza Lyoni* (Blackwall), as studied under the Phase Contrast Microscope. By Vishwa Nath and Rajindar M. Dhawan. Pp. 55–62. Rs. 1/8/–. No. 71 (Chemistry): Sodium Meta-Vanadate as Volumetric Reagent. Part 3: Diphenylamine Indicator Method. By Balwant Singh and Ranjit Singh. Pp. 63–66. Rs. 0/12/–. (Hoshiarpur: Panjab University, 1954 and 1955.) [108

Sudan Government: Ministry of Agriculture. Annual Report of the Research Division 1951/52. Pp. ii+192. (Khartoum: Ministry of Agriculture (Research Division), 1954.) [108

American Numismatic Society. Numismatic Notes and Monographs. No. 129: Chemical Composition of Parthian Coins. By Earle R. Caley. Pp. v+104 (3 plates). (New York: American Numismatic Society, 1955.) 2.50 dollars. [108

United States Department of Commerce. Weather Bureau. Technical Paper No. 11: Weekly Mean Values of Daily Total Solar and Sky Radiation. Supplement No. 1. Prepared by Sigmund Fritz. Pp. 4. (Washington, D.C.: Government Printing Office, 1955.) [108

# USE AND ABUSE OF ENGLISH IN SCIENCE

EXPOSITION by the spoken or the written word is a skill which is not easily acquired; and dging from the adverse comments made on the forts of scientific men for many years past, they ave been particularly unfortunate in this field. Yet little reflexion will show that they are not alone in nding difficulty in conveying to others, even those f similar interests, their thoughts and views. So far s writing is concerned, the acknowledged masters pend a life-time practising their art. Such skill, artly a natural gift and partly acquired, is given to ew; but that is no reason why others should not trive to set down their thoughts in clear and pleasing erms.

Scientific men have a double task: they have to escribe their work to laymen and also to other cientists—sometimes those working in very different elds. Yet this task is not really a double one; there s fundamentally only a difference of emphasis. The ame qualities of clarity, simplicity and accuracy are till of major importance.

In an article on p. 851 of this issue of *Nature*, Dr. John R. Baker takes scientific men to task specifically for the way in which their papers are written and are presented. Thus he is narrowing down the general ssue, though it could be expected that any improvement in this particular respect would quickly have beneficial effects elsewhere. It is, of course, by no means a novelty to complain that many scientific men write in an uncouth and slovenly style; that complaint has been a common topic of discussion by directors of research for many years. It was indeed a factor in the discussions at the older universities a few years ago on the desirability of retaining at least one of the ancient languages in the entrance requirements. The argument was that, quite apart from any possible usefulness of the fleeting acquaintance with the classics and ancient history thus acquired, there was considerable value in the discipline of translation and the knowledge of the meaning of words and their roots which were acquired. Whether or not a limited knowledge of Latin and Greek is beneficial from this point of view, it is worth noting that the university members of the Committee of Vice-Chancellors and Principals in the recent report on university entrance requirements still commented on the inadequate command of English shown by many of those seeking to enter a university. This topic was also mentioned by Dr. R. P. Linstead in his recent inaugural address as rector of the Imperial College of Science and Technology.

Some specific points are, however, made by Dr. Baker which merit immediate consideration. After mentioning grammatical errors, he turns to what he terms "grandiloquence". Here, in passing, attention may be directed to the letter by Prof. H. N. Barber n *Nature* of October 15, p. 750, which surely needs no comment. It will, of course, be agreed that where certain terms or phrases have a specific technical meaning, they must be used. Even so, it is not a bad thing to consider from time to time whether their continual use in the course of perhaps a single paragraph, however justifiable on the grounds of accuracy, does not lay the writer open to the charge of using technical jargon. It is clearly a point on which a certain amount of thinking is necessary.

On the question of the use of a German construction for the sequence of adjectives and nouns, Dr. Baker is probably right in stating that the practice is growing. In some cases—and Dr. Baker quotes examples—only the judicious use of the occasional hyphen can save a phrase from meaning the reverse of what is intended; the meaning may still be obvious from the context, but it should not be necessary to have to go to the context in such short phrases. It is difficult to find any real justification for the use of this style. To a limited extent it may give crispness to a statement and save the use of the word 'of'; but its general adoption seems dangerous and unnecessary. Dr. Baker's examples could readily be multiplied, and point to the growth of a new style in scientific writing which has nothing to commend it.

Passing now beyond Dr. Baker's article, reference may be made to another tendency—perhaps it is only a mannerism—which has been noticed in recent years, namely, an unusual use of some common verbs. Thus an author may write that he "reacted zinc with hydrochloric acid", or he "combusted" something, or that "a metal distorts upon cooling", or that "a wave propagates in a straight line". Such phrases are frequently seen in communications submitted to *Nature*, from Great Britain as well as elsewhere, and sometimes it is difficult to be sure whether or not a new technical meaning is being given to a hitherto common word. Unless some particular quality is intended by the use of common words in this way, it would seem that an unnecessary grammatical change is being introduced. The English language, in spite of its lack of inflexions, is wonderfully fluid and surely does not need to be subjected to such twists in order to accommodate new terms or to re-express old ones.

Another problem which is causing increasing concern—to printers as well as to editors—is the frequent and indiscriminate use of abbreviations in the form of a single capital letter, or a group of capitals, to represent the name of a substance, or perhaps even an adjective or adverb. The printer is concerned because a page of text sprinkled with capital letters is not pleasing in appearance; and, like other craftsmen, he feels that his efforts are being frustrated. It may be argued that this is of no concern to the scientist; but surely his work is worthy of good presentation, and there is satisfaction and even advantage in recording the results of research in an elegant style.

So far as the use of abbreviations themselves is concerned, the subject was discussed some time ago in these columns. As was pointed out then, a little consideration will show that abbreviations can often be replaced by pronouns without loss of clarity or accuracy. No one writing for the general reader would willingly use the same noun several times in a single sentence; yet when abbreviations or symbols are adopted, there seems to be no hesitation in repeating them—often as many times as possible. Biochemists are great offenders in this respect, and their excuse must be that many of the substances they use have unwieldy names. Similarly, organic chemists are hampered by a cumbersome nomenclature, which however admirable from the point of view of describing a substance, invites the use of abbreviations; indeed, the industrial organic chemist has found it necessary to invent names or use specific symbols like DDT for the sake of the users of his products. But a sense of proportion must be maintained in devising and using specialized terms; thus it seems pointless to write *p*-ClHgBA for *p*-chloromercuribenzoate, and positively dangerous to use H for histidine. The habit—for it is little else—of introducing abbreviations is now spreading through physical chemistry to physics and to mathematics; indeed, to all sciences. Thus E has been used for 'enzyme', with the derived symbols ES for 'enzyme substrate' and ESI for enzyme substrate inhibitor, and M.O. for molecular orbital; and what is the physicist to think when he finds a plentiful sprinkling of the term MIT on a page, only to find on careful reading that it is an abbreviation for monoiodotyrosine and not the Massachusetts Institute of Technology? Then, again, can the use of ARG for autoradiograph be justified? Mathematical signs occasionally appear in a line of text, especially the sign for 'is equal to'. These examples are taken from manuscripts submitted to *Nature*, and many others might readily be quoted.

It may be claimed that, if an author writes out the name or term, followed by his chosen abbreviation, on the first occasion of its use, or includes a list of the abbreviations he proposes to use, then he is justified in employing his abbreviations throughout the remainder of that particular piece of writing. But is every scientific communication to have its own glossary? Consider the confusion—and additional space required—which would occur in a journal such as *Nature*, in which two dozen or so specialized communications appear every week. The fact is that these abbreviations are, in the main, laboratory and notebook shorthand, or even slang, very valuable in their proper place, but nevertheless a new language, which at present does not seem suited for the considered statement offered for discussion and appraisement by other workers.

The use of abbreviations, especially initial letters, is now becoming so fashionable among scientists that one suspects authors sometimes go out of their way to use them; for example, SV for seminal vesicle. With the increased sliding growth among the various disciplines of science, resulting in such departments of research as biochemistry and biophysics, this fashion may, if not checked, defeat its own ends and produce a veritable 'Tower of Babel'. Indeed, the time does not seem far away when hig school pupils will have to learn a new table of symbo apart from those atomic.

A further problem, which may not occur to mo writers, has to be faced in the preparation of a index. Abbreviations or initials sometimes occu alphabetically in quite a different position from tha which would be occupied by a full term, thus causin confusion during reference.

Dr. Baker begins his article by disclaiming an intention of setting himself up as a stylist; and i taking up various points he makes, and adding others we must make a similar disclaimer. Much of wha has been said is clearly a matter of opinion, an those holding strong views are unlikely to be converted. Nevertheless, the mode of presenting scientifi results has been criticized over a long period of years and it behoves scientists to give the matter carefu attention and to consider whether they can, by din of a little more care and thought, free *themselves* o the charge of talking and writing jargon. In th present age, the promotion and exposition of research can be almost as important as the work itself.

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# SCIENCE AND THE HUMANITIES

## Science and the Human Imagination

Aspects of the History and Logic of Physical Science. By Dr. Mary B. Hesse. Pp. 171. (London: Student Christian Movement Press, Ltd., 1954.) 12*s*. 6*d*. net.

IT is surely one of the most significant features of our generation that not only are we contemporary with a flood of new scientific discovery which has already changed the pattern of our physical life, and is rapidly changing the pattern of our thinking, but we are also very conscious of the need to understand this strange new activity called science and to assess its real status and its relationship with other great movements of the human spirit. This little book by Dr. Mary Hesse, herself a mathematician in the University of Leeds, is an attempt to answer the questions: What is science? Is it something fixed and determinate, or is it variable and responsive to the thought-forms of its day? What right have we to say that science is a true account of the natural order? And how is the scientific method related to art and religion?

Dr. Hesse deals with these questions in two stages. First she describes the changing models of science, and shows how the tumultuous flow of new discoveries in physics, from the electron in 1897 to the new quantum theories of 1926, have made old models no longer tenable, and forced us to see what ought indeed to have been recognized all the time, that our models and concepts are, after all, only models and concepts the suitability of which to represent the inaccessible 'things-in-themselves' must be judged by each generation according to the criteria accepted at the time; they can never be final, and they always involve imagination and intuition. One of the most valuable sections of this part of the book is where the author urges a return to the old schoolmen's way of argument 'by analogy', supplementing our more conventional recognition of identity and difference. For argument by analogy involves us in an act of response to our environment wider and re generous than that which men of science have metimes claimed, and at the same time it joins m with the artist and the poet.

In the second half of the book, Dr. Hesse deals h the status of scientific theory. She is much racted to the operational view, according to which that we may rightly ask or expect of science is an swer to the question: What will happen to this if lo that? All explanations, or interpretations, are necessary, unprovable and probably meaningless! ith this in mind, she criticizes Eddington and Dirac cause many of their concepts are not definable in rms of direct measurement, and what they call servables' are by no means always observable. t the author admits that this will not do, for there an element of awareness in scientific work which akes us feel that we do indeed grapple with someing real, however inadequately it may be conveyed us in our current models.

In some ways this is the weaker half of the book, d it is hard not to feel that Dr. Hesse is still a tle uncertain in her own mind. Thus, when e comes to the end of the book and asks about possible synthesis of science and religion, all e can say is that "there is no satisfying synthesis . . this side of the Kingdom of God"; and hen she asks if any transcendental faith can be cepted with conviction in the modern world, she plies that the question must "remain unanswered ntil it comes spontaneously from the quality of life the Christian community". But surely the whole tivity of science is a silent witness to a transcendtal faith—in a reality so exciting that it comands our study, and so deeply other than us, at we never get beyond the world of model and ncept to represent it. I cannot myself escape the nviction that this part of the book would have een more convincing if more biology and less physics ere incorporated in it, and if more questions had een asked about man-the-scientist as well as those bout the nature of scientific studies. But this is a ery readable book, and a stimulating one, which ertainly carries the argument further than some of e other fairly recent popular expositions of science ave done. We can even excuse a few scientific accuracies in face of the extreme honesty of the hole approach, and the recognition that science, art d religion have each their part to play in the atisfactions of human living.

C. A. Coulson

# RECEPTORS AND SENSORY PERCEPTION

## eceptors and Sensory Perception

Discussion of Aims, Means, and Results of Electrohysiological Research into the Process of Reception. Mrs. Hepsa Ely Silliman Memorial Lectures.) By r. Ragnar Granit. Pp. xii+369. (New Haven, onn.: Yale University Press; London: Oxford niversity Press, 1955.) 5 dollars; 40*s*. net.

AN indolent reviewer might claim that there is really no need for him to do more than direct ttention to the full title of this book. It is about 'Receptors and Sensory Perception", and it is the ubstance of the Silliman Lectures which Prof. agnar Granit gave at Yale in 1954. It is therefore n up-to-date presentation of one of the growingoints of neurophysiology, composed for a scientific, but not necessarily biological, audience by one who is an acknowledged expert in the field he has to cover.

Scientists ought not to need reminding of the quality of Silliman Lectures or of the debt which we all owe to the Silliman Foundation. It has induced a long list of the foremost investigators to emerge from their laboratories to put on record the general theme of their work. Some of the earlier books in the series, like those by J. J. Thomson and Rutherford, are now out of print; but most of them have been milestones. Some have been reprinted and have lost none of their impact, like Sherrington's "Integrative Action of the Nervous System"; but there can be very few of them which have not greatly influenced the progress of scientific work in the twentieth century.

Ragnar Granit's own contributions to the physiology of vision have been a constant inspiration for many years, and he has already brought them together in 1947 in his book on the retina. Here, however, they can be seen in less detail but in better perspective against the general background of sensory physiology. In the earlier chapters, for example, he gives an excellent account both of the older work on the discharge of impulses from sensory end organs and of the recent developments in the study of cutaneous receptors and the function of different kinds of receptor structure and peripheral nerve fibre. Zotterman's recent work on thermoreceptors is well described, and, if we are still left in doubt about the nervous mechanism of pain, it is not Granit's fault that the evidence is still incomplete.

The chapters on the nervous organization of the retina will naturally be read with the greatest attention by all who are concerned with the problem of colour vision, and they will find a clear statement and defence of Granit's dominator–modulator theory. For the general physiologist, however, the concluding chapters on the muscle receptors are perhaps the most interesting, for here we can see how even the most straightforward kind of receptor is subject to a constant adjustment by the central nervous system to make it provide the right kind of information.

In fact, it is not praising Granit's book too highly to say that it is a worthy contribution to the series of Silliman Lectures.

Adrian

# INTERNATIONAL CO-ORDINATION OF GALACTIC RESEARCH

## Co-ordination of Galactic Research

Edited by A. Blaauw. (International Astronomical Union Symposium No. 1, held at Groningen, 22–27 June, 1953.) Pp. viii+59. (Cambridge: At the University Press, 1955.) 7*s*. 6*d*. net.

RESEARCH into the nature of the stellar system in which we live has always formed a very considerable part of astronomy; but during the past ten years notable advances arising from a number of new techniques and ideas have greatly stimulated interest in this field. Among the new techniques radio astronomy has had resounding success, especially in dealing with interstellar matter, and is still producing a great flow of important new results. It is true that many of the radio observations have as yet no clear interpretation, but we believe that we now have the tools to map the spirals of the Milky Way, and to gain great insight into the dynamical structure of the whole system. Simultaneously, the older optical methods have been strengthened by the use of Schmidt telescopes, especially with narrow-pass filters or objective prisms, bringing us a wealth of new data relating to both stars and interstellar material. Equally important improvements in other practical techniques, for example, in photoelectric photometry, are also playing a great part in galactic research.

There has in addition been a ferment of new theoretical ideas. Baade's suggestion that there are two distinct stellar populations in the Milky Way is growing into a more general concept of families of stars having as much as a thousand-fold range in life-times and reaching a corresponding variety of stages in evolution, whether viewed as individual producers of energy from nuclear sources or as particles in the general dynamics of the galaxy. That graveyard of stellar evolution theories, the Hertzsprung–Russell diagram, has now assumed greater significance and greater complexity than ever before. Undismayed by the revelation of these and other complications, theorists are pressing on with their studies of stellar interiors, attempting to compute the evolutionary changes to be expected in stars as a result of the burning of hydrogen or other nuclear fuels.

Concurrently with rapid advances in our knowledge of the Milky Way system and of similar nearby systems such as the Andromeda spiral nebula *M*31, there has been a proliferation of new problems urgently needing investigation. But there has been little increase in the available labour force to deal with these; indeed, an insatiable demand for young scientists from other subjects has made it increasingly difficult to maintain the supply of competent astronomers even at its present modest level. In a situation of too many problems and too few astronomers, one method is to restrict attention to the more outstanding problems and to proceed as far as possible by a careful, but very limited, sampling of the sky. One of the chief purposes of the conference reported in this volume was to discuss ways by which this could be done.

The conference was organized by a sub-committee of the International Astronomical Union's Commission on Stellar Statistics and was largely inspired by Prof. J. H. Oort, himself one of the leading authorities on galactic research. The report gives a very useful summary of work in progress at the date of the meeting, June 1953, and many suggestions for the more urgent programmes of further research. It confines itself for the most part to the standard techniques of optical astronomy, studies of variable stars, photometric measurements of various kinds, spectrum classification, proper motions, radial velocities, etc.

This is one of the first astronomical books in which the term 'man-hours' occurs, in my opinion a belated appearance. Observational astronomy is peculiar in the enormous numbers of objects requiring investigation and the slowness with which the desired information can be collected. A great deal of the work now waiting to be done might quite well have been started thirty years ago, and the need was doubtless in part already understood then. The chief reason why so much has not yet been properly begun is the same reason why the *Carte du Ciel* has never been finished: there is a lack of man-power for routine work which requires persistence and precision above the ordinary, but can sometimes be tedious and dull, which gives results of essential importance but nevertheless brings little thanks or recognition from the scientific community. Looki at twentieth-century astronomical history, o wonders how many of the programmes suggested this report will be completed in thirty years time.

The widespread use of automatic machinery industry and its appearance in other fields of scienti research have turned the thoughts of some astronome to its application to routine astronomical programme In principle, this seems quite possible; but as eve engineer knows, there is a very long step from designi a machine in principle to bringing it into successf and reliable operation. Not all astronomical pr grammes could be attacked in this way, and eve successful machinery would have serious limitation but we may be forced to a choice between an adequa volume of machine-made results or next to no resul at all. The conference, however, appears to ha stuck to well-established methods and to have give little thought to such developments.

I must confess to some pessimism with regard t our ability to finish urgent tasks in galactic researc by existing methods, but nevertheless can strongl recommend this volume to anyone seriously intereste in Milky Way problems. It should be compulsor reading for British optical astronomers, the gre majority of whom have in recent years tended to lo touch with this important branch of their subjec despite the notable achievements of their radi colleagues.

R. O. Redman

# MATHEMATICAL TABLES OF THE NATIONAL BUREAU OF STANDARDS, WASHINGTON

United States Department of Commerce: Nation
Bureau of Standards

Tables of Functions and of Zeros of Functions Collected Short Tables of the National Bureau o Standards Computation Laboratory. (Applied Mathematics Series—No. 37.) Pp. x+211; 2.25 dollars.

Table of Salvo Kill Probabilities for Square Target (Applied Mathematics Series—No. 44.) Pp. ix+33 30 cents.

Tables of the Error Function and Its Derivative (Applied Mathematics Series—No. 41.) Pp. xi+302 3.25 dollars.

(Washington, D.C.: Government Printing Office 1954.)

THE first of these three volumes brings togethe eighteen short tables of functions and of zeros o functions, most of which have appeared before i various periodicals, three only being new publications Among others, it contains the integrals of the tw Bessel functions of zero order over ranges from 0 t 8·50; $\int_1^\infty e^{-xu}u^{-n}du$, $x$ ranging from 0 to 10 and $n$ fron 0 to 20 through integers; Struve functions; Fourie coefficients up to order 100 of powers of $x$ up to $x^{10}$ sines and cosines for radian arguments between 10 and 1,000; and $x^n/n!$ for $x$ up to 10 and $n$ up to 40 i integers. As regards the tables of zeros, there ar included those of the Legendre polynomials of orde 1–16, the first fifteen Laguerre polynomials, Besse functions of simple fractional orders, and thei derivatives, and the first ten complex zeros of sin $z-z$ Explanatory formulæ and bibliographical reference are given in all cases.

The second volume, "Table of Salvo Kill Probabilities for Square Targets", contains thirty-three pages devoted entirely to the tabulation of a single probability function defined as a double exponential integral extended over a square. It is considered as a function of five independent parameters, each of which has several representative selected values, the first being the number of missiles released in salvo up to a maximum of two hundred, and the others being concerned with the dispersion and the assumed lethal probability of a single missile. The significance of these parameters is explained in detail in the introduction.

The third work, "Tables of the Error Function and its Derivative", is of considerable extent and first appeared in 1941 under the title of Mathematical Table 8. Apart from a short subsidiary section, it is entirely concerned with the tabulation of the normalized error-function

$$\frac{2}{\sqrt{\pi}}\int_0^x \exp(-\alpha^2)d\alpha$$

and its derivative $\frac{2}{\sqrt{\pi}}\exp(-x^2)$.

All the entries are to fifteen decimal places, and the ranges of $x$ are 0 to 1 at intervals of 0·0001, 1 to 5·6 at intervals of 0·001, and a few subsequent values between 5·6 and 6. In the last range the differences between the two functions and 1 and 0, respectively, are of course extremely small, affecting only the fourteenth and fifteenth decimal places. In the short supplementary table (previously mentioned), these differences are given to eight significant figures for $x$ between 4 and 10 at 0·01 intervals with their appropriate inverse powers of 10, the last of which is $10^{-45}$. Eleven pages of introduction include details of the methods used in computing and checking the tables and a bibliography.

J. H. PEARCE

# PHYSIOLOGY IN COLD CLIMATES

## Man in a Cold Environment

Physiological and Pathological Effects of Exposure to Low Temperatures. (Monographs of the Physiological Society—No. 2.) By Prof. Alan C. Burton and Prof. Otto G. Edholm. Pp. xiv+273. (London: Edward Arnold (Publishers), Ltd., 1955.) 30s. net.

THIS book on the "Physiological and Pathological Effects of Exposure to Low Temperatures" has been written under the joint authorship of a biophysicist and a physiologist, and is the second of a series of monographs of the Physiological Society. The authors are to be congratulated on making readily available for the first time information largely derived from research carried out for the Armed Services. During and just after the Second World War a very considerable amount of literature accumulated, which the authors have examined and presented in a very readable form, together with the conclusions which they have drawn with great care and restraint from the varying points of view. There are both author and subject indexes, and at the end of each chapter very full references are given. The text is admirably illustrated with charts and diagrams. The first part of the monograph deals with the physical laws governing the interchange of heat between man and his environment. Towards the end of this section the authors make the important point that "In almost every case of the general problem of enabling men to survive and function efficiently in adverse environments as at high altitude, the answer to the problem proved to be in the field of engineering, rather than in modifying human physiology"; however, "the engineering answer is not perfected without the fundamental knowledge of the underlying physiology".

The next three chapters discuss the insulation afforded by the air, the clothing and the tissues of the body. Man has been able to extend his sphere of activity both in hot and in cold climates by the use of clothes; but as yet no really satisfactory means of protecting the face has proved practical, and the exposed regions of the body play an important part in determining the 'tolerance time' of a particular clothing assembly. The chapter on the estimation of the thermal demand sets out the variables other than temperature that can affect the heat loss of the human body, and a 'unitary estimate' of these varying factors such as wind chill, corrected effective temperature, solar radiation, and radiation increment, can be introduced as a correction factor to the environmental temperature, and an estimate of the clothing requirements obtained from a single parameter. The chapter on the possibilities of maintaining a thermal steady state in the cold deals also with comparative physiology, and it is pointed out that "A survey of what methods of compensation are actually used by animals in cold environments is most useful, since it permits us to explore the possibilities of further exploitation of methods of compensation, which have not been fully utilized by animals".

Shivering is discussed under the heading of the metabolic response to cold. Recent work has shown that there is an increased 'thermal muscular tone' prior to the onset of shivering; but the question of extramuscular metabolic increments in response to cold is still open, as a great deal of evidence both for and against this increment has been produced. There is an increased voluntary dietary intake in response to cold; but so far no simple explanation of this response has been found to be tenable. Acclimatization to cold is considered under general bodily changes and local changes. There is some evidence against acclimatization to cold, and it would seem that any acclimatization sustained is only of short duration when compared with that in response to chronic exposure to heat.

Hypothermia, both chronic and acute, is discussed, and the consensus of opinion as regards the treatment of these conditions is that: rapid rewarming should be carried out in cases of acute hypothermia, and rapid rewarming with correction of the body fluid balance and administration of glucose for cases of chronic hypothermia; moderate rewarming is to be condemned. The various pathological changes taking place in response to local cold injury are discussed, and it is considered that "there is a great need for more detailed studies in this field which profitably could include more precise definition of the conditions necessary to produce mild injury".

The last chapter of the monograph very appropriately deals with problems for future research, and must act as a stimulus to those who are apt to think that this branch of climatic physiology lies dormant except in times of national emergency. The monograph is a valuable storehouse of information and should be read by everyone who is interested in the physiology of cold climates.

J. R. BROWN

## Michael Faraday

Man of Simplicity. By Prof. James Kendall. Pp. 196+4 plates. (London: Faber and Faber, Ltd., 1955.) 12*s*. 6*d*. net.

THERE is no resisting Prof. James Kendall. He begins at a disadvantage, for one picks up his book with the thought that this is another small book about Faraday, of which there are already rather too many. Then it is a little disconcerting to meet in the early pages a sentence such as this: "Humphry invited Michael to come to the Royal Institution for an interview". Despite the author's apology, this familiar mode of address of the two principal characters seems unnecessary, and it asserts rather oddly in passages where third persons, for example Wollaston, are accorded the more formal surname. There is, also, to one reader at least, some over-emphasis on the 'simplicity' of Faraday's nature. Simplicity and ingenuousness had their place in a complex character; but to stress them unduly is to give a false impression of the man as a whole.

Personal prejudices on points of this kind are, however, forgotten after a few chapters, and the reader finds himself swept along on the tide of Prof. Kendall's enthusiasm. The treatment of Faraday's scientific work does not pretend to be very full or comprehensive; but the story of his life is admirably and sympathetically told, the significance of the principal researches is brought out in the narrative, and the result is a very readable book. It is, incidentally, to anyone who has heard Prof. Kendall lecture on the subject, a delightful reminder of the lecturer.

## Atoms in the Family

My Life with Enrico Fermi—Designer of the First Atomic Pile. By Laura Fermi. Pp. 284+15 plates. (London: George Allen and Unwin, Ltd., 1955.) 18*s*. net.

ONE could wish that every great scientist had a wife with such literary skill and sense of humour as Mrs. Laura Fermi. Her book is much more than just a biography of her famous husband, the late Enrico Fermi, though naturally he is the chief person in it. It gives snatches from his childhood and from his life as a student and young professor, unpretentiously written against a background of the Italian scene and the rising of Fascism. From there the narrative moves to the United States and those—for her—most puzzling years 1939–45 in which Fermi, though still technically an enemy alien, moved about between New York, Chicago and Los Alamos on mysterious errands. Only when the atom bomb had blasted the veil of secrecy did Mrs. Fermi and the other wives of scientists find out that the first atomic pile had come into operation three years previously, and that Fermi had been one of the leading minds in that stupendous enterprise which resulted in Hiroshima and Nagasaki.

But Mrs. Fermi keeps an admirable balance between the great events around which her life had to shape itself and the small everyday things of which that life consisted. She is a good observer of people, and her pen-portraits are admirable. Many of the people I knew in Los Alamos have come to life again for me through her shrewd observations. Nor does that shrewdness desert her when it comes to describing her own husband. He lives in these pages as his friends knew him—admirable but not faultless, and likeable even in his faults.

Naturally, the book should not be considered as material for the historian, but practically all the scientific facts she quotes are correct (and, by th way, admirably presented for the non-scientist), ar I have found only a few minute and quite irreleva inaccuracies in the events she writes about. This a human, engaging and entertaining book, written a time when Fermi was still in good health, befo the illness which caused his untimely death soo afterwards.

O. R. FRISCH

## The Botany of Cook's Voyages and Its Unexpecte Significance in Relation to Anthropology, Bi geography and History

By Prof. Elmer Drew Merrill. (Chronica Botanic Vol. 14, Number 5/6.) Pp. iv+161–384+plat 80–92. (Waltham, Mass.: The Chronica Botanic Co.; London: Wm. Dawson and Sons, Ltd., 1954 4.75 dollars (cloth).

DR. MERRILL is a systematist and plant geo grapher of great seniority. In this curiou and uneven book he examines the herbaria collect on Captain Cook's first and second voyages. Hi main purpose is to decide to what extent there wa a diffusion of crop plants, weeds and cultures acro the Pacific Ocean between America and Asia befor Magellan's voyage in 1520. This is a problem whic has for a long time interested scholars, and it ha recently been popularized through the Kon-Tik expedition and the writings of T. Heyerdahl.

There undoubtedly is room for further critica discussion of the botanical evidence for and agains the early blending of American and Polynesia cultures. But such a discussion would need to b objective, urbane, and free from prejudices an polemics and innuendoes about the competence o other workers in the field. Dr. Merrill's book fulfil none of these requirements. One must only regret that in this book Dr. Merrill's knowledge and experi ence have been deployed in a manner which does no enlist the confidence of the reader nor illuminate th subject.

E. ASHBY

## Optics

By Arnold Sommerfeld. (Lectures on Theoretical Physics, Volume 4.) Translated by Otto Laporte and Peter A. Moldauer. Pp. xiii+383. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 6.80 dollars.

THE appearance in English of this part of Sommerfeld's lectures on theoretical physics is a very welcome addition to the literature. In Sommerfeld's course of lectures, theoretical optics formed an important section which does not correspond to any definite course in most British universities. In Britain the material, in so far as it is treated, would usually be found either in a course on electromagnetic theory in general, which would not allow time for detailed treatment of many optical problems, or in a course on physical optics, which usually includes less of the mathematical theory. This text by one of the masters in the mathematical treatment of wave problems will nevertheless be valuable for use with courses of both kinds and of great help to those who want to take optics further than the normal undergraduate teaching permits.

As in the other volumes, the use of powerful mathematical techniques is presented and applied without losing sight of the physical ideas behind them, or of the fact that one is dealing with knowledge which, in the last resort, is derived from experiment.

R. E. PEIERLS

# ENGLISH STYLE IN SCIENTIFIC PAPERS

By Dr. JOHN R. BAKER
Department of Zoology, Oxford

MANY scientific papers published in Great Britain are written in a style quite different from that adopted by good English authors. There would be no disadvantage in that, if an improved version of our language had been invented for cientific papers. This, however, is not so. For larity and directness one must turn to non-scientific authors. One hesitates to direct attention to this ubject lest one be accused of setting oneself up as a stylist. There is no such intention here. It is proposed merely to suggest a few ways in which cientific papers could be made simpler, clearer, and more pleasant to read.

To prevent any misunderstanding, it must be emarked at the outset that it is no part of my purpose to try to oppose the use of necessary scientific words. On the contrary, the precise use of certain technical terms, carefully defined and internationally understood, is an obvious necessity. We shall be concerned here with the words that stand between the technical terms.

If one examines all those passages in scientific papers that are least in accord with good English style, one finds that there are three main kinds of error, which may be described briefly as those of grammar, grandiloquence and German construction.

It would be absurd to treat the subject of grammar at any length here, since good advice on this subject is so readily available. Grammatical errors in scientific papers sometimes make it impossible to be sure what a sentence is intended to mean. In other cases the mistakes are troublesome only because they distract the reader's attention from the subject under discussion. The words ending in *-ing* (especially *using*) are very frequently misused. One repeatedly finds such statements as this: 'Examining a capillary under the microscope, after staining with carmine, it resembles a homogeneous hyaline tube'. Yet anyone who is intelligent enough to carry out scientific research at a university can easily grasp everything that it is essential to know about the use of present participles and gerunds in fifteen minutes.

The menace of grandiloquence seems to derive from the time when doctors used many Latin words; and indeed these errors are much more common in medical and biological than in chemical and physical writings. It is difficult to account for the fact that an Englishman will write '*vide supra*' when he means 'see above'. It is noticeable that those who use Latin tags most freely do not always know enough of that language to realize that the word 'data' is plural.

Long words derived from Greek or Latin roots are often used for expressing very simple ideas. When a man wants to say that something is visible to the naked eye on merely opening the body-cavity, he tries to make it sound grand by saying, 'this phenomenon can be macroscopically observed upon laparotomy'. Sometimes he uses short words, but chooses an elaborate way of expressing himself. Thus, if he wants to refer to a sheet of metal about 1/100 in. thick, he says that it is 'of thickness $\sim 10^{-2}$ in.'. If his intention is to tell his readers that the longest of the six pairs of chromosomes in a cell is about three times as long as the shortest, he writes, 'the maximum size range of the six pairs as represented by the ratio length of chromosome 1/length of chromosome 6 is about 3/1'.

The grandiloquent writer brings in abstract words where none is required. Instead of writing 'because the surface of the retina is spherical', he substitutes 'because of the sphericity of the retinal surface'. Instead of saying that something is near the nucleus, he says that it 'occupies a juxta-nuclear position'.

Genteelism is allied to grandiloquence. People who think it polite to call a napkin a 'serviette' have their counterparts in science, who cannot soil their mouths with paste or mash but must say 'Brei' instead. Another example is 'sacrificed' for killed. Allied to genteelism is the deliberate use—not just occasionally, but over and over again—of archaic words instead of their exact equivalents in plain modern English (for example, 'save' for except).

Vogue-words have their place in the vocabulary of the grandiloquent; but what may be called negative vogue-words must also be mentioned here—perfectly good words that for an inexplicable reason must not be used. Why must the word 'about' never be used by the grandiloquent? Why must they always say '*circa*', '*ca.*', '*c.*', 'approximately', 'around', 'of the order of', and even '$\sim$'? What is the objection to 'separate'? Why must 'discrete' invariably be substituted? (A case can be made for the occasional use of 'discrete', when special emphasis on complete separation is necessary.) 'After' is another negative vogue-word.

Grandiloquence and related foibles, however, are not the worst enemies of good English. A still more serious and more insidious evil exists.

In ordinary speech or writing it would never enter anyone's head to say 'a tea containing cup'; one would naturally say 'a cup containing tea'. Yet in scientific journals one will find (for example) 'iron containing globules', when what is meant is 'globules containing iron'. It is questionable whether the writers of such phrases have ever asked themselves why they adopt this construction, which is strange to our language and does nothing to improve it. Why do they say 'a hyaluronidase treated area' when they mean an area treated with hyaluronidase? Why place a complex adjectival phrase before the noun, and why omit the clarifying preposition? Why say 'non-formalin containing fixatives' instead of fixatives not containing formalin? Why 'eight micra thick sections' when one means sections $8\mu$ thick? Or why does a man who would never dream of saying 'the Jones associated people' write of 'the nucleolus associated chromatin'?

These, however, are relatively innocuous examples, compared with many that disfigure our scientific journals. 'A methylene blue stained preparation of rabbit ear skin' is bad enough, but not quite so bad as '*Dytiscus* red flight muscle sections' or 'the use of acidified (by $HNO_3$) or alkalized (by ammonia) solutions of silver'. Even these, however, are not the worst English that it is possible to write, if one is determined to pile up qualifying words other than adjectives in front of the noun they qualify. The limit is perhaps reached by 'adenosine triphosphate activated actomyosin contraction'. (To spare the reader trouble, I may mention that this means the contraction of actomyosin, activated by adenosine triphosphate.) These are words put together without the slightest attempt at clarity or any consideration for the reader. The phrase is worse than merely illiterate: it is rude.

This piling-up before a noun of words that are not adjectives, but are used adjectivally, is rather a new fashion in English scientific writing. It was seldom seen in Britain a quarter of a century ago. There can be scarcely any doubt about its origin. That many American scientists are of German descent is obvious when one looks at lists of authors in journals published in the United States. The process of piling up adjectival phrases is familiar to everyone who knows the German language. It does not make for clarity. It comes naturally to a German to write 'die einzigen, durch unmittelbare Beobachtung sicher zu ermittelnden Stellen' or 'das von dem Objectivsystem in der der Lichtquelle zugeordneten Ebene entworfene Beugungsspectrum'. Unnecessarily difficult though this construction may seem to an Englishman, yet the German language does at least help us, through the inflection of the words, to follow our path through such passages as these. But when this kind of construction is forced artificially on our much less inflected tongue, and the prepositions are omitted, all pretence of clarity is lost.

The German–American style did not originate with men who had set themselves the high ideal of improving our language as a vehicle for scientific ideas. It was, on the contrary, the product of childhood, introduced by people whose parents had spoken in sentences constructed in their native, German way. It is strange indeed that an Englishman or Scot, accustomed since infancy to a simple syntax, with logical order of words, should copy a German–American imitation of English, just because he happens to be writing in a scientific journal. Our own language, as written by those who know and love it, can scarcely be surpassed for clarity, directness and simplicity.

It is noticeable that scientific books published in the United States are often written in a style that is close to ordinary English (though the American people have their own special words, spellings and phrases). The difference in style between American books on one hand and papers on the other suggests that the publishers correct the style of writing where necessary, while the editors of journals do not. It must be remarked that the German influence is altogether lacking from some American scientific papers, which are models of lucidity and good style. A paper by Michaelis[1] on the reaction of dyes with nucleic acids may be quoted as a particularly fine example.

How can the standard of English in scientif journals be improved? One thinks at once of tl obvious works of reference—of Fowler[2], Partridg and Gowers[4]. Quiller-Couch's lecture "On Jargon" is packed with good advice and horrid example The teachers of English in our schools could hel very much, if they were to study the errors made i scientific papers and base their instruction to scienc students on their findings. Style, however, is largel dependent on example. Good reading makes goo writing. One could almost imagine that some of th contributors to our scientific journals had never rea anything but German–American. Yet good example abound, in books of widely different scope. A trio s diverse as Macaulay, P. G. Wodehouse and Si Winston Churchill have this in common, that thei English is lucid. There is no dearth of good example to suit every taste.

A strange fact that gives some basis for optimism is this. When an author has finished the scientifi part of his paper, he often addresses a note of genera information to the reader. At this point he suddenl discloses for the first time that he can write English for his ideas are clearly expressed. If one wished to translate what he now says into the style adopted in the rest of the paper, one would have to write something like this: 'Some related interest possessing observations by the present writer *et al.* will be the subject of *ca.* $10^{[illegible]10}$ discrete communications'. The fact that he does not write like that shows that he need not have done so in the body of the paper.

One last, necessary word. The best English writers occasionally use some of the strange constructions mentioned in this article, often to produce a special effect for a particular occasion. They do so, however, only at long intervals. The greater part of their writing is so smooth and fluent that the reader forgets that he is reading and knows only that he is absorbing ideas.

*Note.* With the exception of the passage in inverted commas in the last paragraph but one, all the examples given in this article are genuine: none was invented by myself or modified to suit my purpose. I am indebted to Prof. A. C. Hardy for a careful criticism of the first draft of this article.

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[1] Michaelis, L., *Cold Spring Harb. Symp. Quant. Biol.*, **12**, 131 (1947).

[2] Fowler, H. W., "A Dictionary of Modern English Usage" (Clarendon Press, Oxford, 1937).

[3] Partridge, E., "Usage and Abusage: a Guide to Good English" (Hamish Hamilton, London, 1948).

[4] Gowers, E., "ABC of Plain Words" (H.M. Stationery Office, London, 1951).

[5] Quiller-Couch, A., "On the Art of Writing" (Cambridge University Press, 1925).

# IMMUNITY AND DEVELOPMENT

"IMMUNITY and Development" was the subject of a session organized by Section D (Zoology) of the British Association at the Bristol meeting. The section opened with an address from the president of Section D, Prof. F. W. R. Brambell; an account of this address has already appeared in *Nature*[1]. In the four papers which followed, two principal themes were developed. The application of immunological techniques in embryology has led to new findings concerning the differentiation of various organs and tissues; these findings, and the way in which they can be fitted into classical embryology, were discussed. The development within the embryo of the immune response itself was also discussed.

Embryological investigations by means of serological techniques were reviewed in a paper by Mrs. R. M. Clayton, entitled "Differentiation and the Development of Tissue Specificity". Preparations of embryonic or adult organs may be inoculated into a suitable mammal or bird, where their protein or polysaccharide components act as antigens, eliciting the production of antibodies. An antibody produced in this way may then be used as a highly specific reagent in tests to distinguish or locate the corre-onding antigen. Tests have been devised in which e untreated antibody is employed *in vivo* or *in itro*; or the antibody may be labelled with a radioctive tracer or fluorescent dye so that its location an be observed. The results of such tests indicate hat adult organisms are composed of a complex osaic of antigens, with different but overlapping atterns of antigens characterizing each organ.

Immunological analysis has been applied to the deelopment of a variety of species, namely, the mouse, hick, newt, frog, sea urchin and certain insects. ome antigens are found throughout the life of an dividual, whereas others arise at definite times and laces during development. Transitory antigens are ound during development, and new antigens tend to ppear at crucial stages of development, such as astrulation or neurulation. During organogenesis nd embryonic induction, characteristic changes take lace in the distribution of antigens. The use of abelled antibody permits refined study of the localzation of antigens: localization has been observed ven at the cellular level. Antibodies have been used o produce alteration from the normal course of evelopment. It has been claimed, but not conlusively demonstrated, that naturally occurring ntibodies play a part in differentiation.

In his paper entitled “Zoological Implications of ctively Acquired Tolerance”, Prof. P. B. Medawar iscussed the new developmental phase of the antiody-producing system, and the corresponding novel ype of immune response, which he and his co-workers re investigating. The phenomenon of actively cquired tolerance can be expressed in the following erms: that mammals and birds never develop, r develop only to a limited degree, the power to eact immunologically against foreign homologous issue cells to which they have been exposed ufficiently early in foetal life. Acquired tolerance may be contrasted with the normal intolerance of mammals and birds to foreign homologous tissue: grafts of tissue from another member of the same species are normally rejected, as a consequence of an immunological reaction on the part of the host against the antigens of the graft. An example of acquired tolerance is the long survival and probable permanence of feather-bearing skin grafts between fowls of differing breeds, the hosts having been rendered tolerant by inoculation of donor tissue cells into the egg.

The fact that an animal is unable to produce antibody against its own tissues may be an example of acquired tolerance. The potentially antibody-producing tissue of an individual, at a stage of development when it is unable to manufacture antibody, is exposed to the antigens of the other tissues. Active tolerance of these antigens may consequently be acquired. Later, when the capacity to manufacture other antibodies develops, the individual is unable to do so against its own antigens. Exceptional antigens, as found for example in the central nervous system, are in fact capable of eliciting an immunity in the individual in which they are themselves found. This can be accounted for by the occurrence of such antigens only in sites normally isolated from the antibody-producing tissue, and therefore unable to provoke tolerance. Other naturally occurring examples of acquired tolerance can be found. A disadvantageous case occurs in man when the cells of a malignant melanoma pass from a mother across the placenta into the foetus, where they multiply and cause death. The survival of the cells in the offspring can be ascribed to tolerance, since cells of maternal origin do not normally survive in the offspring. Another example of tolerance acquired between individuals is provided by the passage of the *Rh* antigen from females into their rhesus-negative offspring. These females may be rendered tolerant of the rhesus antigen as a consequence. If they afterwards bear a rhesus-positive foetus, agglutinating antibody is manufactured less readily against the rhesus antigen of the embryo.

A remarkable deduction can be made from experiments in which normal lymph node cells are injected into a mouse bearing a foreign skin graft to which it is tolerant. The cells enter and presumably colonize the lymph nodes of their host; in due course the grafted skin is destroyed. Antigens must therefore be passing at all times from tissues such as the skin into the lymph nodes, whether or not the tissue is treated by its host as foreign.

A subject closely connected with the immunological relationship between mother and foetus was discussed in the paper of Prof. E. C. Amoroso, “The Endocrine Environment of the Foetus”. Hormonal relationships are found between the maternal organs concerned with pregnancy, between these organs and the foetus, and between the organs of the foetus. Uterine changes during pregnancy do not depend solely on stimuli emanating from the foetus, since many of the normal features of pregnancy can be elicited in the absence of a foetus. As the ovum moves down the oviduct it comes at first under the influence of the ovarian hormones, which control the state of the oviduct walls. Implantation is also under the control of ovarian hormones, and, via the ovaries, of the pituitary. Delayed implantation, a phenomenon of widespread and varied occurrence among mammals, is controlled jointly by the uterus, ovaries, and pituitary. After implantation, the maintenance of pregnancy is dependent on the ovarian hormones; however, some animals (including man) are able to produce the ovarian hormones in organs other than the ovaries, probably in the placenta. It is thought that in certain species the placenta is also able to secrete hormones functionally equivalent to œstrogen and progesterone. The action of the ovarian hormones in maintaining normal pregnancy appears to be on the uterine walls, and not on the foetus itself; for extra-uterine pregnancy may be maintained in the rabbit after ovariectomy.

Recent progress in the techniques of surgical manipulation of the foetus has advanced the analysis of endocrine relationships within the foetus. Decapitation technique has proved particularly helpful in the hands of the French school. The adrenal and thyroid glands of the foetus appear to be under the control of the foetal pituitary, as is also the growth-rate. The extent of pituitary control varies between different species. The differentiation of the genital system is under the control of hormones released by the gonadal primordia; the gonads and cranial duct differentiate from discrete primordia in either sex, whereas the urogenital sinus, the accessory ducts and glands, and the intromittent organ develop from neutral primordia. The appearance of ‘freemartins’ in heterosexual cattle twins is due to the passage of hormones in the blood stream when the circulations of the two individuals are crossed. The conventional explanation is that hormones from the male reach the female, arrest the differentiation of female structures, and stimulate the male components. An alternative explanation is that the female gonad may itself be affected, and that the masculinization is due to the hormonal influence of the freemartin gonad. The results of surgical removal of the foetal gonads indicate that the later differentiation of the male reproductive structures is under the control of androgenic secretions from the testis, although the role of oestrogenic secretions from the ovary is less clear. The production of gonadotrophins by the placenta is also thought to influence the development of the foetal gonads. Striking enlargements of the gonads of the foetus or new-born have been found in man and in such diverse species as the grey seal, horse, giraffe and elephant.

The subject returned to the detection of antigens during differentiation with a paper entitled "Hereditary Differences between Cells detected by Immunological Means", given by Dr. N. A. Mitchison. Knowledge of cellular heredity and differentiation is more advanced for micro-organisms than for the tissue cells of higher animals. Advances in the genetics of micro-organisms have followed the discovery of unit cell markers, the hereditary properties of which can be investigated; the conclusion may be drawn that unit cell markers are needed for the embryological study of differentiation. Antigens are eligible candidates as such markers. However, the results so far obtained with inter-specific immunization against organs are disappointing. Cross-reactions with the antigens of other organs are invariably found.

In marked contrast with this lack of specificity the results of auto-immunization, where an animal immunized against tissue from its own body. Prec immunities against central nervous system, periphe nerve, uveal tract and testis have been obtain experimentally by the use of Freund's adjuva Unfortunately for their usefulness in embryolog these auto-immunizations appear to belong to t category of immunological reactions mediated cells, and are therefore inaccessible by the standa techniques of serology. However, other types immunological response appear to belong to the sa category, such as transplantation immunity and t delayed reaction in hypersensitivity. Special tec niques developed for their investigation may also applicable to auto-immunization; for example, t transfer of immunologically activated cells in adoptive hosts, or the skin reaction to antigen immunized animals.

Several points of interest were raised in discussio The possibility that acquired tolerance might be use in hybridization was referred to, as was t possibility that a graft in a tolerant host might pic up antigens from the host. The need was mentione for a repetition of the experiments of Guyer an Smith, which were claimed to show that heredi ary changes could be produced by immunologic means.

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[1] *Nature*, 176, 441 (1955).

# PEACEFUL USES OF ATOMIC ENERGY

## RADIOISOTOPES IN CHEMISTRY, TECHNOLOGY AND INDUSTRY

By Dr. HENRY SELIGMAN
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NOBODY expected great revelations at the Geneva Conference on "The Peaceful Uses of Atomic Energy" on work concerning radioisotopes. Isotope applications, in contrast to some other subjects discussed at Geneva, were always free from any security restrictions, and therefore exchange of knowledge and techniques as well as results was possible in the past. The conferences which dealt exclusively with isotopes technique at Oxford (1951 and 1954) were good examples of such collaboration in this field between many countries. An article referring to biochemical, biological and agricultural uses has appeared already in *Nature* (October 22, p. 765). One part of the plenary session and five full sessions were devoted to isotope uses in chemistry, technology and industry.

The first paper of the plenary session, which dealt with survey papers in the field of technical isotope uses, was by P. C. Aebersold (United States), who discussed the importance of isotopes in technology and industry. His paper gave a very complete survey of all practical industrial uses of isotopes in the United States. The specific uses he mentioned were beta-emitters on phosphor materials for luminescence, and the applications of isotopes for voltage production. He discussed several possibilities of making radioisotope-batteries, like the exposure of a semi-conductor to radiation. He also discussed the use of radiation of fission products, and was hopeful that the sterilization of certain drugs would be not only possible but also economical. The following lecture, by H. Seligman (United Kingdom), describe advances during the past two years made in th United Kingdom in industrial isotope techniques He mentioned the development of an instrument fo detecting corrosion of pipes from the outside, a new type of instrument for well logging to find the oil-brine interface, and the possibility of sorting coa from shale. J. Guéron (France) gave examples o recent French development in that field. He discussed the work of finding leaks in underground cables and the measurement of hydrogen content in soils by neutron scattering. The tracing of sand in the Mediterranean was described, and details given on the identification of carbon deposits in boreholes using radioactive methods.

The specialized isotope sessions dealt with the following subjects: (1) general uses, production and handling; (2) reaction mechanisms; (3) activation analysis; (4) research in metallurgy; (5) control and technology; (6) fission product applications.

### General Uses, Production and Handling

C. E. Eddy (Australia) and C. Simane (Czechoslovakia) gave a survey describing the uses of isotopes in their countries. S. E. Eaton (United States) gave some examples of isotope uses in industry, such as investigating the mechanism of silver plating, and the study of de-icing of aircraft tyres by using tagged silicones.

The production of isotopes received relatively little space at this Conference. A. F. Rupp (United States) ave a survey of large-scale isotope production at ak Ridge, and P. E. Carter and L. O. Myerscough United Kingdom) gave a paper on the production of eta-ray sources for industrial and clinical uses. K. amsahl and K. Taugbol (Norway) reported on their ecent successful preparation of carrier-free phoshorus by a simple diffusion method. Two other apers dealt with the handling of isotopes.

## Reaction Mechanisms

A paper by V. N. Koudratyev (U.S.S.R.) gave examples of work done in the Soviet Union to show the high efficiency of tracer techniques in studying the mechanism of chemical reactions. Kondratyev pointed out that the greatest progress can only be made in this field if the tracer methods are employed together with other more orthodox methods of investigation. He mentioned the investigation of the mechanism of the formation of aldehydes, the isotopic exchange of sulphur between elementary sulphur and organic polysulphides and many others. J. Turkevitch (United States) reported on the use of stable and active isotopes in the study of heterogeneous catalytic reactions. He discussed, for example, his work on the migration of the double bond in an organic system using tritium. Carbon-14 has been used for investigating the Fischer–Tropsch reactions between carbon monoxide and hydrogen with an iron catalyst. A great number of investigations were also mentioned using deuterium as the label. W. G. Brown *et al.* (United States) summarized work on the use of tritium in chemical research. They discussed the isotope effect on reaction-rates and the mechanism of nitrobenzylhalide reactions.

## Activation Analysis

Only a few papers were given covering this field. One by V. V. Jakovlev (U.S.S.R.) dealt with the determination of rare earths by neutron activation in graphite, beryllium and germanium. I. P. Alimarin (U.S.S.R.) gave details of the application of radioisotopes in co-precipitation methods, the stability of complex compounds and many other analytical problems. A. A. Smales (United Kingdom) outlined recent advances in radioactivation analysis. One example was the determination of trace impurities without using any radiochemical separations, with a single-channel gamma-spectrometer. Other applications described the determination of elements with much greater accuracy than was possible with orthodox methods.

## Metallurgy

G. V. Kurdyumov (U.S.S.R.) dealt in his paper with the investigation of diffusion and atomic interaction in alloys with the aid of radioisotopes. This well-established method of following the behaviour of marked isotopes in alloys has been applied by Kurdyumov for ferrous as well as non-ferrous alloys.

## Radioisotopes in Control and Technology

J. L. Putman (United Kingdom) gave some details on the work proceeding in the United Kingdom in his paper on the development of thickness gauges and allied instruments. Technological advances in instrumentation based on the prompt emission of γ-rays after absorption of neutrons have been used in well-logging equipment, and single-channel gamma-response has made the development of corrosion detectors a possibility. C. Crompton (United States) spoke on applications of radiation involving penetration and reflexion. Interesting applications are those of X-rays from *K*-capture to detect and measure sulphur. Crompton also gave details of the utilization of bremsstrahlung from strontium-90 to measure silt densities in lakes. Another application of bremsstrahlung was described by P. Leveque *et al.* (France). He gave details of such a source used for radiography when very low γ-ray energies are necessary. J. L. Putman and S. Jefferson (United Kingdom) discussed the application of radioisotopes to leakage and hydraulic problems; in both these fields much progress has been made in the United Kingdom. A. M. Samarin (U.S.S.R.) described the study of production processes of steel and iron by the use of radioisotopes. The elimination of phosphorus and sulphur during the production process has been followed and equilibrium studies completed. Solidification phases have also been measured after radioactive indicators have been added to an ingot. A paper by D. B. Grozin (U.S.S.R.) dealt with the by now orthodox methods of metal–wear investigations of oils for motor-car engines. The general feeling was that the metallurgical applications, while not new, are extremely useful; and they are in widespread use in Russian industry.

M. Kato (Japan) gave details of work done in his country dealing mainly with isotopes applied to process and quality control. A paper by U. Been and E. Saeland (Norway) dealt, among other things, with some interesting industrial uses of isotopes in Norway. They showed how isotopes have helped in understanding different factors in the production of cement, and they have determined the amounts of catalyst used during the production process.

## Fission Products and their Application

One session was devoted to the application of radiations from fission products, a subject which will be of great importance in the near future. It is no accident that on this topic five of the seven papers came from the United States. That country has until now done most of the research in this field. The next few years should bring much more information on the use of these 'strong' sources, as all countries are making great research efforts in this field. L. C. Anderson *et al.* (United States) dealt with the use of gamma-radiation for chlorination of aromatic compounds. They have proved that for certain chlorinations the use of a powerful gamma-source may well be economical. They gave some details on polymerization products of ethylene. The radiation effects on long-chain polymers were dealt with in a paper by A. Charlesby (United Kingdom), who gave a survey of the developments in that field to date. B. E. Proctor and S. A. Goldblith (United States) gave a well-balanced summary on sterilization of foods. The authors predict "the initiation of commercial processes for irradiation sterilization of some pharmaceuticals, food, tissues and packaging materials in the present decade". L. E. Brownell and J. J. Blumer (United States) think the sterilization of medical supplies by gamma-irradiation promising. H. J. Lomberg and S. E. Gould (United States) found that by irradiation the trichinosis cycle in pork can be interrupted, and they believe that this treatment will also be economical. A paper by E. G. Linder *et al.* (United States) dealt with the conversion of radiation into electrical energy. They conclude that practical power sources can only be achieved economically if low-energy beta emitters of long half-life can be made available at low cost and in large quantities. When, however, only microwatt applications are needed, the present sources suffice.

Isotopery was exhibited at both the Palais des Nations and the Palais des Expositions. Most isotope exhibits were in the Palais des Nations. The Russians showed quite a number of their industrial applications and equipment made for process control. The United States' effort, although generally more on the reactor side, gave still a complete picture of isotope applications. The French exhibited a few, but original applications. The United Kingdom isotope applications were shown in the Palais des Expositions placed centrally between exhibits of British industry. These applications illustrated very well the progress of the past three or four years.

The Geneva Congress gave a very good cross-section of all isotope work although, owing to the very full agenda, there was far too little time to discuss single problems in detail. The spirit in general was above all expectations. The sponsors must be congratulated on the choice of papers, and the very smooth organization which they achieved in spite of the short time given to them for the arrangement of the Conference. I feel that, in order to get the maximum benefits out of such interesting meetings, it may be better in future to have the isotope conferences separate from those on atomic energy.

# THE PAMETRADA RESEARCH STATION

## OPEN DAYS FOR ENGINEERS

FIVE years ago the Pametrada Research Station, Wallsend on Tyne, held a series of open days for a whole week to publicize the first five years of its existence (see *Nature*, 165, 963; 1950). During the first week of last October, the Station was again opened, to show its further progress. This time there were fifty-three separate exhibits in the laboratories, more than half of which had been developed in the period under review, some showing most ingenious applications of science to the solution of engineering problems in this field. The research association came into existence "to carry out research, to improve and develop complete steam and gas turbine installations and to advise member firms on all matters associated with the design and layout of marine turbines and gearing, and to set up standards of fit and finish required in the principal components of turbine machinery". Its name is derived from the initial letters of its full title: The Parsons and Marine Engineering Turbine Research and Development Association. To see the Research Station in action as the visitors did, ten years after its foundation, was to appreciate the courage and faith of its founders in the value of applying science in their industry. The aim of the director, Dr. T. W. F. Brown, then was, and still is, not merely to keep marine engineering in Great Britain abreast of competition, but also to keep it ahead of the rest of the world.

The value of the site, buildings and equipment now exceeds a million pounds, while there is a staff of more than three hundred. Some of the equipment for full-scale trials of marine turbines is the largest of its kind in the world. No such test equipment existed in the early days of the steam turbine, and this may have been one of the causes of its very slow development in the years immediately following the death of Sir Charles Parsons in 1931. To apply scientific methods to the improvement of marine propulsion machinery to-day, it is of immense value to have test equipment large enough to make full-scale trials ashore.

Most of the work at the Station has been done on the steam turbine; but during the past five years considerable effort has been devoted to improving the gas turbine for marine work, and the experimental 3,500-s.h.p. marine gas turbine that was on view five years ago has since been run over a wide range of operating conditions and with different fuels. These have shown that, when residual oil is used (which is necessary in marine work for economic reasons) serious troubles are encountered with fouling and corrosion, unless expensive additives are used.

The most impressive exhibit was the experimental gas-turbine rig, in which the combustion chamber and stator were operating at a gas temperature of 2,200° F. and a mass flow of 5¼ lb. per second. The stator was lined with blades of ceramic material, and the demonstration was shown without the turbine rotor so that the distortion of the stator and combustion chamber could be studied with the combustion chamber alight. This rig will later be fitted with a turbine rotor having liquid-cooled blading, each hollow blade containing a mixture of liquid sodium and potassium metal, to transfer heat down the blade axis to the root embedded in the rotor shaft, which is water-cooled. A special technique is required to handle the liquid alloy of sodium–potassium, which is used as the heat transfer medium, because it is so chemically active in the presence of air and moisture. Means for doing this were shown in another exhibit, the so-called 'dry box'—a glass-sided chamber, in which helium is continuously circulated over the specimens. The design is based on that of a similar chamber used at the Atomic Energy Research Establishment, Harwell, for handling radioactive materials. Impurities in the helium atmosphere of the dry box of 1 part in 100,000 can be detected.

Apparatus was on view designed for studying liquid cooling for gas-turbine rotor blades. A single hollow blade with a suitable liquid enclosed in the cavity was carried at the end of a rotating arm, driven by a steam turbine at speeds up to 11,000 r.p.m., heat being supplied electrically to the extremity of the blade and taken away by water flowing over its root. Exhibits on a smaller scale showed studies of refractory materials such as silicon carbide that are suitable for use as nozzles in uncooled furnace linings in high-temperature gas turbines. One of the several tests to which these parts were subjected was repeated thermal shock, the temperature being changed in a matter of seconds from 1,000° F. to 2,200° F., and vice versa, for hundreds of hours.

Research on the steam turbine is at present mainly concerned with the development of a double-casing high-pressure turbine in which the inner barrel exhausts into the annular outer casing, which is therefore subject to exhaust steam pressure and temperature and so is relatively cool (400° F.), when compared with the inlet temperature (900–1,200° F.). A 14,000-h.p. high-pressure turbine of this type was shown under test. This design is a logical development from a number of successful double-casing low-pressure turbines already in service at sea. Tests have been carried out on a quarter-scale model of this turbine casing to determine the transient distortions of the casing such as may occur during manœuvring and under steady-running conditions. Another exhibit in this section was an instrument that has been developed to enable turbine rotors to be rebalanced in their own bearings on board ship at low speeds. The bearing pedestal vibrations were detected by a relative electromagnetic pick-up activated by a tunable mass–spring system that could be tuned to resonance at the turbine rotor speed, so that vibrations at this frequency were highly magnified. By suitable attachments the vibrational velocity, which is proportional to the out-of-balance resultant force, and the position of this force around the shaft from a reference point were indicated, to provide the information required for rebalancing.

The staff at Pametrada have become famous for their application of electronic techniques to the study of noise and vibration on ships at sea, very largely due to the inspiration and leadership of the late Mr. H. G. Yates, senior designer. Specialist instruments have been designed for this work, including a portable vibration-meter, Muirhead–Pametrada wave analyser, low-frequency wave analyser, automatic wave analyser and electronic torsiograph. The use that has been made of such equipment on board ship has now made it possible for the vibration characteristics of even the most complicated gear and turbine machinery to be predicted in the design stage with a considerable degree of accuracy.

Much attention has been paid to the improvement of transmission machinery, both by the study of toothed gearing of all kinds and by the design and testing of hydraulic reversing transmissions, of which a working model was on view. Six scale models in 'Perspex' showed the space requirements, machinery weights and fuel consumptions for comparable machinery installations of various types designed for a power of 10,000 s.h.p. Present-day requirements of steam turbine, gas turbine and diesel engine were shown by the first three, which could be compared with the others—a high-temperature high-pressure steam turbine set, a high-temperature gas turbine with water-cooled blading, and a steam turbine set supplied with steam from a nuclear reactor.

It was shown that during the past decade the cost and weight of marine turbine and transmission machinery has been reduced by 15 per cent and 50 per cent respectively, while efficiency has been improved 12 per cent. An impressive array of pictures of ships engined by Pametrada designs was on view, the total shaft horse-power of those completed and already in service exceeding 2¼ million. A recent change of policy has led to installations of Pametrada design being built by two licensees in Holland and one in Canada. The hope of those responsible for the exhibition is that owners of ships having seen it may go away and order the most up-to-date machinery embodying the results of this research, instead of being content with conventional designs.

# CHEMICAL RESEARCH LABORATORY, TEDDINGTON

## OPEN DAYS

THIS year the Chemical Research Laboratory, Teddington, of the Department of Scientific and Industrial Research, held its open days during September 27–30, and again the invitations attracted a large number of visitors from government departments, industry, universities and schools. Some of the outstanding exhibits by the six research groups are briefly described in this article.

A feature in the Corrosion of Metals Group was the illustration of advisory services to industry, public bodies and other inquirers. These services, which constitute an important part of the work of the Group, were depicted in two ways: one gave typical inquiries and replies in summary form, the other showed selected letters and the replies almost in full. The questions and answers dealt with a wide variety of subjects and from diverse sources, such as an interested layman, a county surveyor and a research association. The information supplied is based on general corrosion science and on the knowledge gained either in *ad hoc* investigation or in fundamental researches within the programme of research of the Group.

The results of radioactive tracer studies of corrosion inhibition were illustrated graphically. Potassium chromate containing a proportion of radioactive chromium atoms is used, and the amount of chromium found on a steel surface after immersion in the radioactive solution is estimated from the amount of radiation emitted from the surface. Using this technique, it has been shown that during immersion in chromate the growth of the protective film containing chromic oxide on the surface of the metal obeys the same law as the formation of a surface film of ferric oxide during exposure of steel to air. One exhibit illustrated the work being carried out on the development of tarnish-preventive wrappings for use with copper, silver and their alloys. The access to the metal of hydrogen sulphide (small traces of which in the atmosphere are responsible for tarnishing) is prevented by incorporating in the wrap a substance that absorbs the sulphide or converts it to an innocuous compound, or acts as a barrier. A number of additives have been found effective. They include chlorophyll, certain salts of chromic, nitrous and phosphoric acids, hydroxides of certain metals, and tannins with and without the addition of alkali. The investigation is still at an experimental stage, but the results of laboratory tests have been confirmed by exposure in an outdoor shed, and in a sideboard and over a mantelpiece of a living room. Patent applications have been filed both in Great Britain and abroad, the exploitation of these patents being in the hands of the National Research Development Corporation.

The exhibits on view in the Inorganic Group covered the three main lines being pursued by the Group, namely, the preparation of pure elements, the separation of the rare earths and the search for useful elements in wastes and low-grade materials. The demand for highly pure elements for semiconductor research has led to a study of methods of purification, and equipment for the zone-refining of bismuth, gallium and tellurium was demonstrated. For the separation of the rare earths, ion-exchange methods are being examined, coupled with the use of the 'complexone' type of reagent. A large plant has been constructed that will handle kilogram quantities of mixed earths. It consists of two banks of eight columns, all interconnected, together with ancillary equipment, and each column has a resin bed about six feet in depth. A laboratory model of the plant was also on view, as well as a small collection of rare-earth minerals. This research also includes the preparation of the pure rare-earth metals; but this has so far been confined to cerium and lanthanum, small ingots of which were shown. The third line of research was illustrated by the search for selenium in waste products and its discovery in sludges collecting in certain parts of the plant for purifying sulphur dioxide produced by the burning of pyrites in flash roasters. Specimens of the various dusts and sludges occurring in the various stages of the purification plant were on view, the selenium content of these varying from a few parts per million to 60 per cent. This source could provide a substantial additional contribution to the limited supplies in Britain. The excellent collection of pure metals stocked by the Pure Metals Committee of the Department of Scientific and Industrial Research was also on view.

A new type of paper chromatography, which makes use of chemically modified cellulose, was exhibited by the Radiochemical Group. By phosphorylation or amination, normal cellulose is converted to cation- or anion-exchange material respectively and from these special forms of cellulose sheets of paper and columns of powder are prepared for the separation of various metal and acid mixtures. Aqueous solutions of simple salts are used as solvents. Field techniques for the determination of trace metals in soils for geochemical prospecting purposes were again on view. The range of metals dealt with has been considerably extended by the use of both chromatographic and colorimetric procedures.

A new ion-exchange process for the recovery of gold from cyanide solution, which takes advantage of the high selectivity for aurocyanide shown by a weak-base dimethylamine-type resin was demonstrated. This resin enables gold to be extracted from a cyanide solution containing other heavy-metal cyanides with almost 100 per cent selectivity. Another ion-exchange exhibit indicated how uranium can be recovered from dilute sulphuric acid solution by adsorption on a strong-base ion-exchange resin. A new development in the use of solvent extraction for the recovery of metals was illustrated by the use of a kerosene solution of acetyl pyrophosphate for the extraction of uranium from an aqueous solution of phosphoric acid. A physical investigation being undertaken uses a quartz spectrograph with a photomultiplier as light detector to study positive-ion plasma oscillations in halogen-quenched Geiger counters.

Among the exhibits shown by the Organic Group was a semi-micro zone-melting apparatus in which 0·15 gm. of compound can be purified. The material under treatment is contained in a glass tube of 2 mm. internal diameter which is moved vertically upwards at a speed of 1 in./hr. A short molten zone is produced by focusing the filtered light from a 100-W. lamp upon the specimen. The removal of 0·05 per cen of induline from naphthalene was demonstrated. A further exhibit was concerned with a new class of compound containing the pentocyanoferrate group (see *Nature*, 176, 80; 1955). Experiments were shown supporting the structure $[Fe(CN)_5H\dot{N}C_6H_4OH]^{3-}$ for the ion, obtained by the reaction of $Na_3[Fe(CN)_5NH_3]$ with *p*-aminophenol. Possible applications of the intensely coloured compounds of this series included in the exhibit were as spot reagents for metals and for aromatic amines in paper chromatography, and their use in organic syntheses.

Methods for the determination of the molecular weights and molecular-weight distribution of high polymers are being investigated by the High Polymers Group. Instruments shown included an ultracentrifuge, a micro-diffusion apparatus and a light-scattering photometer. Of particular interest was the ultra-centrifuge, which can be used both for analytical and preparative purposes and in which the sedimentation of polymers in solution can be studied both visually and photographically. Zimm–Myerson type osmometers are being used for demonstrating the behaviour of synthetic membranes of graded permeability which have been prepared during research on the osmotic properties of membranes.

Other exhibits by the High Polymers Group illustrated the preparation and uses of ion-exchange membranes. These exhibits included a model electrodialytic cell of the type which can be used for the desalting of brackish water; the water to be treated is passed continuously through the cell, which contains a series of compartments separated by cation- and anion-exchange membranes arranged alternately. In fundamental studies on ion-exchange equilibria, factors determining the selectivity of ion-exchange resins have been investigated. A simple method for the preparation of paper with ion-exchange properties has recently been devised in which the paper is prepared by incorporating a finely divided ion-exchange resin in a cellulose pulp, and experiments were shown illustrating the use of both cation- and anion-exchange papers of this type in chromatographic separations.

The National Collection of Industrial Bacteria, which this year has supplied more than a thousand cultures to industry and research establishments, demonstrated the various techniques employed: methods of preservation, pure culture isolation, freeze-drying in various suspending fluids, morphological and biochemical tests, methods of assay, etc. There were also striking displays of pigment-producing bacteria and antibiotic-producing organisms.

The Microbiology Group also exhibited a new and unusual cytochrome isolated from the strictly anaerobic sulphate-reducing organism, *Desulphovibrio desulphuricans*; it is notable as the first cytochrome to be observed in an obligate anaerobe, and it acts as the major link between the oxidation of organic carbon compounds and the reduction of sulphate by the cell. A continuous fermentation technique, almost automatic in operation, is being used for the reduction of sulphate to sulphide, with hydrogen gas as the reducing agent and carbon dioxide as the main carbon source for cell growth. The same process is being used in the mass production of sulphate reducers for the extraction of cytochrome. Another demonstration illustrated the production of hydrogen sulphide (and therefore sulphur or sulphuric acid) from raw sewage sludge enriched with sulphate. The hydrogen sulphide is produced at the expense of methane normally evolved during the anaerobic digestion of sludge ; but this drawback is being overcome by the development of methane-producing strains resistant to the inhibitory effect of sulphide. Bacteria concerned in the decay of pyretic fossils, a cause of some perturbation in museums, were also on view.

# OBITUARIES

## Prof. James B. Sumner

JAMES B. SUMNER, professor of biochemistry at Cornell University, Ithaca, New York, best known as the first to achieve the crystallization of an enzyme, died on August 12 at the age of sixty-seven at Roswell Park, Buffalo, New York. He had been in excellent health up to a few months before his death. He is survived by his wife, three sons, two daughters and seven grandchildren.

The crystallization of urease in 1926 was Prof. Sumner's most important scientific achievement. The history of this work can be read in his own words in "The Story of Urease" (*J. Chem. Education*, 14, 255 ; 1937) by anyone who wishes a first-hand, true-to-life account of his prolonged efforts to purify the enzyme and then to defend his idea of its chemical nature against severe and intolerant criticism. His skilful refutation of this criticism required experiments of a highly ingenious and exacting nature.

Prof. Sumner was also well known for his work on the enzyme catalase. Another of his major accomplishments that is, however, not so widely known was the first crystallization of a hæmagglutinin (concanavalin *A*) from jack-bean meal, and the discovery that this protein required the presence of a divalent metal for its action.

Prof. Sumner was an excellent teacher as well as research worker, as the writer can testify from personal experience. He constantly brought his lectures to life by means of a variety of personal anecdotes. He was probably at his best, however, in the less formal teaching of his assistants and graduate students, to whom he communicated his wide knowledge of practical laboratory technique.

In carrying out his own research, Prof. Sumner impressed one as being something of a magician. He would often work furiously without revealing exactly what he expected to discover, and then the rabbit would appear. It should be added, however, that in the case of urease, nine years of persistent work were required before his final objective of isolating the enzyme was attained. His thinking was concrete rather than abstract, and his mind operated by brilliant flashes of intuition rather than by the more laborious process of logical deduction from a given set of premises.

Prof. Sumner was somewhat abrupt in manner, and this was apt to lead people to an attitude of reserve towards him until they found by closer association that his true nature was one of kindness and humanity. He was a very loyal friend. He was free from the intolerable conceit often shown by persons of considerable attainment, although he was justifiably proud of his accomplishments. It is unfortunate that, despite being made a joint recipient of the Nobel Prize in 1946 and being elected to the U.S. National Academy of Sciences, he appeared to retain a certain amount of embitterment from the unjustified criticism to which he had at one time been subjected.

Prof. Sumner lost one arm above the elbow in a hunting accident when he was in preparatory school. This may have been an important factor that spurred him on to success in biochemistry, in the face of discouraging advice. In spite of this handicap, he also became an excellent tennis player, and was fond of outdoor sports such as skiing, sailing and hiking.

Prof. Sumner introduced a new era into biochemistry. He lived to see the fruition of his discoveries and on his deathbed he must have felt the satisfaction, in spite of his great suffering, of knowing that he and his work had already become a recognized and important chapter in the history of biochemistry.

ALEXANDER L. DOUNCE

## Mr. Harold Burrows, C.B.E.

HAROLD BURROWS, whose death occurred on September 29, will be greatly missed in the world of medical science. His career was both brilliant and unique. After leaving Marlborough College, he qualified in medicine at St. Bartholomew's Hospital, London, in 1899. He soon distinguished himself as a surgeon and, serving in that capacity in the First World War, was twice mentioned in dispatches. At the conclusion of hostilities he retained his link with the Services by accepting the appointment of consultant surgeon to H.M. Forces with the rank of colonel. In 1919 he was made C.B.E. On resuming his profession after the War he gradually built up one of the largest practices in the west of England, becoming consulting surgeon to both the Welsh Orthopædic and the Gosport War Memorial Hospitals. Harold Burrows received the Jacksonian Prize of the Royal College of Surgeons in 1922 and in the same year was appointed a Hunterian professor. The latter distinction was again conferred upon him in 1933 and 1935.

Shortly after publishing "Pitfalls in Surgery" in 1926, which was an important contribution based largely on his own experiences as a doctor, he became conscious of the strain his large practice had upon his health, and was finally persuaded to abandon clinical work. In 1927 he became a voluntary worker in the research department of the Royal Cancer Hospital, which later became known as the Chester Beatty Research Institute. Burrows was a keen and observant naturalist with a profound biological background, so the transition from medical practice to the life of a laboratory worker was not unduly difficult. In 1930 he was appointed experimental pathologist to the research staff of the Hospital.

Even while engaged in medical practice, Burrows had managed to keep abreast with scientific literature, and his special interest lay in endocrinology and the relationship of hormones to certain forms of cancer. Very naturally this became his special field ; but his interests in cancer research covered a very wide range. He published, apart from his several textbooks, more than seventy papers since he gave up practice in 1927. Some of these articles, mainly on experimental carcinogenesis, were published in collaboration with Sir Ernest Kennaway, Sir Charles Dodds and Profs. J. W. Cook, W. V. Mayneord and E. Boyland. Apart from these numerous scientific contributions, his book "Biological Action of the Sex Hormones", published in 1945, was in many ways a classic. With his combined clinical and biological knowledge, few were better qualified than Burrows to write a book on this complex subject.

It was a critical review of the subject and dealt mainly with the physiological activities of the sex hormones and the reactions of normal tissues to them. A second edition was published by the Cambridge University Press in 1949.

After his retirement from the Chester Beatty Research Institute in 1945, he collaborated with E. S. Horning and published "Œstrogens and Neoplasia" in 1952. This book dealt exclusively with the part played by the sex hormones in both the induction and prevention of certain forms of endocrine cancer, and included much of Burrows's own fundamental work. When Lacassagne in 1932 published his fundamental discovery that œstrogens were implicated in the cause of mammary cancer, Burrows was already working on the same problem and was therefore one of the first to confirm Lacassagne's results. Continuing his researches along these lines, he was the first to discover the relationship of œstrogens to the induction of scrotal hernia in rodents, and also to find that œstrogens are not only carcinogenic but al carcinostatic, since they are capable, under certa conditions, of restraining the growth of some form of hormonal neoplasms.

Burrows was particularly interested in the endo crine factors involved in the causation of tumours the reproductive organs, and shortly before he die at the age of eighty he had already completed th manuscript for a book on this important subjec His last contribution was published in 1954 in th *Journal of Obstetrics and Gynæcology.*

Harold Burrows's many researches over a wid field of cancer, especially those on the study of dis orders of the endocrine glands and their relation t the induction of neoplasia, form a very importan contribution to our present-day knowledge of thi subject. Many have lost a good colleague; but a can take consolation in the fact that his work ha helped to enrich the annals of science.

E. S. Horning

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# NEWS and VIEWS

## The Negative Proton

The University of California and the U.S. Atomic Energy Commission have jointly announced the detection of the negative proton, or 'anti-proton' (cf. *The Times*, October 20). Protons which had been accelerated to an energy of 6,200 MeV. in the bevatron, the proton synchrotron of the University of California Radiation Laboratory at Berkeley, were allowed to collide with a copper target. Negatively-charged particles coming out in a forward direction from this collision were selected and separated in momentum by a focusing and analysing magnet system to provide a beam of negative particles of known momentum. After a time of flight of about one-tenth of a microsecond, this beam may be expected to consist mainly of negative pi- and mu-mesons, with some negative *K*-mesons (mass about 965 electron masses) and possibly negative protons. These particles were then distinguished both by measurement of their time of flight from the target (since particles of different mass have different velocities for given momentum) and by means of a device measuring the velocity of each particle passing through by the angle of its Čerenkov radiation. In this way the presence of negative particles with protonic mass (within about ten per cent) and distinct from the known *K*-particles and hyperons was established. Their rate of production for the momentum and direction of this experiment was about one negative proton for every 50,000 negative pi-mesons with the same momentum and direction.

No clear evidence of the existence of the negative proton had previously been available. A very direct interpretation could be given for several isolated cosmic-ray events which have been reported by invoking the negative proton, but these interpretations were not unambiguous. On the other hand, theoretical physicists have always had great difficulty in constructing any relativistic theory of the neutron and proton which did not require the existence of their 'anti-particles', the anti-neutron and the negative proton. The theories which have been proposed suggested that these anti-particles could be created together with a proton or a neutron, a nucleonic pair-creation process, when sufficient energy was available to form the rest mass of the nucleon-antinucleon pair in accord with the Einstein relationship between rest mass and energy. The negative proton would be stable in vacuum, but it was expected to react rapidly on collision with normal nuclear matter, a negative proton and a normal nucleon undergoing mutual annihilation and becoming transformed into lighter mesonic particles. It seems most probable that this annihilation process would generally lead to two or three fast pi-mesons, although there are also other possibilities. It has not been established experimentally yet which are the annihilation processes of importance.

The discovery of the antiproton has removed a major uncertainty in theories of the structure of the basic nuclear particles. It may thus be compared with the discovery in 1932 of the antiparticle to the electron, the positively-charged electron known as the positron, in accordance with the prediction of Dirac's theory of the electron. The importance of the present discovery lies in showing that symmetry between particle and anti-particle, already known to hold for the electron and positron and for the positive and negative pi-mesons, is characteristic also of the heavy nuclear particles, and may therefore be expected to be a general and deep feature of any account of the elementary particles of Nature.

## Industrial Fund for the Advancement of Scientific Education in Schools

Some companies which are concerned in the chemical, electrical and mechanical engineering fields of industry, viewing with growing disquiet the shortage of scientists, mathematicians and technologists, have decided to take steps to assist the teaching of pure and applied science and mathematics in secondary schools. The names of the companies are: Associated Electrical Industries, Ltd.; British Insulated Callenders Cables Co., Ltd.; British Petroleum Co., Ltd.; British Portland Cement Manufacturers, Ltd., Group; Courtaulds, Ltd.; The Distillers Co., Ltd.; English Electric Co., Ltd.; Esso Petroleum Co., Ltd.; General Electric Co., Ltd.; Arthur Guinness, Son and Co., Ltd.; Imperial Chemical Industries, Ltd.; Imperial Tobacco (Great

Britain and Ireland) Co., Ltd.; Rolls-Royce, Ltd.; The Shell Petroleum Co., Ltd.; Tube Investments, Ltd.; Vickers, Ltd.; The Wellcome Foundation, Ltd. These companies have accordingly established n Industrial Trust, to be known as the Industrial Fund for the Advancement of Scientific Education n Schools. For capital works at maintained schools, public funds are available, but no such help exists for independent schools and direct grant schools, at many of which the facilities are seriously inadequate hrough lack of capital resources, and it is therefore o these that the sponsoring companies are directing heir intentions. The assistance will be given solely y the provision of capital grants towards the uilding, expansion, modernizing and equipping of cience buildings in independent schools and direct grant schools in the United Kingdom, the Channel Islands and the Isle of Man. More than one and a alf million pounds has already been guaranteed; ut it is believed that many other companies that epend on adequate supplies of pure and applied scientists and technologists will wish to add their support. Indeed, only shortage of time has prevented their being approached already.

An Executive Committee of the Fund has been formed, consisting of the following: Sir Wilfrid Anson; Mr. R. A. Banks; Sir Hugh Beaver (*chairman*); Mr. E. H. O. Elkington; Dr. Willis Jackson; Mr. W. E. Jenkins; Prof. G. F. Mucklow; Mr. J. A. Oriel; Dr. F. Roffey; Dr. C. P. Snow; Sir Alexander Todd; Lieut.-Gen. Sir Ronald Weeks; Mr. A. H. Wilson. The secretary of the Committee is Mr. Peter Ashton, of Courtaulds, Ltd., and the address of the Fund is 20 Savile Row, London, W.1. It will be the responsibility of this Committee to adjudge and assess all applications; its decisions will take into account both the volume and quality of the existing science teaching in any school, as well as the nature of the proposals put forward to extend and improve t, and the steps which the school has taken to help itself.

## Future Policy of the Wellcome Trust

Sir Henry Dale, chairman of the Wellcome Trust, has recently explained the activities of the Trust in relation to the Wellcome Foundation from which its funds are derived, and also the character of its benefactions up to date. The Trust came into existence in 1936 on the death of Sir Henry Wellcome, though the activities of the Foundation and its associated branches commenced much earlier. The first demand on the Trust was the payment of very heavy estate duty, for which Sir Henry Wellcome had made no provision in his will, and for the first five years of its existence all the income of the Trust, which was derived from dividends received on its shares in the Wellcome Foundation, Ltd., was devoted to paying off this duty. Although the Foundation's profits during the Second World War rose considerably, due to the expansion of business in the manufacture of medical and therapeutic supplies, most of the money was either taken as excess profits tax or used in the new capital expenditure demanded by the urgent war-time expansion of its activities. Nevertheless, the Trust has been able to function to a limited extent, the most notable of its benefactions being the endowment of a Wellcome chair of tropical medicine and a Wellcome chair of pharmacology in the University of London. In addition, it has given funds for numerous fellowships and studentships both in Britain and overseas, and has also made provision for an important new medical library for the Royal Society of Medicine, and for three large museum floors, for anatomy and pathology, as a major part of the new building of the Royal College of Surgeons in Lincoln's Inn Fields. Sir Henry Dale pointed out that whereas the activities of the Trust in the past have necessarily tended to be sporadic, the time has now been reached when it can be assured of a substantial income and therefore has the opportunity to initiate a planned policy for spending its resources. To ensure such a longer-term policy and a more co-ordinated planning by the trustees, a full-time administrative staff is needed to deal with the charitable aspect of the Trust's functions, and Dr. F. H. K. Green, formerly principal medical officer on the headquarters' staff of the Medical Research Council, has been appointed scientific secretary of the Trust with the chief responsibility for the executive organization of its spending policy.

## Message for the Foreign Ministers at Geneva

On October 21, on the eve of the meeting of Foreign Ministers at Geneva now in progress, a public meeting was held in the Central Hall, Westminster, to give expression to the sense of urgency widely felt that there should be a fruitful outcome of the discussions. The meeting was sponsored by Earl Russell, Lord Boyd Orr and Prof. C. F. Powell, and a message signed by them and Sir Richard Coppock was sent to Geneva. In it they refer to the Geneva meeting as the natural successor of the July meeting of heads of States, and continue: "At this moment, so crucial for the future of man, we should like to bring to the attention of the Foreign Ministers the warning signed by some of the most eminent scientific authorities in different parts of the world, which dealt with the perils of nuclear war. That statement suggested that neither the public nor the governments of the world are adequately aware of the dangers facing the human race. We feel that statement still to be true; and that the Foreign Ministers need to approach their discussions with a deeper awareness of these dangers. The Foreign Ministers, like all of us, have to learn to think in a new way. They have to ask themselves how they can reach specific agreements on the problems before them so that they will rule out any military contest of which the result must be disastrous to all. . . . We wish to impress on them the view that agreements on one problem will improve the possibility of agreement on others; but that disagreement on any one problem should not rule out discussion and negotiation of others. On the question of Germany and European security, it is good that the governments have recognized that these problems are closely linked. There can be no stable peace while Germany remains disunited, but its unification must be brought about in a way which will not involve an important accession of strength to either East or West and will help to end the division of Europe into two hostile blocs. On the question of a disarmament plan involving reduction of conventional arms, the abolition of nuclear weapons and an effective scheme of control, the viewpoints of both sides now seem so close that agreement ought to be possible". Other matters mentioned are further measures for the exchange of visits and information, the easing of trade restrictions as a contribution to world economic stability, and the recognition of the Peking Government. The message concludes: "In making the cold war a nightmare of the past, the Foreign Ministers will have the support not merely of the peoples of both sides, but of the species Man".

## Humane Killing of Animals

The Universities Federation for Animal Welfare has issued a revised edition of its pamphlet, "Kind Killing", dealing with the humane killing of animals (pp. 28; from the Federation, London, 1955; 6*d*.). The booklet is particularly valuable because the author, Dr. Jean Vinter, realizes that in many circumstances the methods advocated may not be practicable. Sodium pento-barbitone, for example, is recommended for killing dogs and cats, but the most humane ways of shooting these animals are also described. Where this cannot be done, the best way of chloroforming is explained, as are the methods to be used in gas poisoning and electrocution. A separate note is included on the disposal of new-born kittens and puppies. Besides mammals, the pamphlet gives some useful hints on the killing of birds, reptiles, amphibians, fish and invertebrates which are nuisances or needed for dissection.

## 1955 "Science in Industry" Essay Competition

Seventy-seven entries were received for the 1955 "Science in Industry" Essay Competition organized by the *Sunday Times* and *Research*. The *Sunday Times* section of the competition proved to be the more popular, forty-three entries being received for it. The entries were remarkable for their diffuseness, and none was written in a style suitable for a newspaper appealing to the lay public. In consequence, no award was made. The standard of the *Research* section of the competition was a little higher. The first prize (£100) and the Waverley Gold Medal were awarded to Dr. F. Peter Woodford for an essay entitled "Living Reagents"; Dr. Woodford, International Wool Secretariat Postdoctoral Fellow in the University of Leeds, also received the special prize (£50) for the best entry from a competitor less than thirty years of age. The second prize was awarded to Dr. E. C. Potter, a physical chemist employed by the Central Electricity Authority, for an essay entitled "Corrosion in the Modern Power Station". Dr. Potter's essay will be published in *Research*.

## University of Birmingham

The following have been appointed to chairs in the University of Birmingham: Dr. D. G. Tucker, formerly senior principal scientific officer at H.M. Underwater Detection Establishment, Portland, to the chair of electrical engineering; and Prof. D. G. Catcheside, professor of genetics in the University of Adelaide (see *Nature*, 168, 234; 1951), to a chair of microbiology. The title of reader in chemical engineering has been conferred by the University on Dr. S. R. M. Ellis, and that of reader in pathology on Dr. D. B. Brewer. The following have been appointed lecturers: Dr. G. E. Brown (mathematical physics), Dr. G. Bullock (physical metallurgy), Dr. R. F. King (geophysics), J. Manhajm (mechanical engineering), Dr. W. T. W. Potts (zoology) and Dr. S. J. Taylor (mathematics). The following have been appointed to research fellowships: T. R. Carson (electron physics), B. W. Downs (mathematical physics), J. Graham (physical metallurgy), Dr. W. H. Holden (National Coal Board fellowship in chemistry), K. B. Mathur (Imperial Chemical Industries, Ltd., fellowship in chemical engineering), D. S. Rowe (experimental pathology), and Dr. W. I. Stephen (Imperial Chemical Industries, Ltd., fellowship in chemistry).

## University of Leeds

The University of Leeds has conferred the title reader in textile industries on Dr. H. N. Chamberla senior lecturer in rayon technology in the Departme of Textile Industries. The following have be appointed lecturers in the University: Dr. D. Armstrong (Brotherton research lecturer in physic chemistry); Dr. P. Gray (physical chemistry); I B. W. Langley (organic chemistry); R. D. Mack (civil engineering); and Dr. R. M. Tennent (physic

## University of London

The following appointments have been made the University of London: C. H. Barnett, seni lecturer at St. Thomas's Hospital Medical School, the University readership in anatomy tenable at th School; and Dr. R. S. F. Schilling, reader in t Nuffield Department of Occupational Health in t University of Manchester, to the University reade ship in occupational health tenable at the Londo School of Hygiene and Tropical Medicine.

## Announcements

Sir George Barnes, director of television, B.B.C since 1950, has been appointed principal of th University College of North Staffordshire, Keele.

Sir Herbert Manzoni, engineer and surveyor the City of Birmingham, has been elected chairma of the General Council of the British Standard Institution in succession to Mr. John Ryan, who ha completed his three-year period of service as chai man. Sir Roger Duncalfe, chairman of British Glu and Chemicals, Ltd., has been re-elected president o the Institution, and Sir Stanley Rawson, vice chairman of John Brown and Co., Ltd., has bee elected chairman of the Institution's Engineerin Divisional Council.

The following new appointments at the Brookly Botanic Garden, New York, have been announced Dr. Walter R. Tulecke, formerly of Arizona Stat College, research associate; Miss Gunny Larsson, o the Arctic Horticultural Research Station at Öjebyn Sweden, for one year as Ellen Eddy Shaw Fellow Miss Charlotte Mentges, of Frankfurt, Germany, t the educational staff.

Prof. John Wotiz, assistant professor of chem istry, has been appointed associate professor, an Maak-Sang Tsao, instructor of chemistry, has bee appointed assistant professor in the University o Pittsburgh.

Sir Bernard Keen, recently director of the East African Agriculture and Forestry Research Organization, has been appointed scientific advisor to Baird and Tatlock (London), Ltd., 14–17 St. Cross Street, London, E.C.1.

Messrs. Griffin and George, manufacturers of scientific apparatus, announce that, as from November 7, the Griffin and Tatlock Division at Kemble Street, Kingsway, London, will be closed: all correspondence should be addressed to Griffin and George, Ltd., Ealing Road, Alperton, Wembley, Middlesex (Tel.: PERivale 3344. Telegrams: Grifgeorge, Wembley).

Erratum. In the communication entitled "Site of Virus-like Particles in Rous Fowl Sarcoma Cells", by M. A. Epstein, in *Nature* of October 22, on p. 785, col. 2, line 3, the word 'are' should be omitted; it is the vacuoles which are visible by phase-contrast microscopy.

# TELEVISION AND FILM UNIT AT THE LONDON ZOO

THE Zoological Society of London, its Gardens at Regent's Park and its Park at Whipsnade have ways enjoyed a great deal of newspaper and radio ublicity. With the advent of the Independent elevision Authority (ITA) several programme-roducing companies have been formed, and some of hem have asked the Zoological Society of London grant them television rights. The Society takes he view, however, that it would be wrong to grant xclusive rights to any one company, and that it ould be equally impossible to have numerous com-anies working on the Society's premises, perhaps even at the same time, and disturbing its work. xclusive rights cannot be granted nor can a com-letely non-exclusive arrangement be contemplated. The Society has therefore decided to make the best ossible zoological material available and at the same ime to retain control of the Society's interests in elevision programmes and films, and to ensure that o responsible organization is denied the opportunity f broadcasting the programmes of its work. This will best fulfil the Society's policy of presenting its work to the public.

Of the several approaches made to the Society, all of which were carefully considered, that made by Granada was by far the most attractive and prac-icable. Granada proposed that the Society, in con-unction with Granada, should establish a permanent esident Television and Film Unit to produce pro-grammes for television, for the cinema, and for more pecific educational and scientific purposes. The Unit will be under the direction of a university-trained zoologist and will have at least two cameramen, perhaps more, preferably people with some scientific interest in zoology. It will cover all the work of the Society at Regent's Park, Whipsnade, on xpeditions abroad or wherever it may be necessary o go for special material. Its first function will be to provide the Society with documentary material, and it will be able to undertake long-term projects which may need a considerable period of time for their completion.

The Society looks to television for something more than revenue alone. It is the medium that can best project the Society's work and encourage the primary object of the Society's Royal Charter, granted in 1829, which is "the advancement of Zoology and Animal Physiology and the introduction of new and curious subjects of the Animal Kingdom" on a scale far beyond the possibilities previously available. The work of the Unit will fulfil these objects laid down in the Charter, and while it will not suffer from any lack of scientific integrity it will have a wide appeal to the public. The use of the new medium will do much more than exploit the easy entertainment value of animals; the possibilities for such a Unit are enormous and have never been grasped by any organization before.

In addition to its long-term projects and quarterly schedules of work, the Unit will keep a daily diary in picture and sound of events of special interest, new arrivals and so on, thus building up an extensive film and sound library for use in making programmes, educational and research films. Documentary matter needing the slow accumulation of material over months or even years will be recorded, and zoological expeditions to all parts of the world will also be an important part of the work of the Unit. Techniques to be used will include photomicrography, slow-motion cinematography, infra-red lighting and the 'hidden eye' to observe animal behaviour continuously over long periods.

The films will be available for production of television programmes and also for exhibition in cinemas, universities and schools. In addition, live broadcasts will be regularly produced. Granada will in general have first option; but the television programmes will be available to other users. Granada will distribute the programmes and films.

Under this arrangement the B.B.C., with which the Society has co-operated fully for many years, will be able to broadcast programmes of zoological interest in association with the new Unit.

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# SMOKE ABATEMENT IN BRITAIN

## CONFERENCE IN BOURNEMOUTH

THE National Smoke Abatement Society may take credit for having provided for many years a platform on which discussion of the problems of smoke abatement have been given full scope. All elements of the community have in their turn been given their say. From year to year there have been heard the oft-repeated claims of the crusaders for cleaner air. For quite a few years careful research work and surveys of atmospheric pollution have been carried out by the Atmospheric Pollution Research Committee, and a conference of representatives of local authorities has been held under the ægis of the Department of Scientific and Industrial Research. One must not forget, too, the contributions to technical development, which have a bearing on these problems, made by a large body of scientists and engineers in fuel technology and resulting in a knowledge of how to burn fuel smokelessly. The Society's platform has again in these fields been the means of publicizing from time to time the painstaking efforts in technical development that must provide the basis of any really effective action in smoke abatement.

In this critical year of the Society's history, the Government's Clean Air Bill is likely to be debated. Accordingly, the proceedings of this year's annual conference of the Society, held in Bournemouth during September 28–30, are of particular interest. In keeping with past traditions, all aspects of the thorny problems to be faced have in some measure received attention, and opinions have been voiced which ought to reach the ears of the legislators. In his presidential address to the Society, Sir Ernest Smith rightly stressed the influence, in bringing about this situation, of the informed body of opinion into which there have been injected a large variety of ideas and much practical understanding by the activities of the Society. This is not to disregard the contributions made by that other large but silent body of expert opinion containing the practitioners of the technologies involved, who for upwards of a generation have provided a technical basis upon which smokeless combustion practice may be achieved. Without the 'know how' to burn fuel smokelessly, legislative action would be ineffective. The need at the present time is the problem of effective application of this existing knowledge.

The conference this year has provided interesting descriptions of recent progress in domestic heating by centralized methods, in particular of the Westminster City Council's district-heating scheme, considered from the financial, engineering and operational aspects. The scheme shows a saving of coal as well as an overall economy, a reduction of atmospheric pollution and improvement in domestic amenities.

Floor warming was an ancient practice known to communities as wide apart as the early Koreans and the Romans. To-day, with the application of electrical heating, the principle of thermal storage may be applied, the electricity being supplied to concrete flooring in 'off-peak' periods. Gradually, but surely, the hardy and reluctant dwellers of the British Isles are succumbing to the lure of the use of partial central heating, an interesting new feature of this practice being the application of forced circulation of hot water in small pipes—a result of research by the British Coal Utilization Research Association. All the heat from the boiler is kept within the living space of the house and is localized mainly in the radiators as the piping is so small. Another interesting article explains how the stuffiness of ducted hot air, another practice emanating from the Romans, may be safeguarded by suitable control of the movement of the air. The above are merely a selection of the many interesting points emerging from the technical discussions of the conference.

On the issues involved in the projected Clean Air Bill, opinions were many and comprehensive, ranging from contributions by the representatives of local authorities to several informative explanations of the purport of the Beaver Report by members of the Committee. These make much more intelligible reading than does the draft of the Clean Air Bill itself. Proverbially, the draft of a Parliamentary Bill in any case provides a form of mental persecution for the layman. The contributions to the Bournemouth conference give at least a clear indication of the intentions of the Report, and the reactions of much representative opinion from the local authorities. The views of the ordinary man and of the industrialist were unfortunately not heard; this is to be regretted, since they may be regarded in some respects as the victims for the sacrifice.

The objectives of the conference were, as would be expected, altruistic and worthy. The factors of practicability of some of the intentions may be quite another matter, about which, it is to be hoped, something may at last be heard in the debates in Parliament, if the victims have not become mesmerized by the certainty of a kill. Nevertheless, it must be agreed that now there looms before us some prospect of wise action which may contribute materially to a cleaner Britain that is so much desired by all. How much cause for thanksgiving may emerge in next year's conference.

R. J. SARJANT

# CAMBRIDGE ASTRONOMICAL SYMPOSIUM

THE symposium on "Astronomical Seeing", he at the Observatories, University of Cambridg during September 12–14, was timed to follow th General Assembly of the International Astronomic Union at Dublin, and thus to take advantage of th presence in Europe at this time of astronomers from all over the world. Its object was to provide forum for the exchange of ideas and informatio relating to the various aspects of the subject. Thes aspects include the accumulated knowledge of visu observers; the extensive *ad hoc* instrumental studie that have been made more recently, especially in th United States; the theory of scintillation, develope mainly with particular reference to radio problems and meteorological information about inhomogeneit and turbulence in the atmosphere. The aim was t provide time in the programme for sufficient dis cussion, so that progress could be made towards th resolution of real differences.

Dr. J. S. Hall (U.S. Naval Observatory, Washington, D.C.) described experiments in which correlation had been found between intensity scintillation in certain frequency-ranges and the speed of the uppe winds. Lamps attached to balloons showed les scintillation even at a height of 30,000 ft. than di stars observed at the same time; but it is probabl unsafe, he said, to conclude from the experiments s far made that appreciable seeing effects come from greater heights. Dr. Hall showed a film of shadow bands crossing the objective of the Washington 40-in telescope, and of extra-focal Hartmann patterns. Dr P. B. Fellgett (Cambridge Observatories) reviewed the physical theory of scintillation. Plane wave-fronts of starlight are diffracted by irregularities in the refractive index of the air, and the diffracted beams interfere to give phase- or amplitude-scintillation according to their mutual phases, which depend on the distance from the irregularities. Brightness-scintillation is usually negligible just below the irregularities, and increases with distance, while phase scintillation decreases slightly. The complex autocorrelation function of the amplitude across the mean direction of travel remains constant; and the mean intensity distribution in a telescopic image is also independent of distance from the source of disturbance. The spatial frequencies in the scintillation differ in general from those in the irregularities of refractive index. Dr. A. Hewish (Cavendish Laboratory) presented quantitative results for some chosen cases. He showed calculations and slides of the detailed development of brightness changes beyond sinusoidal phase-changing layers of various amplitudes; of the interchange between brightness changes and phase-scintillation; and of the corresponding autocorrelation functions of complex amplitude, showing the dominance of harmonics of the layer-frequency when the phase change is large. The corresponding statistical developments were shown for a layer having a Gaussian autocorrelation function of refractive index.

Dr. G. Keller (Perkins Observatory, Ohio) gave a detailed account of work at the Perkins Observatory. Observations have been made of the temporal power-spectra of brightness changes for various telescope apertures; the correlation of scintillation in certain frequency-ranges with upper-wind speed; correlation of upper-wind direction with the dependence of cintillation, observed through a slit covering the bjective, on the position-angle of the slit; and the egree of coherence between scintillation in selected requency-ranges observed in two neighbouring pertures. Dr. W. H. Steavenson (Cambridge) dis- ussed the effects which can be distinguished visually n extrafocal images or when the eye is placed at the ocus of the telescope. The 'high seeing' appears as hadow patterns blown at high speed across the perture, and defocusing experiments indicate an verage height of origin of about 10 km. Slower hadow bands originating within a few hundred feet f the telescope can be seen to move with the surface vind. Local dome and tube effects are recognizable y their geometry. In large reflectors, the cooling of he mirror causes disturbances in the thin layer of ir at the face of the mirror; these are much more erious than the well-known changes in mirror sphericity and can often be the dominant cause of mage spread. Dr. A. Hynek (Ohio State University, Columbus) reported studies of image motion made by Dr. A. G. Wilson at Flagstaff, Arizona. Star-trails recorded on fast-moving film showed the amount of movement, the proportion of the time that the image is sharp, and the occurrence of multiple images. These studies were made with special reference to the design of methods of photographing Mars, and an important conclusion is that at Flagstaff the instantaneous image movement is nearly the same over the whole disk of the planet. Dr. Hynek also reported some very recent work at Ohio State University which included measures of image movement in two colours. If image-spread were an effect of rapid image motion, this might provide a further test of the remark of Hewish and Keller that the red images may be expected sometimes to have a sharper 'core' than the blue.

Dr. B. H. Briggs (Cavendish Laboratory), describing radio observations of the scintillation at neighbouring wave-lengths, said that in the ray-interference approximation the correlation across the spectrum is simply related to the spread in the ray path-lengths between the source and observer. Rapid frequency-change experiments yield records similar to the spectrum-scintillation photographs of Zwicky, and the problems of interpretation are also similar. Dr. E. H. Linfoot (Cambridge Observatories) took up the question of measuring the harm done by bad seeing. Seeing effects reduce the rate at which a given telescope can record information about the sky. The loss can be estimated in terms of the mean transmission factors (sine-wave response factors), which are essentially equal to the mean autocorrelation function of the complex displacement across the aperture. Dr. Linfoot showed how the reduction in information capacity (in Shannon's sense) can be calculated from the statistics of seeing; generally speaking, the loss is of second order when the phase-errors are small. Dr. R. Goody (Imperial College of Science and Technology, London) presented meteorological data on turbulence and convection in the atmosphere. By day, in clear weather, convection is most intense near the ground and falls rapidly throughout the first 1,000 ft. Convection is enhanced over large mountains and islands. A small island should have good daytime seeing, and even a few feet of height above the ground could be beneficial. Aircraft results show inhomogeneities at various heights. A few accelerometer records from balloon flights show increased turbulence near the tropopause, but it is not known whether this is typical. The northern edge of the jet stream in the northern hemisphere is sometimes very turbulent. Generally, however, the atmosphere is non-adiabatic and is continually being mixed, so that the causes of seeing effects are unlikely to be confined to any narrow range of height.

In the discussion, widely different opinions were expressed about the usefulness of the ray approximation to the Huyghens wave treatment. One view is that ray theory is adequate under suitable conditions for small phase perturbations. It was urged in reply that ray theory is essentially the limit of wave theory as the wave-length becomes very small compared with the relevant geometrical path-differences, so that it is expected to be valid (as in aberration calculations) only for large phase-changes. It was the general opinion that the phase-changes corresponding to good seeing could be of the order of a few radians, but the lack of any specific measurements of this fundamental quantity illustrates how much is still to be learnt. It was pointed out that the combined effect of spatial smoothing by the objective aperture, and temporal smoothing in the electrical filters, would in general make the amount of scintillation recorded photoelectrically dependent on the transverse speed of the shadow bands. Until this is allowed for, it cannot be said whether the observed wind-scintillation correlation represents an actual physical connexion between wind-speed and optical inhomogeneities in the air. Non-isotropic inhomogeneities would necessarily give rise to telescopic images that are not radially symmetrical, although this effect might be masked by disturbances originating at another height. It was suggested that the height of origin of scintillation could be found in principle from the cross-over wave-length in the colour scintillation; from the ratio of phase to brightness-scintillation at different wave-lengths; and by the analogue of the spaced-receiver experiments of Briggs *et al.*, the linear transverse velocity being found from the correlation of scintillation in two apertures and the angular velocity by observations of two neighbouring stars. A plea was made for observations in narrower wave-length ranges.

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# HUNGARIAN–CZECHOSLOVAK POLAROGRAPHIC CONFERENCE

FOR the first Hungarian–Czechoslovak Polarographic Conference held in Veszprém, Hungary, during August 11–14, seventeen Czechoslovak polarographists, mostly from the Polarographic Institute of the Czechoslovak Academy of Science, were guests of the modern Chemical University in Veszprém at the meeting arranged jointly by the University, the Hungarian Chemical Society and the Hungarian Academy of Science. Prof. J. Heyrovský was the leader of the Czechoslovak delegation; from the Hungarian side, Dr. Polinszky (dean), Dr. Preissich (secretary of the Chemical Society), Dr. Cieleszky (chairman of its Polarographic Section), and Prof. Bognár (general secretary of the Hungarian Academy) organized the Conference extremely successfully. The Minister of Education, Prof. Erdey-Grúz, a prominent physico-chemist, was in the chair. At the opening of the Congress, a diploma of honorary fellowship of the Hungarian Academy of Science was presented to Prof. J. Heyrovský, who then delivered an address on the "New Trends in Polarography". Prof. L.

Erdey addressed the general assembly on the "Development of Polarography in Hungary".

The forty-six communications that followed were divided into two parallel sections, one for applications in inorganic analysis, the other for biochemistry and biology. Lectures and discussions were in German, English, French, Hungarian and Slovak. General oscillographic polarography was discussed at a conjoint meeting by J. Heyrovský and quantitative oscillography by R. Kalvoda, who demonstrated their specially constructed cathode-ray oscillographs. As innovations may be mentioned: polarographic estimations of chromatograms (J. Proszt and J. Kis), automatic polarographic analysers of long duration (J. V. A. Novák), streaming of electrolytes induced by alternating currents (J. Dévay), derivative currents obtained by electromagnetic induction (J. Proszt and J. Paulik), deposition of magnesium at the streaming electrode (K. Győrbiró, L. Poós and J. Proszt). In the biological section, several communications concerned Brdička's protein test, the determinations of vitamins, oxygen in tissues, alkaloids and many applications in pharmacy and food production, and the study of macromolecules by means of suppression of maxima.

The communications will be published in full in German by the Hungarian Academy of Science in a special volume. Brief abstracts of the papers may be obtained through Dr. E. Bodor, Chemical University, Veszprém, Hungary.

It should be added that Veszprém lies close to the famous Lake Balaton, on the banks of which the delegates enjoyed discussions for several days after the Congress. J. Heyrovský

# NATIONAL PHYSICAL LABORATORY, TEDDINGTON

## REPORT FOR 1954

The annual report for 1954 of the National Physical Laboratory, Teddington*, consists of the report of the Executive Committee which was presented to the General Board at its meeting during the afternoon of May 20, 1955, the annual open day of the Laboratory (see *Nature*, 175, 1102; 1955), and detailed reports, prepared by the respective superintendents, of the work of the nine divisions and Test House of the Laboratory.

The Executive Committee refers with particular pleasure to the visits of Their Majesties the King and Queen of Sweden on June 29, and of the members of the Royal Commission on the Civil Service on May 12. Other visitors during the year included parties from the Royal Naval College, Greenwich, and delegates from the joint spring meeting of the Institute of Metals with the Société Française de Metallurgie, and from the General Assembly of the Internationl Union of Pure and Applied Physics. A thirty-minute television outside-broadcast directly from the Laboratory took place on June 2, and the work of the Laboratory, with special reference to aerodynamics research, was also described in a schools' broadcast on October 27. In addition, the director of the Laboratory, Sir Edward Bullard, took the leading part in a studio programme, entitled "Power from the Sun", which was broadcast on October 11.

At the beginning of the annual report, the name of the members of the General Board, the Executive Committee, the Promotions Sub-Committee, the Froude Ship-Research Sub-Committee, and a newly constituted body, the N.P.L. Advisory Committee on Radioactive Standards, are listed. The new Committee formerly existed as an informal body, consisting of representatives of the Atomic Energy Research Establishment, the Radiotherapeutic Research Unit of the Medical Research Council, the Royal Cancer Hospital and the National Physical Laboratory; Dr. B. W. Robinson, superintendent of the Physics Division of the Laboratory, was appointed chairman of the Committee. In order to make the work of the Laboratory better known to industry, two liaison officers were appointed during the year for a three-year period, and it is reported that they have visited thirty-two research associations and have made direct contact with a number of industrial firms. The new building for the Metallurgy Division, which contains the refractories section, the X-ray section and laboratories for work on radioactive tracers, was formally opened by Sir Lawrence Bragg on April 6, and in June a new Division, that of Control Mechanisms and Electronics, was formed by amalgamating the control mechanisms section of the Metrology Division with the Electronics Division. The field of work to be covered by the new Division is a wide and important one, dealing with the automatic control of experimental, industrial and administrative operations and the development techniques and equipment for data-processing and computation; but, at present, work is to be restricted to a continuation of that previously carried out by the two original sections.

The Laboratory took part in several exhibitions of scientific apparatus, including the Physical Society annual exhibition, the Royal Society soirées and a conversazione arranged by the Institution of Civil Engineers. Two international symposia were held during the year at the Laboratory, one in May on "Creep and Fracture of Metals at High Temperatures" and the other in November on "Precision Electrical Measurements". The proceedings of the symposium on "Automatic Digital Computers", held in March 1953, and four new booklets, Nos. 5–8, in the series "Notes on Applied Science" were published during the year. In addition, one hundred and forty-six scientific papers were contributed by members of the staff of the Laboratory to various journals and periodicals; lists of these are appended to each detailed divisional report.

The individual reports of the various divisions of the Laboratory indicate the wide range of scientific subjects covered. The Laboratory has, in addition to an extensive research programme, part of which is paid for by other government departments, certain specific responsibilities, including the maintenance of standards and routine test work. It would appear that the programme contains more items than are really desirable, and a reduction in the number in order to enable more rapid progress to be made with the remainder, and perhaps also to commence on a few new urgent items specially appropriate to the Laboratory, is being considered. The Aerodynamics Division has carried out important work on the application of boundary-layer control to the reduction of drag and the increase of lift. Helicopters appeared on the research programme of the Division for the first time, and a twin-rotor model for wind-tunnel tests was being made. Some fundamental work con-sting of high-speed tunnel experiments on the flow f air at supersonic speeds over elliptic cones has ready received practical application in the behaviour f high-speed aircraft and the use of highly swept ings.

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* Department of Scientific and Industrial Research. National Physical Laboratory: Report for the Year 1954. Pp. viii+98+7 plates. (London: H.M.S.O., 1955.) 4s. net.

In the Control Mechanisms and Electronics ivision work has continued on digital computers, nalogue computers and data-reduction devices. Two magnetic-drum stores have been installed on the ilot model of the automatic computing engine ACE); an enlarged and improved version of the lectronic simulator has been put into service and used in conjunction with the London School of Economics for an extensive study of economic systems; and, at the request of the Committee on High-speed omputers of the Department of Scientific and Industrial Research, a group was formed in May to study he mechanization of large-scale clerical operations y means of electronic-digital techniques and equipment. A new impulse generator for 3·2 MV. was installed during the year in the high-voltage section of the Electricity Division, and, in connexion with its work on frequency standards, a highly stable oscillator controlled in frequency by a cavity resonator has been developed by the Division. Steady progress was maintained with the cæsium atomic-beam standard.

The Light Division has spent several years developing methods for the production of diffraction gratings using techniques suggested by Sir Thomas Merton. The stage has now been reached where good-quality and reasonably sized gratings, suitable for use in research and industry, can be produced comparatively cheaply. Work on the application to the control of machine tools of the system of moiré fringes which is formed when two identical diffraction gratings are superimposed with their rulings nearly parallel has also been actively pursued. The Metrology Division reports considerable progress in the development of autocollimation and pneumatic gauging as a means of making highly accurate dimensional measurements for research and industry, and mention is made of the machines that have been built in the Laboratory to measure bore diameters of 0·1–6 in. to an accuracy of ± 0·000 01 in., in addition to an apparatus to measure the diameter of wire as fine as 0·000 2 in. to a similar accuracy. A new absolute determination of gravity, in which the free up–down motion *in vacuo* will be timed, is envisaged, in order to improve the accuracy of measurement of barometric pressure and hence the steam point, and some preliminary work has already been done on the proposed interferometric method for measuring the distance over which the motion is to be observed. Consideration is also being given to the construction of a transportable primary-standard barometer for additional improvement of the precision of realization of the temperature 100° C.

In the Metallurgy Division an investigation of the processes taking place during the fatigue of metals has been started, and in the study of intercrystalline fracture of ion alloys and certain copper alloys at low temperatures some remarkable results have been obtained. A comprehensive report was issued in October 1954 giving results of creep tests lasting up to ten thousand hours (more than a year) on steels to be used in the British Electricity Authority's new power stations. The Physics Division has co-operated in an international comparison of three resistance thermometers, constructed at the United States National Bureau of Standards, Washington, D.C., the Institute of Metrology, Leningrad, and the National Physical Laboratory, respectively, and its acoustics and sound measurement section has given assistance with a form of acoustical treatment designed by the Building Research Station for the stonework of the new Coventry Cathedral. The radiology section has constructed a new free-air ionization chamber for use with X-rays generated up to 300 keV. Features of the new chamber are that it is of the guarded-field type and that the air pressure and the potential of the case relative to that of the electrode system can be varied. The Mathematics Division has devoted most of its time to the solution of problems for industry and other government departments, using the pilot model of the automatic computing engine, and one of the largest problems tackled has been the analysis of stresses set up in the steam-catapult retardation structure in H.M.S. *Ark Royal*. An interesting development reported by the Ship Division is that tests were undertaken for the first time during the year on sailing yachts. Considerable assistance in other connexions has also been given by this Division to the Yacht Research Council.

Finally, the annual report, which is presented with an attractive cover and is illustrated, concludes with a report of the Test House and with a list of the senior staff of the Laboratory, arranged according to the various Divisions.

# EDUCATION IN ENGLAND AND WALES DURING 1954

THE report of the Ministry of Education on "Education in 1954"* gives statistics for primary and secondary education in England and Wales and for university awards and further education during the year; but the section on advanced technological education in technical colleges continues to display the confusion in which technological education still lies and which the institution of a new award recently announced by the Minister does nothing to remove. The number of children in the maintained schools increased by about 120,000 in 1954 and will continue to grow, but by decreasing amounts, until 1958. The number of children in the infant schools had already started to decline by the beginning of 1954; but the secondary schools will not receive their largest increase in numbers until 1958, and the peak will be reached at the end of 1960. The provision of additional places in secondary schools is well in hand: of some 210,000 new places brought into use during the year ended October 1, 1954, 75,000 were in secondary schools, while a further 200,000 places were under construction; and the building programme for 1954–55 is providing some 120,000 places in secondary schools out of a total of 187,000.

The number of teachers increased by 6,100 in 1953, and for 1954 the increase is estimated as more than seven thousand, while the entry of 11,768 students for two- or three-year courses at training colleges was the highest recorded. Generally, the staffing position tended to improve during the year; by 1961 at latest, nearly all primary-school classes should be reduced to the regulation size of forty pupils or less, and in the secondary schools over the same period it should be possible to maintain the present staffing standards, which are appreciably better than those of five years ago. The supply of graduate teachers of mathematics and science has continued to cause serious concern, quality rather than quantity being the deficiency in 1954; but difficulty is anticipated in recruiting even a sufficient number of these teachers to meet the growing needs of the secondary schools. Sir David Eccles, in his introduction to the report, refers to the action he has taken to see whether existing salary scales for such teachers engaged in more responsible or advanced work are adequate for their purpose and likely to lead to the needs of the schools being properly met, and also to the consultations with the universities, industry and other departments as to the possibility of restraint in the recruitment of graduate scientists. This approach has been deprecated by the Advisory Council on Scientific Policy in its subsequent report, but no other proposals are made for meeting the shortage, although area training organizations and colleges have considered the possibility of increasing the output of non-graduate teachers able to take some part in teaching science and mathematics, especially in secondary modern schools. The main difficulty has proved to be one of suitable candidates. The National Advisory Council on Education for Industry and Commerce was asked to examine the requirement for trained technical teachers, and on its advice the Minister decided to retain the technical training colleges in Bolton, Huddersfield and London.

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* Education in 1954: being the Report of the Ministry of Education and the Statistics of Public Education for England and Wales. Pp. viii+197. (Cmd. 9521.) (London: H.M.S.O., 1955.) 7*s.* 6*d.* net.

The National Advisory Council submitted revised proposals for a national award in advanced technology and has also paid particular attention to the development of sandwich courses, which it discussed with the Federation of British Industries. Although during the year another 113 advanced courses at technical colleges were approved for the special 75 per cent grant (making a total of 493) and the number of advanced short courses for scientific workers and technologists already employed in industry was practically doubled, it is clear that the confusion between technical and technological education persists; and that the proposal to develop ultimately some thirty technical colleges into advanced regional colleges carries grave risks of spreading available resources too thinly to be effective even if staff of the requisite calibre can be attracted. Building projects to the value of more than £7·5 million were completed during 1954 at further education establishments, out of a total £58,858,000 completed. The Minister announced at the end of the year an increase for 1955–56 of £2·5 million in the annual building programme for technical education, as well as the relaxation of certain restrictions on the type of course for which new technical college building can be approved. At the same time, he emphasized the need for continued economy in educational expenditure and for giving priority to certain selected projects if the new advances are to be made good and delay avoided in proceeding to further advances.

More than fourteen thousand students entered universities and university colleges in 1954 with financial assistance from public funds, and further progress is reported towards more uniform practice among local education authorities in standards of selection and in rates of grants. Thirty State scholarships were again offered for mature students, and, since these arrangements were instituted in 1947, 204 such scholarships have been awarded, mostly in English, economics and politics, but in recent years increasingly in natural sciences and mathematics. Referring to Colonial students, the report states that in 1954 the training colleges accepted 161 students from twenty different Colonial Territories and also found places for four students from the Sudan and twelve from Iraq and for seventeen Colombo Plan scholars. There is ample evidence that the experiment of training Colonial teachers in training colleges in Great Britain is proving a success: the students are well liked and hard working, and seem to enjoy the life and work of the colleges. Exchanges of teachers with Commonwealth countries and the United States only totalled eighty-eight (eighty-six in 1953), and only eleven went to European countries (nine to France, one to Germany and one to Austria).

The report also covers the Victoria and Albert Museum and the Science Museum, London, noting that completion by 1960–61 of the Centre Block of the Science Museum building will have accomplished the second of the three stages of development recommended by the Bell Committee in 1912. Issues in the Reading Room of the Science Library were 26,002, compared with 25,241 in 1953; requisitions for external loans rose from 94,772 to 101,683, and 176,960 photocopy sheets were issued compared with 157,894 in 1953. On the major issue of a science centre and the project for a national lending library of science and technology, the report is silent.

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# ELECTRON MICROSCOPIC OBSERVATIONS ON THE STRUCTURE OF THE SIEVE PLATES IN *CUCURBITA*

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THE movement of solutes through the phloem of plant stems has long been an object of intense study and has produced a voluminous literature. In spite of this, however, it cannot be claimed that any of the proposed mechanisms of transport are any more satisfactory now than they were when first suggested. The explanation is not far to seek. It is generally agreed that translocation occurs along the sieve tubes at rates which are enormously higher than could possibly obtain by diffusion alone. Whether these rates are achieved by convection (for example, mass flow) or by some kind of 'activated' diffusion (for example, movement at an interface) the major barrier to flow occurs in the sieve plate, and it has become very clear that further advances must await a thorough elucidation of the structure of this plate

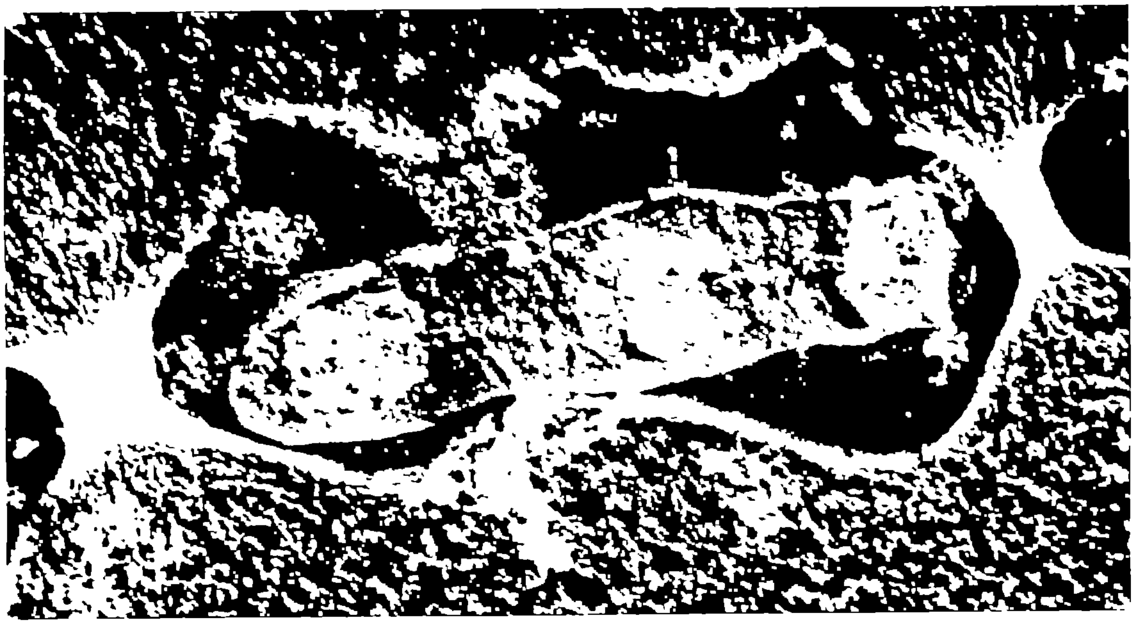

Fig. 1. Longitudinal section through sieve plate of young *Cucurbita* stem. Shadowed palladium-gold, magnification 18 700 ×. Note the two pores on either flank cut in almost median section; the position of a third pore, out of section, may be detected in the centre

and, in particular, the nature of the content of the sieve pores. This has been emphasized in a recent discussion of the structure of phloem in terms of its functions[1].

We have now completed a series of preliminary observations on the sieve plates of *Cucurbita* which we consider to represent a distinct advance of sufficient importance to be recorded at this time. Pieces of stem 4–5 in. long cut from young plants growing in a greenhouse were immersed for two hours in 0·3 *M* sucrose. This treatment was intended to reduce the turgor pressure in the sieve tube elements and hence to minimize slime plug formation, following the method of Currier, Esau and Cheadle[1]. Separate vascular bundles were then dissected from a central piece about 1 cm. long and fixed in a 1 per cent solution of osmic acid in a veronal-acetate buffer at *p*H 7·25. After washing in buffer solution for two hours they were imbedded in the usual way in a mixture of 10 parts butyl and 3 parts methyl methacrylate. Ultra-thin sections, both transverse and longitudinal, were cut on a Hodge-type microtome made in this laboratory. The methacrylate was removed by passing the sections through amyl alcohol and amyl acetate and the preparations shadowed with palladium-gold. These sections are all of sieve tubes which we presume to be functional.

The transverse sections of sieve plates are not presented since they are not of a quality to yield any new information. They do, however, substantiate as

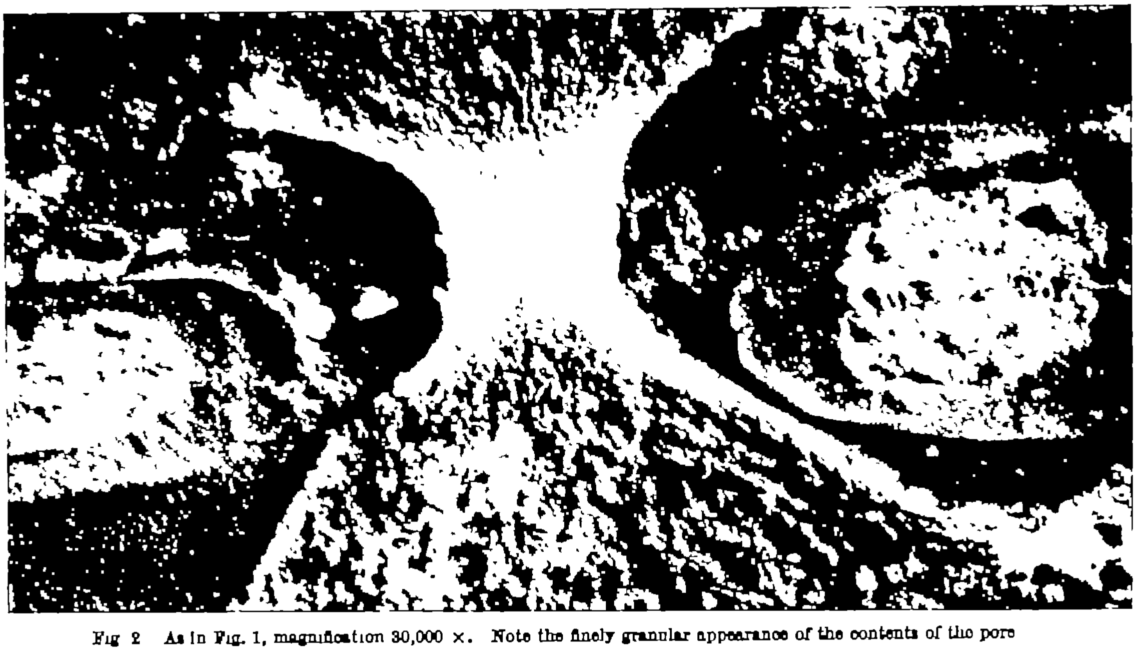

Fig 2 As in Fig. 1, magnification 30,000 ×. Note the finely granular appearance of the contents of the pore

fully as such sections can the diagrammatic representations made by Esau[2], namely, that the pores appear to be plugged with material confluent with what appears to be the cytoplasm of the sieve tubes. Representational longitudinal sections, however, which were much more successful and are in any event more likely to yield critical information, are illustrated in Figs. 1 and 2.

Examination of these photographs leads to several important conclusions:

(1) The cytoplasm is continuous from one sieve tube to the next through the sieve pores. The contents of the pores are withdrawn from the pore walls; but this is probably an artefact induced largely by the pretreatment with the sugar solution. It would seem that in Nature the pores are completely plugged. This at last confirms the suspicion voiced by various workers (for example, Crafts[3]) based on much less adequate observation under the light microscope.

(2) There is no continuity of vacuole across the sieve pores. Although the cytoplasmic strands have collapsed, this can scarcely have been due to collapse of a hollow tube, for in that case we would have expected to observe the vacuole opening out on each side of the pore into that of each of the contiguous elements.

(3) The wall of the sieve plate has itself an unexpectedly complex structure. We do not wish at the moment to comment further upon this.

(4) There appear to be few or no micro pores through the walls as large as 200–300 A. as postulated by Crafts[3] in a recent review. The shrinkage of the cytoplasm in the pores makes it difficult to assess the probable condition in untreated material, so that the size of any presumptive micro pores here remains an open question.

Space will not permit a complete analysis of these findings in terms of translocation mechanisms even if this would be profitable at this time. It may, however, be pointed out that even this preliminary work may reasonably be interpreted as demanding a new approach to the problem. The mass flow hypothesis of Münch[4] postulates a continuity of vacuoles from sieve element to element as part of the flow path. This is now demonstrably erroneous, and, in view of the fact that mass flow of the whole cytoplasm is difficult to conceive, the complete hypothesis as first formulated must fall. The attempts made by Crafts[3] to meet this eventuality, by assuming the existence of capillaries in the cytoplasm of the pores of the order of 200–300 A. wide, seems to be on no safer ground even if such pores could be shown adequate to cope with the solute movement. In any event, a simple calculation shows that, even assuming Poiseuille flow in such fine capillaries, the pressure gradient across the thickness of the sieve plate would need to be so high as to be inconceivable.

Similarly, the intervention of cytoplasmic streaming championed by Curtis[5] can scarcely be considered any longer feasible even on anatomical grounds alone. For unless the cytoplasm streams through the pores—demanding a complex and carefully regulated two-way flow which seems highly unlikely—the rate of movement would then be limited by diffusion through the pores. Most workers seem, moreover, to doubt that streaming occurs in mature functioning sieve tubes. Finally, the diffusion at an interface discussed by Van den Honert[6] meets with the difficulty that the only continuous interface available is a solid–liquid interface. Movement at such interfaces is known to be much too slow to account for the measured rates of solute transfer.

It could therefore be that the time has come to discard mechanisms which are fundamentally purely physical. A recent paper by Kursanov[7] emphasizes the probable role of metabolic factors in solute transport in phloem; we can only add that the apparent continuity of the cytoplasm suggests strongly that vital processes play a more important part than is sometimes assumed.

[1] Currier, H. B., Esau, K., and Cheadle, V. L., *Amer. J. Bot.*, **42**, 68 (1955).

[2] Esau, K., "Plant Anatomy" (John Wiley and Sons, 1953).

[3] Crafts, A. S., *Farad. Soc. Disc.*, No. 3, 153 (1948); *Bot. Rev.*, 17, 203 (1951).

[4] Münch, E., "Die Stoffbewegungen in der Pflanze" (1930). See also Crafts, ref. 3, p. 234.

[5] Curtis, O. F., "The Translocation of Solutes in Plants" (1935). Curtis, O. F., and Clark, D. G., "Introduction to Plant Physiology".

[6] Van den Honert, T. H., *Proc. Kon. Akad. Wet. Amsterdam*, **35**, 1104 (1932).

[7] Kursanov, A. L., *Botanicheskii Zhurnal*, **37**, 585 (1952) (in Russian).

# SPECIFICITY IN CHEMICAL AND ENZYMATIC OXIDATIONS OF GLUCOSE ANOMERS

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THE chemical oxidations of glucose[1,2] and methyl glucosides[3] to gluconic acid are often more rapid with the β- than with the α-anomers. The reagent most extensively studied is bromine in solutions buffered at about $pH$ 5·4[4]. Under these conditions, the pyranose ring is converted first to δ-gluconolactone in high yield. Gluconic acid is then formed by slow hydrolysis of the lactone. The ratio of the rates of oxidation at 0° is $\beta : \alpha = 39{\cdot}2$, and similar increased reactivities are found for the β-forms of a number of pentoses, hexoses and disaccharides[2].

Elucidation of the mechanism of these reactions should have an important bearing on the biochemical oxidations of glucose, for which an even higher order of specificity exists. In one such enzymatic oxidation, using notatin (glucose aerodehydrogenase), it was shown that, like the chemical reaction with bromine, the initial product is δ-gluconolactone; further, the reaction is more rapid with β-glucose[5]. It has now been demonstrated unequivocally that the specific substrate of notatin is β-D-glucopyranose[6]; α-D-glucose is oxidized at about the rate of other sugars and the ratio of rates in this case is the highest yet observed ($\beta : \alpha = 156$). An analogous case is that of the glucose dehydrogenase isolated from ox liver, which is also specific for β-D-glucose[7]. Glucose

-phosphate dehydrogenase similarly produces 6-phoshogluconolactone from the Robison ester[8]; the ynthesis of this ester by catalytic saponification of : 2 : 3 : 4 - tetraacetyl - β - D - glucose 6 - phosphate[9] trongly suggests that in this case, too, the enzyme s specific for the β-anomer.

In this communication, an attempt will be made to interpret these chemical and enzymatic specificities in terms of a conformational analysis similar to that developed in the case of *cyclo*hexane and other alicyclic compounds. Such an analysis indicates that the hydroxyl group on carbon atom 1 of α-glucose is in a sterically hindered position, and that reactions directly implicating the hydroxyl group will take place more readily with β-glucose. Mechanisms for the chemical and biochemical oxidations will be discussed in the light of stereochemical considerations.

## Conformation of Glucose

Although the possibility of strainless 'chair' and 'boat' forms of the pyranose ring was recognized by Haworth[10], glucose is usually represented in the Haworth perspective formula as a (strained) planar structure, the substituents being considered as above or below the plane of the ring. In 1947, Hassel and Ottar[11] discussed the structure of molecules containing *cyclo*hexane or pyranose rings and stated that: "All experimental evidence indicates that the six-membered pyranose ring found in many sugars will generally have the staggered form corresponding to the symmetrical *cyclo*hexane ring", that is, to the 'chair' form. The possible conformations for pyranoses were considered in detail by Reeves[12], who concluded that in the case of D-glucose the most stable conformation was that indicated as C1 in Fig. 1. The alternative 1C structure (which is derived from C1 by ring conversion[13]) contains more 'instability factors'. Hassel and Ottar further pointed out that if the pyranoses existed in such 'chair' forms, the substituents would occupy either the axial (*a*) or equatorial (*e*) position as in the case of the *cyclo*hexane derivatives (in this communication, the recently recommended nomenclature of Barton *et al.* will be used[14]).

These considerations have been borne out in detail by X-ray analysis of the crystal and molecular structure of α-D-glucose[15]. The pyranose ring is found to be six-membered in the 'chair' conformation and with the predicted *cis*-glycol grouping on carbon atoms 1 and 2. Although this proof of the 'chair' conformation (C1) is conclusive only for the solid state, this most stable conformation almost certainly persists in solution, as the work of Reeves indicates[12]. More accurate representations for the glucose anomers therefore are the formulæ (I) and (II) for α- and β-glucose respectively (Fig. 2). In α-glucose, the hydroxyl on carbon atom 1 is in an axial position, all the other hydroxyls and the primary alcohol group being equatorial. In β-glucose, all the hydroxyls and the primary alcohol group are equatorial. Differences in the infra-red spectra of α- and β-anomers have recently been observed and related to the fact that the hydrogen atom in the α-anomer is in the equatorial position[16].

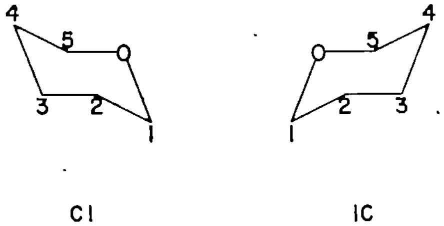
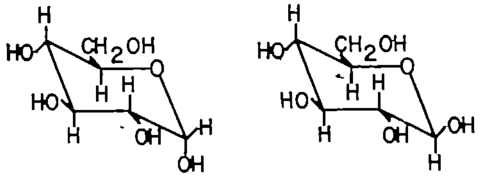


Fig. 1. Chair conformations of the pyranose ring. (These conformations have been redrawn from those of Reeves (ref. 12) so that the position of the oxygen atom in C1 corresponds with that in the conventional Haworth formulæ



(I) (II)

Fig. 2. Conformations of α-glucose (I) and β-glucose (II)

## Reactivity of Axial and Equatorial Groups in Glucose

It was pointed out by Barton[17] that, because of their more crowded nature, axial groups in alicyclic compounds would tend to be hindered in their chemical reactions. (Examples of compounds sterically hindered in this way have been summarized recently by Klyne[18].) By analogy, therefore, the axial hydroxyl group at carbon atom 1 in α-glucose would be expected to be less reactive than the corresponding equatorial hydroxyl group in β-glucose. This greater reactivity of β-glucose should also extend to compounds in which the hydroxyl group is substituted. There is, indeed, much evidence to show that derivatives of β-glucose are the more reactive, and the following examples are cited in support of this contention.

(*a*) Acid hydrolysis of β-methyl-D-glucopyranoside is almost twice as rapid as that of the α-glucoside[19]. For most glycosides a similar increased rate of hydrolysis of the β-anomers is observed (for examples, see Pigman and Goepp[20]). A notable exception to this generalization is the case of the methyl-D-gulopyranosides, where the α-anomer is more readily hydrolysed. A possible explanation is the anticipated[12] conformational instability of the C1 structure for D-gulose; in the 1C alternative, the α-hydroxyl on carbon atom 1 would be equatorial.

(*b*) The reductive cleavage of β-benzyl-D-glucopyranoside tetraacetate to 2 : 3 : 4 : 6-tetraacetyl-β-D-glucopyranose takes place rapidly and smoothly in dry ether with a palladium catalyst[21]. The corresponding α-derivative is cleaved with difficulty and only incompletely. Similarly with the benzyl-D-xylopyranoside triacetates, the reaction is more rapid with the β-anomer. Since D-xylopyranose has the C1 conformation, this is comparable to the case of D-glucose. With benzyl-D-arabinopyranoside triacetates, the reverse ratio (α > β) was observed. This is in harmony with the postulated 1C conformation for D-arabinose[12], where the α-hydroxyl would be equatorial. Unfortunately, comparable data for the α- and β-benzyl-L-arabinopyranoside triacetates (where the conformation is C1 and where the cleavage of the β-compound should be the more rapid) were not recorded.

(*c*) Only phenyl-β-glucoside reacts with aqueous alkali to form 1 : 6-anhydroglucose; after two weeks boiling of the α-form with 2·6 *N* potassium hydroxide, there was no rotational change, and 85 per cent of the starting material was recovered in crystalline form[22]. Since this reaction is believed to require the formation of a 1 : 2-anhydride[23], the reaction would take place more readily with the di-equatorial (β) than with the axial-equatorial anomer (α).

(*d*) Differences in stability of the pentaacetyl-D-glucopyranoses[24] also point to the hindered nature of the α-acetoxy group. Thus the reaction of the β-anomer with titanium tetrachloride is very fast, producing (initially) tetraacetyl-β-D-glucopyranosyl chloride. The α-anomer, on the other hand, is very stable under these conditions.

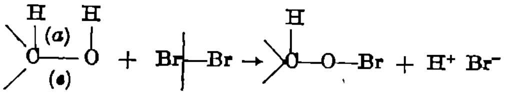
## Mechanism of Chemical Oxidation of β-Glucose with Bromine

Although, therefore, in the reactions of the type $—OH \rightarrow —OR$ or $—OR \rightarrow —OH$, *cyclo*hexane and glucopyranose compounds react most readily when the reagent attacks an equatorial substituent, an apparent exception to this generalization exists in some oxidations of the type $=CHOH \rightarrow =CO$. Barton pointed out[17] that the oxidation of some *cyclo*hexanols (to *cyclo*hexanones) with chromic acid in acetic acid solution takes place more readily at an axial than at an equatorial group ; similar differences occur with N-bromosuccinimide in the steroid field. This exception to the general rule that equatorial groups react the more readily was resolved by Barton's suggestion[17] that in these oxidations the rate-determining step was still an attack on an equatorial substituent, that is, on hydrogen. In other words, the rate-determining step did not involve the hindered axial hydroxyl group. This suggestion has received elegant confirmation from the studies of chromic acid oxidations by Westheimer *et al.*[18]. These studies show that the mechanism of such chromic acid oxidations does involve attack on the hydrogen atom as the rate-determining step.

It is apparent that for a given reaction with a pair of anomers the ratio of rates will be determined by two factors : (*a*) the actual reaction mechanism will determine which of the substituents is subject to the rate-determining attack ; (*b*) the overall reaction will be the more rapid when the substituent subject to the rate-determining attack is equatorial.

Turning now to the case of glucose oxidation by bromine, it is suggested that the reaction mechanism of this oxidation involves, as a rate-determining step, a direct reaction at the hydroxyl group. This seems most likely in view of the electrophilic nature of bromine. Since the hydroxyl at carbon atom 1 in β-D-glucose is equatorial, this group should therefore be more reactive in such a reaction than the corresponding (axial) hydroxyl of α-glucose.

Although in the reactions of sugars and halogens it is usually difficult to specify the precise nature of the substrate or oxidant, it has been shown that in the bromine reaction (which with β-glucose is rapid even at 0° and gives almost theoretical yields of the lactone) free bromine is the actual oxidant[8]. Isbell and Pigman suggested that the oxidation took place through an addition product between the ring oxygen atom and bromine[8]. Only in β-glucose was further reaction possible because of the favourable steric situation. Whether or not this addition occurs, it is now suggested that the electrophilic reagent (bromine) will make an initial attack on the equatorial hydroxyl group leading to the hypobromite intermediate (III). If this is the rate-determining step, the rate should be diminished by acid, in harmony with the observed facts.

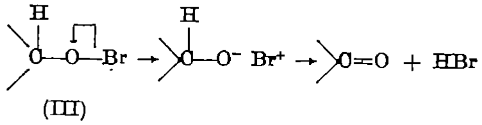


(III)

Considerable evidence substantiating a hypobromite intermediate such as (III) is found in the known reactions of the simple aliphatic hypohalites. Primary and secondary hypohalites are very unstable, particularly to light[26] ; although it has more recently been stated that, in the complete absence of traces of acid, ethyl hypochlorite is stable for several hours[27]. On spontaneous decomposition, primary hypohalites yield aldehydes, secondary hypohalites yield ketones, and the more stable tertiary hypohalites yield a ketone and an alkyl chloride according to the following equations[28] :

$$\begin{aligned} &RCH_2OCl \rightarrow RCHO + HCl \\ &R_2CHOCl \rightarrow R_2CO + HCl \\ &R_3COCl \rightarrow R_2CO + RCl \end{aligned}$$

Similar studies led to the conclusion that secondary hypohalites are the least stable[26]. Although alkyl hypobromites are less well known, methyl and ethyl hypobromites can be prepared, at least in solution[29]. It seems reasonable, therefore, to postulate (III) as an intermediate and to make the further assumption that it decomposes rapidly to form the $=CO$ group of the lactone in the same way as do the secondary hypohalites. Since oxygen is more electronegative than bromine, the reaction is written as below ; that is, as a transfer of a hydride ion to a brominium ion. Such a transfer is very similar to that proposed by Hammett for the mechanism of the Cannizzaro reaction[30].



(III)

In one case a slightly increased reactivity of α-glucose to an oxidizing agent, chlorous acid, has been observed[31]. This reaction is certainly more complicated than that with bromine, as indicated by the approximate stoichiometric relationship :

$$RCHO + 3HClO_2 \rightarrow RCOOH + HCl + 2ClO_2 + H_2O$$

Additionally, some cleavage of the carbon chain occurs with formation of oxalic acid. Owing to unfavourable experimental conditions, it was not possible to prove or disprove whether δ-gluconolactone was an intermediate product. It is tentatively suggested that, in this chlorous acid oxidation, the molecular species involved is the free aldehyde (or aldehyde hydrate) form of glucose. Although the results of Jeanes and Isbell[31] are insufficient for precise kinetic calculations, it can be estimated that for the initial period the ratio of oxidation-rates (α : β) is about 2. This is of the same order as the observed ratio of rates of mutarotation ($k_\alpha : k_\beta = 1{\cdot}883$)[8], a process which probably does involve the free aldehyde form. The slightly more rapid oxidation of α-glucose is therefore a result of the more rapid opening of the ring which occurs with this anomer.

Marked differences of rates in favour of β-glucose occur in the oxidation with sodium hypoiodite in alkaline solution[1b] (β : α = 25). It is believed that similar considerations to those outlined above in connexion with the bromine oxidation will also apply in this case.

## Mechanism of Enzymatic Oxidation of β-Glucose

It was originally concluded by Bentley and Neuberger[5] that the initial step in the notatin reaction was removal from glucopyranose either of a proton and an electron, or alternatively a hydride ion. In the absence of definite information, these reactions were written so that the hydrogen atom removed first was that attached to carbon. If the arguments developed here are correct, it will be more likely that the initial point of attack by the enzyme is the equatorial hydroxyl group. It is suggested that this attack is developed through an electrophilic site on the enzyme surface (indicated as *X* in Fig. 3), leading to the removal of a proton and the formation of an enzyme-substrate intermediate (IV). This intermediate is analogous to that (III) postulated in the bromine oxidation. The final steps are now very much the same as those originally suggested, that is, transfer of a hydride ion from the intermediate (IV) either directly to the prosthetic group, flavin adenine dinucleotide (FAD), or possibly first to some other reactive site on the enzyme surface. The overall result is thus the transfer of the proton removed initially and the hydride ion to flavin adenine dinucleotide. Although this has been discussed in terms of an ionic mechanism, as originally pointed out[5] it could equally well be represented as a radical mechanism. The only essential difference between the mechanism now proposed and that originally suggested is that the initial point of attack is now believed to be the equatorial hydroxyl group.

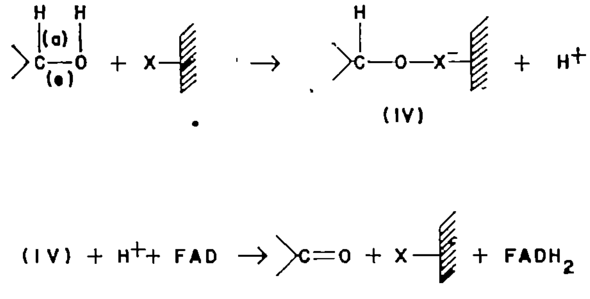


Fig. 3. Mechanism of oxidation of β-glucose with notatin. (*X* is a postulated electrophilic site on the surface of the enzyme)

The biochemical oxidation =CHOH → =CO has also been extensively studied in the inositol series, both with bacterial suspensions (*Acetobacter suboxydans*, *Aerobacter aerogenes*[31,32]) and with cell-free enzyme preparations[33]. The specific stereochemical requirements for these oxidations are that the group being oxidized must be an axial group, and that the carbon atom *meta* to this group must carry an equatorial hydroxyl. These oxidation mechanisms, therefore, are different from those operating in the case of glucose, but closely resemble the chromic acid oxidations discussed earlier; it seems most probable that they involve attack by the enzyme on the equatorial carbon–hydrogen bond as the rate-determining step. Mechanisms analogous to that proposed for the chemical oxidations[25] can readily be envisaged for these enzymatic reactions.

## Conclusion

The observed differences in the rates of oxidation of the glucose anomers are believed to be explained on the basis that: (*a*) the reaction mechanism necessitates a rate-determining attack on a hydroxyl group; and (*b*) that in α-D-glucose the axial hydroxyl is sterically hindered.

It seems likely that similar principles will be helpful in many other branches of carbohydrate chemistry and in the interpretation of some aspects of enzyme specificity. It is perhaps significant that an enzyme (mutarotase) which catalyses the interconversion of α- and β-glucose has recently been described in some notatin preparations[34] and in animal tissues[35].

[March 21

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## LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

### Experiments on the Complete Suppression of Stammering

We have been conducting simple physical experiments upon people severely handicapped by various forms of stammering or stuttering, and have obtained results of surprising generality. Under certain conditions of external control, these people may be induced to speak fluently at normal speeds, and with no difficulty. The experiments clearly illustrate the fact that stammering (at least of all the varied classes examined) is caused, not by motor, but by perceptual faults.

The twenty-five volunteer subjects (all adult) of this preliminary series were introduced through speech-therapy clinics and exhibited various degrees of speech difficulty. In several cases tonic spasms up to a minute in duration were observed. In all cases, speaking was interrupted by hesitations, repetitions or silent periods. Various objective measures of the degree of speech difficulty have been adopted (for example, time to read a standard text; number of speech breakdowns; sum of durations of the gaps, hesitations and repetitions in utterance). These objective measures enabled us to estimate the improvement during external control.

External control has been exercised by interfering with the complex of monitoring and control processes associated with speaking. Two methods have been employed. In the first, a very loud tone was applied through headphones to the ears of the subject, preventing his perception of the voice sounds which he produced. A frequency of about 150 cycles per second was found most effective. The subject was required to read aloud from a simple text of about 120 words; the results are illustrated by Fig. 1. In this figure, (*a*) shows the duration of repetitions, hesitations and gaps in the speech of these subjects, summed over the period of the test, before the tone is applied; (*b*) shows the same observations when the tone was applied. In both cases, the results have been presented in sequence of subjects, rearranged along the horizontal axis in order of their usual degree of speech difficulty.

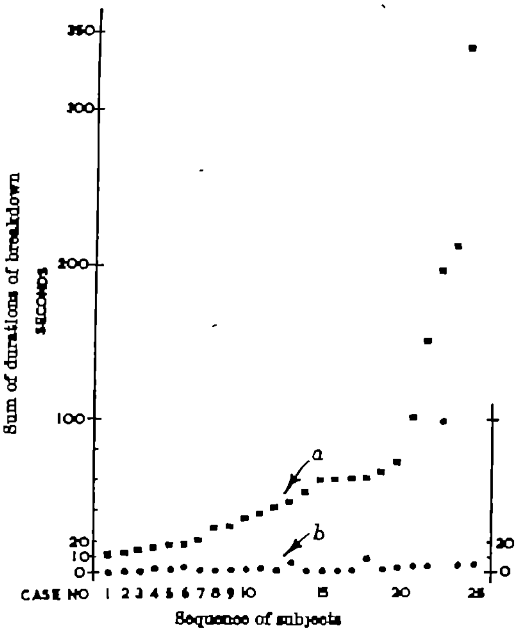

Fig. 1. Total duration of all hesitations, repetitions and silent intervals in the speech of stammerers reading a 120-word test: (*a*) usual performance; (*b*) with applied tone

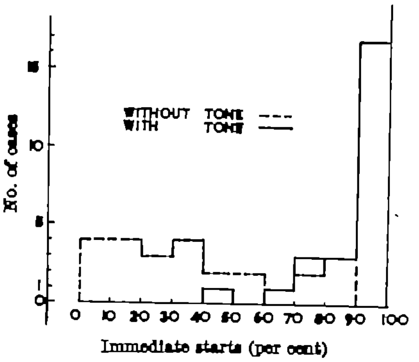

Fig. 2. Histogram showing distribution of cases according to ability to make immediate starts in utterance, both without and with applied tone

In twenty-four cases out of twenty-five, the improvement was remarkable. The exception was the only individual who normally worked in surroundings with a high ambient noise-level.

We also measured the ability of each subject to make an immediate start in utterance, each time a new starting point was indicated, by pointing to a new part of the text. Successive points were indicated randomly and in rapid sequence. We found that when the tone was applied, hesitation was markedly reduced in every case (Fig. 2).

Since aural voice-feedback for speech monitoring is mediated mainly through air and bone conduction, it seemed of interest to verify their relative influences on stammering. Blocking the air-conduction pathway only (as by stopping the ears) did not consistently alter the speech habits of stammerers; on the other hand, if both pathways were blocked (as we have shown with the above technique) stammering virtually ceases.

The second method of interference with the monitoring processes does not involve reading. The subject 'shadows' an unseen message read by the operator steadily and continuously. 'Shadowing' means repeating concurrently. In this situation, the subject did not see the text, and was obliged to concentrate on the message. It is known that such 'shadowing' presents no difficulty to people of normal speech habits[1]. It now seems that stammerers also find little difficulty and can be induced to 'shadow' fluently when reassured, even without practice.

Both normally fluent speech and stammering are believed to be habit-forming for the speaker, and on this basis the shadowing technique has been used by one of us as a form of clinical treatment for stammering. The patients were taught to copy intonation and rhythm while 'shadowing', and to work at steadily increasing speeds.

In five severe cases of stammering, this method has produced a striking improvement in a period of two to four weeks; this improvement has been maintained in all cases to date; no negative results have so far been obtained.

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[1] Cherry, C., *J. Acoust. Soc. Amer.*, 25, 975 (1953).

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# The Four Possible Waves in Ionized Gas in a Magnetic Field

According to the magneto-ionic theory of Appleton[1] and others, two distinct radio waves may be propagated through ionized gas permeated by a magnetic field. More recently, three hydromagnetic waves have been found for the same medium[2,3]. A 'plasma' or electron sound wave has long been known, but only investigated for the relatively simple cases of zero magnetic field[4,5] or propagation across the magnetic field[6]. Finally, sound waves must be capable of propagation in the magneto-ionic medium. These numerous waves have been discovered from diverse approaches, and the connexion between them, if any, is not clear.

All waves in the magneto-ionic medium comprise electromagnetic fields associated with oscillations of the electrons and heavy ions. They should all be disclosed by solving the field equations together with suitable momentum transfer equations. The resulting dispersion equation for fully ionized gas is found to be of the fourth degree, indicating four, and only four, possible waves. In more complex gas mixtures other modes appear, but these may be regarded as oscillations of the ion gas within the neutral gas, together with forced oscillations of the latter. Other additional waves which seem to exist when drift motions are present[7] are not real[8], but may result from motion of the observer relative to any irregularities fixed in the gas. Since only four different wave types occur, some of the waves mentioned above must be identical.

At 'low' frequencies (where heavy-ion motion is important) the 'ordinary' and 'extraordinary' hydromagnetic waves have been found and discussed[9]. Their magnetic and electric vectors are elliptically polarized, tending to circular and plane for propagation along or perpendicular to the steady magnetic field. As the frequency rises, these waves retain their identity, although the refractive index of the medium is not necessarily always a real quantity. At 'high' frequencies (when heavy-ion motion is unimportant) they have, as simple limiting cases, the radio ordinary and extraordinary waves of Appleton's theory.

A third wave may occur at low frequencies which we call the 'magnetic-sound' wave. It is almost plane polarized, with the gas velocity vector lying between the wave normal and the magnetic field. A limiting case is a nearly pure sound wave along the magnetic field; its field is an electric potential only. As would be expected, the magnetic-sound wave is not disclosed when gas pressure is neglected (as by Åström[9]).

The fourth wave is important at high frequencies; it is analogous to the magnetic-sound wave and might be termed a 'magnetic-plasma' wave. Like the magnetic-sound wave, it has a simple limiting case in the well-known plasma waves propagated along the magnetic field[6]. The general case of the magnetic-plasma wave (like the magnetic-sound wave) is far more complicated than the special case. It has a full electromagnetic field and a Poynting flux. It does not appear in the usual magneto-ionic theory because electron gas pressure is neglected, an approximation which usually has a small effect on the ordinary and extraordinary waves but annihilates the magnetic-plasma wave.

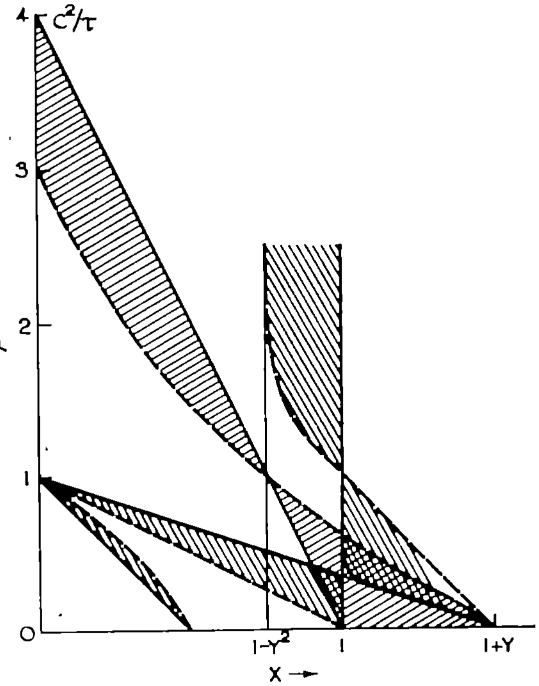

Fig. 1. Refractive indices of the ordinary, extraordinary and magnetic-plasma waves. Ordinary and extraordinary waves, ▨; magnetic plasma waves, ▩

Further study of magnetic-plasma waves is important, particularly in regard to the part they may play in the origin of intense solar radio emission. The microscopic approach used by Gross[6] leads to excessive mathematical difficulties in the general case, as well as some very surprising results in the special case he investigated. The use of transport equations may introduce some inaccuracies but permits a general survey of the wave properties to be made with relative ease. A preliminary investigation has been completed.

Vital properties of the ordinary and extraordinary radio waves were demonstrated graphically by Ratcliffe[10], whose plot is shown in Fig. 1. Here $\mu$ is the refractive index of the medium and $X$ and $Y$ the ratios of the 'plasma' frequency and gyro-frequency to the wave-frequency; $c$ is the velocity of light and $\tau$ is one-third the mean square random velocity of electrons. Full and dashed lines correspond to propagation along and across the magnetic field; the cross-hatched areas between correspond to the full range of oblique propagation. The graph allows wave velocities and reflexion points (in a variable medium) to be estimated. The corresponding plot for the magnetic-plasma wave is shown and seen to overlap that of both ordinary and extraordinary waves. Thus, under suitable conditions the ordinary (or extraordinary) and magnetic-plasma waves having the same frequency and direction of propagation have identical velocities and so will tend to travel as a composite wave.

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Sydney. June 23.

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## Anomalies in the Cosmic-Ray Shower Curves for Lead

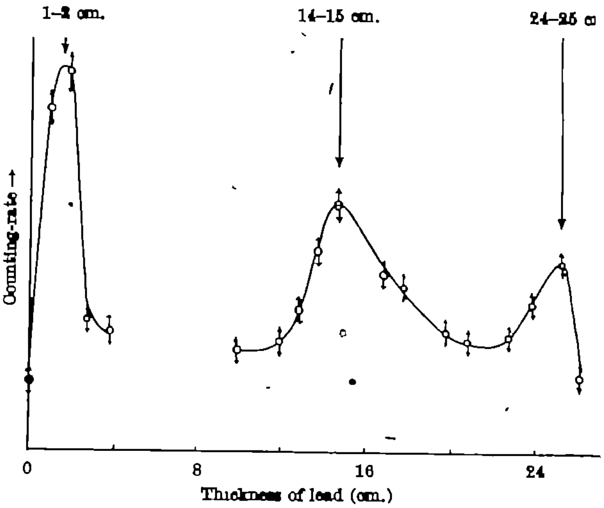
SHOWER curves have been investigated by a number of workers. The first maximum at a thickness of 1–2 cm. of lead is well established and has been satisfactorily explained. The existence of second and third maxima in the shower curve at greater thickness of lead has, however, been a matter of controversy.

Clay and Scheen[1] have found a second maximum in gold, mercury and lead; they used three-fold coincidences. Its appearance with four- and five-fold coincidences was, however, not equally well pronounced in their experiments. Clay and Klein[2] have confirmed the existence of the second maximum in tin as well, using three-fold coincidences. They, however, do not find any trace of the third maximum, as observed by Swan and Ramsey[3]. Nielsen, Morgan and Morgan[4], using four- and five-fold coincidences, give no convincing proof of the existence of the second maximum.

The second maximum has been explained by Clay and Scheen by assuming that a cosmic ray meson produces a high-energy knock-on electron in lead and the two particles account for three-fold coincidences. A four-fold coincidence will only occur if another electron is produced in the absorbing material either by a knock-on electron, by cascade processes or by the primary meson itself. They believe that this theory explains the divergent results of different workers about the second maximum.

Experiments have been carried out here using three-fold and four-fold coincidences. Our experimental arrangement is similar to that used by Clay and Scheen. The top tray consists of seven counters each 2·5 cm. in diameter and 35 cm. long placed in parallel immediately below the lead layer. The distance between the top and bottom trays was about 17 cm. The second maximum is found to occur at a thickness of 14–15 cm. of lead, and it is pronounced in all the curves obtained by an amount greater than the standard deviations. There is also a third maximum at a thickness of 24–25 cm. of lead. This occurs in all the experiments, though it is never as clear as the second maximum.

There was an indication that the second and third maxima were situated at greater thickness with four-fold than with three-fold coincidences. We have tried five-fold coincidences as well, but have not been able to detect any shift in the position of the second and third maxima obtained with the four-fold coincidences. The thickness of the lead layer was changed in steps of 1 cm. in these experiments.



The experiments were carried out under a concrete roof about one foot thick, at Lahore, lat. 31° 33′ N.

Fig. 1 gives a typical curve showing the first, second and third maxima in lead obtained by us using four-fold coincidences. We thank Mr. Taseer for drawing the figure.

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## Minor Oscillations of Magnetographs

AT the Alibag Magnetic Observatory, two sets of photographic magnetographs have been in use for several years past. The magnetograph room is an insulated cubicle with double walls, double roof and double basement. A working floor or basement of flagstones is supported by trusses several feet above the ground. Isolated pillars with circular guard air-spaces come up through the insulating layers and the working floor of flagstones right from the ground. The Watson magnetographs (horizontal force, *H*; declination, *D*; and vertical force, *V*) and their recorders have rested on these isolated pillars since 1903–4. The La Cour magnetographs and their recorders are on pillars erected only above the working floor, with no rigid connexion to the ground below. The *D* instrument has been in use since 1936 and the *H* and *V* instruments have been in use since 1946.

The Watson and La Cour magnetographs for *H* and *V* have nearly the same order of magnification and are equally sensitive; but the La Cour *D* instrument is more sensitive than the Watson *D* magnetograph.

A thunderstorm passed over Alibag on June 2, 1955, between 1530 and 1900 hr. I.S.T. While the wind speed did not exceed at any time 25–30 m.p.h., the thunderclaps were very loud and persistent over

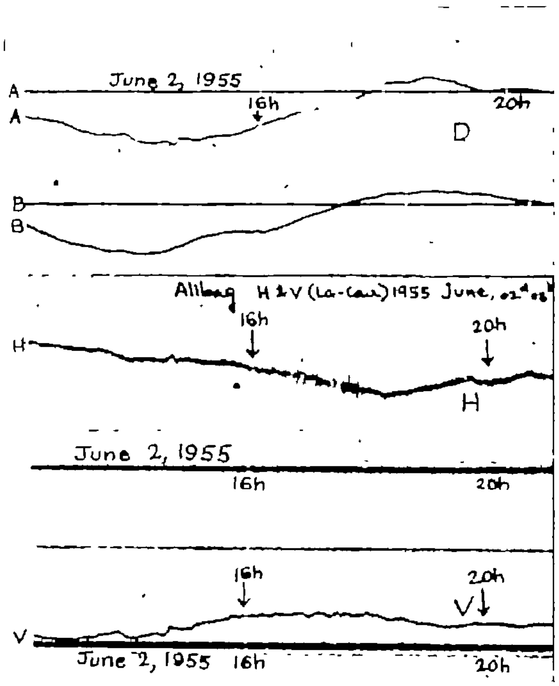

Fig. 1. La Cour magnetograms (*D*, *H* and *V*) during a thunderstorm on June 2, 1955, between 1630 hr and 1900 hr. I.S.T. *A*, June 02d. 08h. 52m. → ; *B*, June 03d. 18h. 41m. →

and near the Observatory. Between 1630 and 1800 hr. I.S.T., the La Cour *H* magnetograph shows (Fig. 1) a large number of oscillations with displacements amounting on either side to 80γ. The La Cour *D* (trace slightly fainter) also shows considerable disturbance at the same time. The *V* trace is not much affected. However, the Watson magnetographs show no disturbance. The La Cour *H* and *D* magnetographs have magnets suspended by fine quartz fibres whereas the magnet of the La Cour *V* has a knife-edge support.

It would be interesting to know if other observatories have recorded similar oscillations, and, if so, the mode of mounting their magnetographs. Ramanathan[1] has discussed the effect at Alibag of lightning discharges on a magnetometer. Records with La Cour *H* and *V* magnetographs had not commenced at that time.

We thank Mr. M. Panduranga Rao for assistance.

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## Double-Illumination Microscopy

When an unstained preparation is viewed through the microscope by transmitted light (substage), light parts of it may appear black for one of two reasons: either they absorb much light or they reflect much light back towards the light-source. In the latter case, 'black' parts can be lit by incidental (suprastage) light; if the transmitted and incident lights differ in colour, then these parts will be clearly seen against a contrasting background with a marked three-dimensional effect. The reflected light is best supplied through a bullseye (or equivalent) condenser from a standard tubular lamp-house. This arrangement concentrates the reflected light beneath the microscope objective sufficiently strongly to balance the light coming through the substage condenser.

Red (magenta) and green (or blue-green) light filters appear to give the best contrast. For most purposes the transmitted light should be green, the reflected light red. If this arrangement of colours be reversed, there is a reversal of emphasis on the parts of the section presented to the eye. Thus 'normal' illumination of a ground section of bone will emphasize the corpuscle spaces and canaliculi of the Haversian systems; 'reversed' illumination will emphasize the bony matrix and its trabecular form.

This 'double-illumination' is as useful with high powers as with low, and is helpful in teaching. Full technical details will be published elsewhere [see *Irish Journal of Medical Science*, October 1955].

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June 24.

## Interference to the Ultra-Violet Spectrophotometry of Barbiturates

The quantitative analysis of barbiturates in body fluids is now generally carried out by ultra-violet spectrophotometry[1]. The difference in absorption at 240 mμ in 0·5 *N* ammonium hydroxide and in acid gives an accurate measure of the quantity of barbiturate.

Work so far published suggests that this is a reliable technique, as very few interfering substances have been noted. It is possible, however, that certain coumarin anticoagulants or other drugs might interfere, and readings over a wide range of frequencies are therefore taken. During the past three months in this laboratory, an interfering substance that possibly occurs naturally has been found in four livers from various cases of sudden death and in one sample of urine submitted from a drunken person who, it was suspected, might have also taken barbiturate.

The compound has been found to be soluble in ether and phenolic in character, and is therefore extracted together with the barbiturates. The method of extraction used was substantially that of Valov[2].

The similarity of its ultra-violet absorption curve with that of barbiturates in 0·5 *N* ammonia and acid (see Fig. 1) indicates that, if this substance is present, it seriously interferes with quantitative analysis of barbiturate by ultra-violet spectrophotometry. The quantities of this compound present in the liver samples have been such as to suggest barbiturate concentrations of 1–4 mgm. per 100 gm. While work is proceeding on the isolation and identification of this compound, it is felt that its presence should be reported immediately in view of the widespread use of the method. In this laboratory the ultra-violet absorption analysis of the barbiturate fraction from viscera is followed by paper chromatography in an *n*-butanol / 5 *N* ammonia solvent system[3]. In this system the unknown compound runs at $R_F$ 0·95,

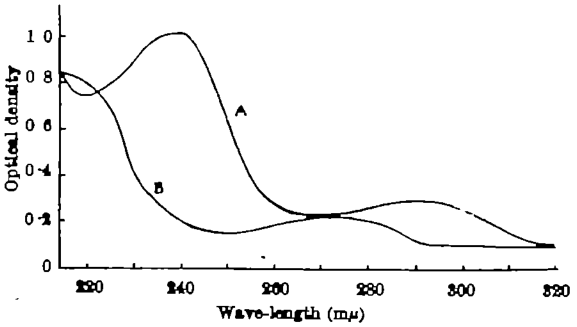

Fig. 1. Curve *A*, in 0 5 *N* ammonium hydroxide; curve *B*, in 0 1 *N* sulphuric acid

thus separating it from all the barbiturates. It also fluoresces blue in ultra-violet light. It does not react with the mercuric sulphate / diphenylcarbazone reagent[3] for barbiturates, but with ferric chloride/ ferricyanide[4] gives a blue spot.

A routine check of the ultra-violet ratio of optical densities at 265 mμ and 290 mμ, coupled with examination of the paper chromatogram under ultra-violet light, followed by elution of the fraction of $R_F$ 0·95 with $N/10$ sodium hydroxide, in which its spectrum is the same as in $0·5\,N$ ammonium hydroxide, as distinct from barbiturates, will show its presence. If this unknown compound is present, quantitative analysis of the barbiturate must be carried out by ultra-violet spectrophotometry after separation of an aliquot of the extract from the interfering substance on a paper chromatogram.

The reason for suspecting that these observations may be linked with a natural compound, possibly of seasonal origin, is not only the variety of cases in which it has been observed, but also the fact that in one case a compound having extremely similar ultra-violet absorption characteristics was isolated from the contents of a stomach. In this case the material was treated with acid ammonium sulphate[5], and the aqueous filtrate was then extracted first with ether, and, after making alkaline with ammonia, again with ether and finally with chloroform. Only in this last chloroform extract was the chromophoric group found. From the liver of this same person there was isolated from the 'phenolic' ether-soluble fraction a compound with the similar ultra-violet chromophore. This, coupled with the previous fact, suggests the substances may be metabolically related. Work is proceeding on the identification of both these compounds.

I thank Dr. F. G. Tryhorn, director of this Laboratory, for advice and for permission to publish this communication.

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## Electrical Effects associated with the Mechanical Deformation of Single Crystal of Alkali Halides

IT has been reported[1] that when single crystals o natural rocksalt are plastically deformed, there is temporary increase in their ionic conductivity. Th increased conductivity appears to decay exponentiall with a time constant of the order of 1 min. The effec has also been reported[2] for synthetic crystals o potassium chloride and bromide, both pure an coloured by the presence of *F*-centres. In this cas the time constant of decay was of the order of 0·5 sec Experiments have been carried out here during th past three years to investigate this effect further using synthetic crystals of various alkali halides[3] The crystals were either grown from the melt usin the Kyropoulos technique or obtained from othe sources.

The measurements were carried out on specimen about 1 cm. × 1 cm. × 0·5 cm. in size cleaved from the crystals. The larger opposite faces were roughened with emery paper, and colloidal graphite was painted on to serve as an electrode, although other electrode materials were investigated. The specimens were placed between two parallel brass disks and a known constant stress was applied. This stress was increased in steps up to a maximum of approximately 200 kgm./cm.². The conductivity was also measured at the same time by means of a sensitive electrometer valve and d.c. amplifier. The ionic conductivity of the specimen was presented as a deflexion on the screen of a cathode-ray oscilloscope, and any change with time could be observed or photographed.

An increase in the conductivity of the following crystals (sources indicated in brackets) was observed under the influence of plastic deformation: potassium chloride (Harshaw Chemical Co., Messrs. Hilger, Ltd., and Durham); sodium iodide (Messrs. Hilger, Ltd.); and potassium iodide (Harshaw Chemical Co.). An increase of conductivity was also observed in sodium chloride from the Harshaw Chemical Co. and potassium bromide from Messrs. Hilger, Ltd., but only at high stresses (> 40 kgm./cm.²). It was notable, however, that no increase of conductivity occurred in samples of sodium chloride from Messrs. Taylor, Taylor and Hobson, Ltd., Messrs. Hilger, Ltd., Dr. Korth, Universities of Aberdeen and Durham. Where the increased conductivity was observed, it was often quite large (hundredfold) and appeared to be proportional to the stress applied. Once the increase had been obtained for any given stress and had decayed, it could only be made to reappear by exceeding the value of the stress previously reached. The time constant of decay of the increase of conductivity was in all cases in the range 0·4–1·1 sec. The experiments on the change of conductivity were carried out over a range of temperature. In general, the effect decreased rapidly with increasing temperature, and at a temperature of 400° C. it was almost negligible.

A second effect was also discovered[3], and this has also been reported independently by Fischbach and Nowick[4]. It was found with all the specimens of alkali halides mentioned above that on the application of a stress a potential appeared between the electrodes on the surface of the crystal. The sign of the potential was quite random for any given specimen, and indeed often changed in the course of an experiment, for example, with increasing stress. The potential effect was very dependent upon the state of the ystal surface and appeared to be caused by local ress inhomogeneities at the surface. Using so far possible equal stress increments, an investigation the variation of the potential effect with mperature was made. It appeared to be independent of temperature up to 180° C. but then ecreased with increasing temperature, becoming lmost negligible at 250° C. The actual value of the otential developed at the electrodes depended on e input resistance of the measuring circuit, a typical ariation being 10 V. for an input resistance of $10^{11}$ hms to 0·1 V. for $10^{8}$ ohms. The crystal thus beaved as a low-power potential source. The appearnce of a potential under stress was also a transient henomenon and it decayed with time. Generally, he time constant of decay was rather smaller than r the conductivity change, being about 0·3 sec. he potential effect was present in all the crystals entioned above but differed in magnitude from one rystal to another.

It would seem that there are two distinct effects resent when single crystals of alkali halides are echanically deformed: first, a change in the ionic onductivity which is associated with the process of omogeneous strain throughout the crystal; secondly, he appearance of a potential at the electrodes caused y stress inhomogeneities. The latter is suggested ince the potential effect depends on the nature of he crystal surface and it can appear when the value f the stress applied to the crystal as a whole is less han the yield stress for plastic flow.

It is hoped to publish a fuller account of this work lsewhere. Acknowledgments are made to the Department of Scientific and Industrial Research for a maintenance grant (T. L. G.), to the Research Fund of the Durham Colleges for a grant for apparatus, to the Physics Department, University of Aberdeen, Messrs. Hilger, Ltd., Dr. K. Korth, and Dr. J. J. Markham for gifts of crystals, and to Prof. J. E. P. Wagstaff for laboratory facilities placed at our disposal.

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## Formation of Complexes of Fluorocarbons and Fluorocarbon Derivatives with Polar Hydrocarbons, Polar Polymers, Proteins and Polypeptides

VARIOUS studies started four years ago have suggested that complexes form between $—CF_3$ and $—CF_2$ groups and polar groups such as —OH, $—NH_2$, —SH, —*R*NH, etc. This interaction appears to be independent of the position of these polar groups and has been observed in solution as well as in solids. Thus, it is quite different from urea-hydrocarbon complexes[1].

In attempting to elucidate the nature of the complex, fluorocarbon acids, the corresponding salts and other fluorocarbon derivatives have been found to protect proteins against heat, various chemical denaturants such as urea, etc.; for example, it has been possible to heat a 1 per cent bovine serum albumin solution to as high as 175° C., store it at that temperature for an hour or more, and find no physical or biochemical evidence of denaturation.

Under slightly different experimental conditions, it was found that the longer-chain fluorocarbons were much more active as protein coagulants[2] than the shorter-chain corresponding derivatives. Since in the case of the carboxylate acid derivatives, for example, the acid strength is essentially independent of the chain-length, it would be necessary to postulate some effect of the fluorocarbon chain-length on the protein, probably through the hydrogen-bond network, through the polypeptide chain and/or through the polar groups on the protein surface. The protective action mentioned above is thought to involve a strengthening of the hydrogen-bond network of the protein molecule. Other evidence gathered as to the existence and nature of the complex is summarized as follows.

The curve of $\Delta n$ (change in refractive index), with $c$, concentration, in systems forming micelles, shows a change in slope when the critical micelle concentration is reached. This is observed in paraffin-chain salts[3], perfluoroacids and other fluorocarbon derivatives. When the solvent is changed from water to 1–5 per cent ethanol in water, $\Delta n$ has a maximum as a function of $c$ for perfluoroacids. Conductivity measurements (Klevens, H. B., and Vergnolle, J., unpublished results) indicate little or no interaction between the alcohol and the fluorocarbon ion. There are also discontinuities in the curves of surface tension versus concentration for solutions of fluorocarbon derivatives in mixed solvents (alcohol–water)[4]. No such discontinuity is observed in paraffin-chain salts dissolved in alcohol–water mixtures. Further, in contrast to the linear decrease in critical micelle concentration of the paraffin-chain salts with increase in alcohol concentration[5], a larger initial decrease in this concentration of perfluorocarbon acids and other derivatives is observed upon the addition of various polar hydrocarbons, followed by a region in which there is little further decrease in critical micelle concentration with increase in the concentration of polar additive[6].

These results indicate the presence of two components in solution: (1) a complex between fluorocarbon and alcohol; and (2) a non-complexed fluorocarbon.

In a study of the spectra of propanol in various solvents[7], it was observed that there is a marked hypsochromic shift when the solvent is changed from a hydrocarbon to a fluorocarbon. This blue shift is much more than is observed for compounds such as the aromatic hydrocarbons, where spectra are usually only sharpened by change of solvent from hydrocarbon to fluorocarbon.

Nuclear magnetic resonance studies (measurements made for me by G. R. Holzman, J. H. Anderson and W. Koth, of the Mellon Institute, and by J. N. Shoolery, of Varian Associates) of perfluorooctanoic acid in water, in a 1 per cent butylamine solution, and when adsorbed on bovine serum albumin molecules, show definite and marked differences in their $—CF_3$ spectra. For equivalent fluorine concentrations in the three systems studied, there was a relative decrease in the $—CF_2$ spectra and a correspondingly much greater decrease in the $—CF_3$ spectra as the solvent was changed from water to butylamine in water, and an even greater change was observed when protein was present.

These latter measurements are the first definitive ones which support the above hypothesis as to direct interaction between $-CF_2$ and $-CF_3$ and various polar groups.

Ultracentrifuge, viscosity and light-scattering measurements and partial molar volume data on these fluorocarbon–polymer systems also indicate some interaction. Details of these measurements will be published shortly.

The major portion of this work was done and various concepts and conclusions were reached, while I was an Advanced Research Scholar under the Fulbright Act in Paris, 1951–52. Further confirmatory evidence was obtained at the University of Minnesota and in the Graduate School of Public Health at the University of Pittsburgh.

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# Direct Spectrophotometric Determination on Paper of Chromatographic Spots of Cobalt and Copper

QUANTITATIVE paper chromatography is likely to become a general micro-analytical method on account of its penetrating power and rapidity. Quantitative determination of spots can be speeded up by direct titration of the spots on paper, with a reproducibility of ± 3–4 per cent in the case of molybdenum and vanadium[1]. Copper, cobalt[2], nickel and chlorides have already been studied, too.

Direct photometry or densitometry in white light has been applied to the measurement of chromatographic spots of vanadium[3] revealed with oxine, of phosphorus[4], of cobalt and copper[5]. The final complex opacity includes opacity of the paper, which has to be checked millimetre by millimetre befo even chromatographic development, and has to b taken into account at the end for the piece of pape at the exact place of the spot. This is not practic when the spot travels too far away from the startin line[6].

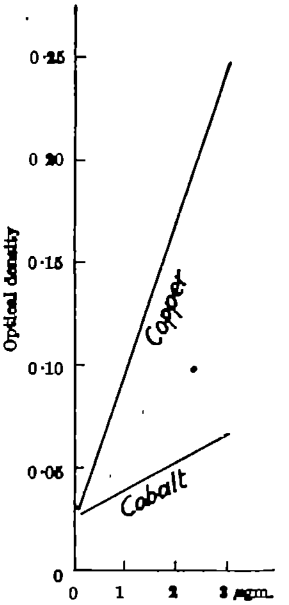

Fig. 1

Direct spectrophotometry on paper for spot revealed chromatographically has a more general an practical application. For example, a definite wave length can be used for these measurements, as whe operating on solutions. This wave-length is chose after drawing both absorption curves, that for th complex and that for the reagent; and it correspond to the spectral region where these two curves sho the greatest absorption difference.

Organic reagents and complexes are so insolubl in water that very little of them is given up to thi solvent from a strip of paper carrying a given quantit of such substances. Photometric measurements ca be carried out, however, by slipping the strip of pape bearing the spot or the vaporized reagent betwee the wall of the usual spectrophotometric cell and prismatic calibrated glass adapter, with a few drop of water to eliminate air bubbles. Optical densitie of vaporized strips with α-nitroso-β-naphthol o

OPTICAL DENSITY FOR 3 μGM. OF COBALT REVEALED WITH α-NITROSO-β-NAPHTHOL

λ = 850 mμ. F = 0·040 mm.

| Paper blank chromatographed | Paper blank chromatographed vaporized | Mean values chromatographed | Mean values not chromatographed |
|---|---|---|---|
| 0·125 | 0 130 0·130 0·130<br>0 129 0·130 0·130<br>0·130 | 0·064 0 064 0 063<br>0·065 0·066 0·065 | 0·050 0·051 0·050<br>0 049 0·050 0·041 |
| | *M*/24 0·1297 | *M*/18 0·064 ± 0·47 per cent | *M*/18 0·050 ± 0·30 per cen |

OPTICAL DENSITY FOR 3 μGM. OF COPPER REVEALED WITH RUBEANIC ACID

λ = 660 mμ. F = 0·095 mm.

| Paper blanks chromatographed vaporized | Mean values chromatographed | Mean values not chromatographed |
|---|---|---|
| 0 010 0·010 0·011<br>0·011 0 011 0·010<br>0·009 0·010 0·010 | 0·245 0·246 0·246<br>0·246 0·245 0·245<br>0·246 0·245 0·244<br>0·245 0·246 0 244<br>0·245 0·245 0·245<br>0 246 | 0·239 0·238 0 239<br>0·240 0·239 0·239 |
| *M*/18 0·0103 | *M*/18 0 2453 ± 0 01 per cent | *M*/18 0 239 ± 0·5 per cen |

beanic acid are so reproducible in this way that e can set the zero of the apparatus on these porized strips. The optical density of the vaporized ot is then measured directly from this zero. There consequently no need to measure blanks, except r control, and the position of the spot in the chrom- togram is of no importance.

Reference diagrams have been drawn from 0·1 to μgm. of cobalt and copper. Concentrations can e checked within these limits with a reproducibility ss than 0·5 per cent.

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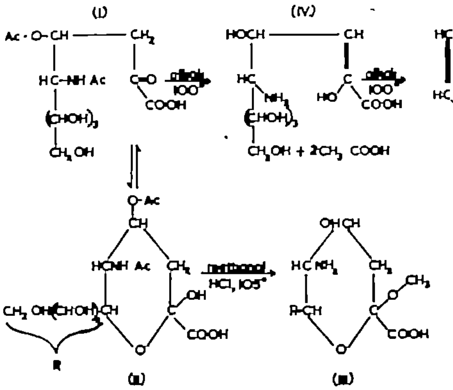
## Structural Relationship between Sialic Acid, Neuraminic Acid and 2-Carboxy-Pyrrole

AN interesting field of biochemical research was pened when Blix[1] isolated from bovine submaxillary gland mucin a crystalline reducing acid, named sialic acid[2]. Its most probable composition is given as $)_{14}H_{23}NO_{11}$ or $C_{14}H_{21}NO_{10}.H_2O$. Bovine sialic acid ontains an N-acetyl and an O-acetyl group, one rimary alcohol group and a total of five hydroxyl groups[3]. Consumption of free iodine, when sialic acid s titrated with hypoiodite, and of one molecule of ydrogen, when the acid is submitted to treatment with sodium borohydride, is interpreted by Blix *et al.*[3] as indicating the presence of a free aldehyde group. The liberation of less than one mole carbon monoxide per mole sialic acid upon treatment with sulphuric acid would suggest the presence of an α-hydroxy group[3].

Neuraminic acid in the form of its alkali-stable methoxy derivative was first isolated by Klenk from gangliosides[4] and more recently from bovine submaxillary gland mucin and from a urine mucoprotein[5], its composition being $C_{11}H_{21}NO_8$ or perhaps $C_{10}H_{19}NO_8$. This substance has no reducing power, but is ninhydrin-positive[4]. Sialic acid and the methoxy derivative of neuraminic acid are characterized by the purple colour they give on heating with Ehrlich's *p*-dimethylaminobenzaldehyde reagent even without alkali pretreatment (direct Ehrlich reaction), by the violet colour they produce on treatment with Bial's orcinol reagent and by the considerable humin formation on heating with dilute mineral acid.

A reducing, nitrogen-containing compound responding to treatment with Ehrlich's and Bial's reagents and with dilute mineral acid in exactly the same manner as do sialic and neuraminic acids was isolated in our laboratory as the product of an enzyme-substrate interaction[6,7]. The influenza virus enzyme and the receptor-destroying enzyme of *Vibrio cholerae* were found to liberate from ovomucin and from homogeneous mucoproteins (prepared from human urine and from bovine submaxillary gland mucin respectively) the above compound, which by dialysis was readily separated from the reaction mixture. Its properties suggested to Odin[8] and Klenk[9] close similarity to, if not identity with, sialic and neuraminic acid respectively. Upon treatment with mild alkali (0·1 *N* sodium carbonate, 100°, 20 min.) 2-carboxy-pyrrole was obtained from the enzymatically released product in a yield of about 0·05 per cent of the pure mucoprotein[9,10]. The same pyrrole compound was formed in a yield of 0·05 per cent from the homogeneous mucoproteins, known to contain sialic acid, by treatment with 0·63 *N* barium hydroxide for 8 hr. at 100° (ref. 10; see also Hiyama[11]).



The proposed structures for sialic acid ($I \rightleftarrows II$) and the methoxy derivative of neuraminic acid (III) would account for all relevant observations. The direct Ehrlich reaction given by I and III may be visualized as proceeding via IV to V, the benzaldehyde acting as a trapping agent for the otherwise acid-labile pyrrole derivative; the alkali stability of III arises from its acetal structure. Neuraminic acid (IV) may be regarded as an aldol type of condensation product of 2-amino-2-deoxy-hexose with pyruvic acid, the aldol type of linkage rendering recovery of the amino-sugar by acid treatment impossible[2,4,7]. The location in this condensation product of a keto, a hydroxyl and an amino-group in the <2,4,5> position provides optimal conditions for cyclization to pyrrole.

Direct evidence for the key reaction IV → V of the diagram was afforded by condensing glucosamine with pyruvic acid in alkaline medium heated for 20 min. at 100°. In this way, 0·5 gm. glucosamine hydrochloride and 5·1 gm. sodium pyruvate, dissolved in 500 ml. 0·17 *N* sodium carbonate, yielded about 1 per cent of the theoretical amount of 2-carboxy-pyrrole. This yield is of the same order of magnitude as that obtained from bovine submaxillary mucoprotein, assuming, as seems most likely[3], that its sialic acid content of 17 per cent is responsible for the production of 2-carboxy-pyrrole. 2-Carboxy-pyrrole was identified chromatographically and spectrophotometrically as described in detail elsewhere[10]; its quantity was calculated by means of the molecular extinction coefficient[10].

Strong support for the structures shown in the diagram is afforded by the finding[12] that *N*-acetyl-neuraminic acid, but not (III), is converted to (V) on treatment with alkali.

The ready conversion by alkali to (V) of (I) and of the enzymatically released product, with our recent observation that concomitant with the enzymatic release of this product the sialic acid content of the bovine mucoprotein is reduced by 64 per cent, leaves little doubt on the identity of the two compounds.

I am indebted to Dr. J. W. Cornforth, London, for advice and suggestions throughout the work.

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## Occurrence of *n*-Nonadecanoic Acid in Ox Perinephric Fat

WHEN *n*-heptadecanoic (margaric) and *n*-pentadecanoic acids[1] were isolated from hydrogenated mutton fat, it was anticipated that all the normal odd-numbered fatty acids appropriate to the series would be present in natural fats. Subsequent evidence points to this being the case. Apart from the occurrence of *n*-$C_{15}$ and *n*-$C_{13}$ acids in unhydrogenated butterfat, and of *n*-$C_{15}$ and *n*-$C_{17}$ acids in unhydrogenated fish-liver oil, *n*-$C_{11}$ acid has been located in hydrogenated butterfat, and all the acids (odd and even) from $C_2$ to $C_{10}$ have been shown to be present in the volatile acids of ox perinephric fat.

We now report the isolation from hydrogenated ox perinephric fat (sample *J*/21) of trace quantities of the $C_{19}$ member, *n*-nonadecanoic acid. The chemical and physical properties of the fraction isolated (denoted *U74S3S*, weight 0·20 gm.) were as follows: saponification equivalent 297·5 (calculated for $C_{19}H_{38}O_2$, 298·5); melting point 67·5–68·0° (literature records are 68·65° [2] and 68·5° [3] for *n*-nonadecanoic acid); X-ray long spacing 43·77 A. (± 0·5 A.) for sample prepared from benzene (literature records[4] 44·13 A. for sample prepared from acetone). Were this fraction 17-methyloctadecanoic acid, its melting point would be less than 1 deg. below that of the normal isomer (literature records[5] 67·3–67·8°), but its X-ray long spacing[6] would be of the order of 36·2 A.

Although *n*-nonadecanoic acid has been prepared synthetically it has not hitherto been isolated from a natural or a hydrogenated fat.

Further details of this work will be published later.

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## Volatile Fatty Acids in Phospholipids

USING the micro-technique of James and Marti it has been established that bovine muscle phosph lipids contain small amounts of volatile fatty acid and it is possible that this finding can be extend to animal phospholipids in general. Hitherto, in t absence of techniques for the micro-estimation of t low molecular-weight fatty acids, it has general been accepted that the fatty acids of phospholipi tend to be of high molecular weight only. A co secutive series of normal fatty acids from $C_2$ to $C_{10}$ h been identified in ox perinephric fat[2].

To minimize post-mortem enzymatic hydrolysis the lipids, the bovine muscle, which had been free from visible fat, was finely minced and heated i boiling ethanol within an hour of slaughter. Th ethanol-ether extracts of the dried tissue, from whic non-lipid impurities had been removed on cellulose were separated into phospholipids and glyceride A preliminary separation was carried out makin use of their differing solubilities in acetone, and fro the impure phospholipid thus obtained (phosphoru content, 3·7 per cent) further glyceride was separate by using silica gel previously activated for 24 h at 120° C. Glycerides were eluted with chloroform[4] while under the same conditions phospholipids wer adsorbed on to the silica gel. The phospholipid (phosphorus content, 3·9 per cent) were then elute with methanol. Purified solvents were used in th extraction and separation procedures. It was foun that the muscle contained 2·71 per cent glyceride and 0·57 per cent phospholipids.

The phospholipids were hydrolysed by refluxing with 1 per cent sulphuric acid in ethanol for 3 hr. and then with approximately 13 per cent potassiu hydroxide in ethanol for 5 hr. After removal of th unsaponified material by ether extraction (6·9 pe cent by weight) the fatty acids were steam-distilled. The soaps of the acids volatile in steam were concentrated to an approximately normal solution and an aliquot was acidified and applied to the gas-liquid chromatogram by the procedure suggested by James and Martin[1]. The column was operated at 137° C.

The acids identified were acetic, octanoic, propionic, hexanoic, butyric, *iso*-valeric and valeric in decreasing amounts on a molar basis. These volatile acids represented approximately 0·17 per cent by weight of the total fatty acids present in the muscle phospholipids.

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## Protection of Deoxyribonuclease from Ionizing Radiation by Adsorbents

THE present communication presents experimental evidence which indicates that adsorption of deoxyribonuclease on a liquid–solid interface affords protection of enzymatic activity from radiation damage. Other means of protecting enzymes in aqueous solutions have been described by various investigators[1–6], but, to our knowledge, no information is available concerning the protective effect of adsorption.

Crystalline deoxyribonuclease (DNase crystalline, purchased from Worthington Biochemical Co., Freehold, New Jersey) with a *p*H optimum at 7·5 was used in all experiments. The enzymatic activity was determined according to Kowlessar *et al.*[7]. Although the enzyme adsorbed on cellulose powder could not be eluted, the suspension of the adsorbed enzyme showed enzymatic activity 10–35 per cent less than that noted when the enzyme was in aqueous solution. 10 ml. of a solution containing 5 μgm. of the enzyme and 5 mgm. of cellulose powder (Whatman standard grade cellulose ashless powder) was irradiated with 1,090 r. in a glass centrifuge tube while being stirred. The radiation factors were: 206 kVp., 1,453 r. per min., 20 m.amp., no filtration and target–object distance of 10·3 cm.

In all experiments, the enzymatic activity of the adsorbed and non-adsorbed deoxyribonuclease fractions, separated by centrifugation, was determined before and after exposure to X-rays. In the case of pre-exposure samples, the system was equilibrated first by stirring for 20 min. A typical experiment (2*a*, *b*) in Table 1 shows that the non-adsorbed fraction of the enzyme was almost completely inactivated, whereas the adsorbed fraction of the enzyme was protected significantly from inactivation by X-rays.

In another experiment (Table 1, 3*a*, *b*) the cellulose was separated after thorough mixing with the deoxyribonuclease solution. The resultant supernatant solution and precipitate were irradiated separately, the precipitate having been suspended in a volume of distilled water equal to that of the supernatant phase. The results of five experiments demonstrate again that the adsorbent protects the enzyme.

The degree of protection afforded the enzyme by the adsorbent is a function of the amount of enzyme in the adsorbed state. This is illustrated by the results in Table 2 relating the amount of cellulose added to the system to the degree of inactivation of deoxyribonuclease.

Varying degrees of protection of deoxyribonuclease from X-radiation are obtained with different adsorbents such as ion-exchange resins, silica gel. 'Celite' and bone ash. This suggests that the mechanism by which adsorption protects the enzyme is not specific for any one adsorbent. The biological implications of such a phenomenon are exemplified by preliminary observations which suggest that deoxyribonuclease is protected from inactivation by X-rays when adsorbed on rat spleen mitochondria.

Table 1. EFFECT OF X-IRRADIATION ON THE DEOXYRIBONUCLEASE – CELLULOSE SYSTEM

| System | Enzyme activity (per cent remaining) Non-irradiated control | After irradiation | *R** |
|---|---|---|---|
| (1) Deoxyribonuclease | 100 | 13 | 13 |
| (2) Deoxyribonuclease + cellulose, irradiated together and then separated | 66 | 29 | 44 |
| (*a*) supernatant | 48 | 5 | 11 |
| (*b*) precipitate | 18 | 14 | 78 |
| (3) Deoxyribonuclease + cellulose, irradiated after separation into solid and liquid phase | | | |
| (*a*) supernatant | 100 | 52±7 | 52 |
| (*b*) precipitate | 100 | 84±20 | 84 |

$$* R = \frac{\text{Enzyme activity after irradiation}}{\text{Enzyme activity of non-irradiated control sample}} \times 100.$$

The enzyme activities in experiments (2), (2*a*) and (2*b*) are referred to (1) as 100, whereas in (3*a*) and (3*b*) the respective non-irradiated sample serves as reference point.

In (3*a*) and (3*b*) the standard deviations are also shown.

Table 2. RELATIONSHIP BETWEEN THE DEGREE OF THE PROTECTION AND THE AMOUNT OF THE ADSORBENT

| Amount of cellulose (mgm.) | Per cent of enzyme + activity remaining after irradiation | Per cent of activity with supernatant* |
|---|---|---|
| 0 | 39 ± 14 | 100 |
| 0 1 | 36 ± 7 | 69 |
| 1 | 35 ± 1 | 84 |
| 5 | 72 ± 13 | 49 |
| 10 | 92 ± 10 | 20 |
| 30 | 80 ± 10 | 6 |
| 100 | 100 | — |

$$* \text{Per cent of activity} = \frac{\text{Activity in the supernatant}}{\text{Total activity}} \times 100.$$

Several hypotheses may be advanced in order to explain the observed protection by adsorbents: (1) the ratio of free radicals to enzyme molecules in the adsorbed fraction is much lower than it is in the supernatant phase; (2) the free radicals do not migrate freely into the micellar space; or (3) competitive reactions on the surface of the adsorbent decrease the number of free radicals available for enzyme inactivation. Since the number of adsorbent particles involved in this system is much less than the number of molecules of the usual protective reagents, and since little protection is afforded the enzyme in the supernatant phase by the dispersed adsorbent (Table 1–2), it seems unlikely that the protective effect obtained is of the customary competitive variety[1,2,3].

These experiments and others of a similar nature will be published in detail elsewhere.

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## A New Method for 'Hydrolysis' of Nucleic Acids with Phosphorus Pentoxide

NUCLEIC acids consist of nucleotides linked together by ester linkages between the phosphate group of one and the ribose group of another nucleotide as shown below:

Base—sugar—phosphate
|
Base—sugar—phosphate
|
Base—sugar—phosphate
|
Base—sugar—phosphate

Hence it should be possible to separate the bases in free form if the sugar links are broken down. Sugars are known to be susceptible to hydration.

Table 1. Phosphorus Pentoxide Hydrolysis of Deoxyribonucleic Acid isolated from Tumour Tissue

Kjeldahl nitrogen value for original deoxyribonucleic acid, 10·5 per cent. Nitrogen value calculated from the bases isolated, 9·3 per cent.

| | (I) Found (μgm. base/mgm. deoxyribonucleic acid) | (II) Calculated nitrogen value from col. I (μgm. nitrogen/mgm deoxyribonucleic acid) |
|---|---|---|
| Adenine } Thymine } | 110* | 44* |
| Guanine | 70 | 33·6 |
| Cytosine | 40 | 15·2 |
| Uracil | — | — |
| | Total nitrogen | 92·8 |

* Adenine and thymine have the same $R_F$ values for the solvent used, hence in the calculation of nitrogen values the mean value for adenine and thymine is used.

Experiments were therefore carried out with the view of breaking down the ribose bridges with a dehydrating agent such as phosphorus pentoxide in order to find if the free bases are liberated. The results form the basis of the present preliminary report of a new method of 'hydrolysing' the nucleic acids.

Nucleic acids separated from biological materials by the method of Chargaff *et al.*[1] and commercial samples of deoxyribo- and ribo-nucleic acids were used for the investigations. To 10 mgm. of dry nucleic acid powder in a clean dry test-tube, sufficient phosphorus pentoxide was added to cover the nucleic acid. The tube was stoppered, shaken vigorously and then heated in an electric oven at 150° C. for two hours. To the charred mass 2·5 ml. of 0·1 *N* hydrochloric acid was added to dissolve the bases. The solution was filtered to separate the carbon particles. The clear solution was then spotted on a Whatman No. 1 filter paper and an ascending chromatogram run overnight using 79 per cent saturated ammonium sulphate solution, 19 per cent water and 2 per cent *iso*propanol as the solvent[3]. After drying the chromatogram at room temperature, the positions of the purines and pyrimidines were located by taking a contact print with ultra-violet light[4] on Kodak rapid reflex document paper (*DOUSTAT*, 23). Corresponding areas on the chromatogram were then cut out and eluted by overnight extraction with 10 ml. of 0·1 *N* hydrochloric acid. The bases were estimated quantitatively[2], using the Beckman spectrophotometer (Model *D.U.*) at 265 mμ. The results of some analyses of tumour deoxyribonucleic acid are shown in Table 1. Here it will be seen that the Kjeldahl nitrogen value for the isolated deoxyribonucleic acid is 10·5 per cent and that accounted for by the isolated bases is 9·3 per cent, thus indicating that the hydrolysis and the recoveries are fairly complete.

The treatment with phosphorus pentoxide is a fairly drastic one, and before the usefulness of the method could be assessed it is necessary to study its effects on pure purines and pyrimidines, to rule out the possibility of destruction of the bases during the process. This has been tested by recovery experiments after treating pure samples of the base individually with phosphorus pentoxide. The result are shown in Table 2.

Table 2. Recovery of Pure Purines and Pyrimidines subjected to Treatment with Phosphorus Pentoxide and Subsequent Separation by Paper Chromatography

| | Quantity of base taken (μgm.) | Quantity of base found (μgm.) | Percentage recovery (per cent) |
|---|---|---|---|
| Adenine | 250 | 250 | 100 |
| Guanine | 250 | 235 | 94 |
| Cytosine | 250 | 245 | 98 |
| Uracil | 250 | 240 | 96 |
| Thymine | 250 | 230 | 92 |

It can be seen that the recoveries are fairly good. Besides the recovery experiments, two other criteri were employed for confirming that the phosphoru pentoxide treatment does not affect the bases namely: (1) ultra-violet absorption spectra; and (2) the $R_F$ values of the bases after treatment with phosphorus pentoxide. The absorption spectra and the $R_F$ values of the bases were unaffected by the treatment.

It appears, therefore, that the new method bring about complete hydrolysis without in any way affecting the recovery of the bases. Further work on this method is in progress.

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## Effect of Denervation on the Histochemical Appearance of Cholinesterase at the Myoneural Junction

The sensitivity of the motor end-plate to acetylcholine is known to increase after denervation. Many workers have investigated by chemical analysis the cholinesterase content of denervated muscle in an attempt to explain this increased sensitivity. The results have, however, been confusing. Marnay and Nachmansohn[1] reported that the cholinesterase content of muscle increased following nerve-section, while Couteaux and Nachmansohn[2] and Stoerk and Morpeth[3] found that it became reduced. Sawyer *et al.*[4], working on skeletal muscle of the rat, guinea pig and rabbit, reported that the concentration of cholinesterase at first became reduced after nerve section and later became increased to considerably more than its normal complement. Since the results obtained by chemical analysis include the cholinesterase present in the terminal nerve fibres[5] and also that present in muscle other than at the motor end-plate, it seemed desirable to investigate the problem using a histochemical method and to confine the study to the cholinesterase content of the motor end-plate.

Fourteen guinea pigs, seven males and seven females, aged about one year were used for the present investigation. The animals were anaesthetized with ether and the sciatic nerve was cut in mid-thigh. One animal of each sex was killed by a blow on the back of the neck at the seventh, eleventh, fifteenth, nineteenth, twenty-second, twenty-eighth and forty-fifth days following nerve section. The denervated gastrocnemius was removed from each animal, and at the same time the normal gastrocnemius was moved from the other leg to serve as a control. The specimens were fixed in 10 per cent formol saline for 6 hr., and frozen sections 50μ thick were cut and then washed in distilled water for 1½ hr. Sections om the denervated and control gastrocnemius muscles were then processed using the histochemical technique described by Koelle[6] and modified by Couteaux and Coërs[7]. To ensure adequate control, denervated and a normal control muscle section om the same animal were always incubated together r exactly the same length of time. The cholinesterase appearances were assessed by studying the concentraon and distribution of the copper sulphide precipitate at the motor end-plate.

All the control muscle sections showed that the cholinesterase at the motor end-plate is situated in the walls of gutters on the surface of the muscle fibres and is present in the form of a series of horseshoe-shaped plates as described by Couteaux and Taxi[8]. The muscles which had been denervated for seven ays showed that the concentration and distribution of cholinesterase at the motor end-plate were the same as in the controls. In the muscles which had been enervated for eleven days, the concentration of cholinesterase was slightly reduced compared with he controls, while in those which had been denervated for fifteen days the concentration of the holinesterase was still further reduced and the gutters were less well defined, the edges being irregular. After denervation for nineteen and twenty-two days, it was difficult to make out the normal outline of he motor end-plate even in muscle sections which had been incubated for sixty minutes; the cholinesterase was greatly reduced in amount and its distribution was uneven; and the horseshoe-shaped plates were no longer visible. In those muscles which had been denervated for twenty-eight days the cholinesterase could only just be recognized as a faint shadow against the pale background of the muscle fibres. No cholinesterase was found to be present in the motor end-plates of muscles denervated for forty-five days. Throughout the investigation the results in both sexes, as would be expected, were identical.

These preliminary observations show that the cholinesterase concentration at the motor end-plate of the gastrocnemius muscle of the guinea pig begins to become reduced at about the eleventh day following denervation, and this reduction progresses until at the forty-fifth day no cholinesterase can be found. This gradual reduction in the cholinesterase concentration at the motor end-plate may be partly responsible for the increased sensitivity of denervated muscle to acetylcholine.

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## Sources of Platelet Factor for the Thromboplastin Generation Test

The thromboplastin generation test of Biggs and Douglas[1] is of great assistance in the diagnosis of hæmorrhagic diatheses characterized by defective thromboplastin generation. One modification, due to Bell and Alton[2], substitutes the more convenient human brain extract for the platelet suspension. Human brain is not a readily available material, and the preparation of the extract from it is laborious and time-consuming.

Platelet factor is believed to be a phospholipid. Soybean is a readily available source of phospholipids, and soybean phospholipid has been used for counteracting thrombocytopenic bleeding in X-irradiated dogs[3]. A preparation similar to that of White *et al.*[3] was prepared by their method from the commercially available soybean product, 'Lecithin Emulgo No. 4'. It is a light-tan coloured powder, rapidly darkening and becoming sticky on exposure to air at 20° C. The yield is more than 50 per cent of the starting material. The powder is homogenized in physiological saline at a concentration of about 10 mgm./ml. to make the stock solution for the thromboplastin generation test. It is stored at − 20° C. It is diluted before use to from 1 : 50 to 1 : 200 with physiological saline to obtain clotting times with normal bloods of 10 ± 1 sec. Both in Cambridge and the United States (personal communication, W. N. Bell), the soybean suspension has been substituted for platelet suspension in the thromboplastin generation test and has proved satisfactory in the diagnosis of hæmophilia and Christmas disease (Fig. 1). It is intended to use it in further studies on abnormal bloods as these become available in Cambridge.

Preliminary experiments have suggested that the Bell brain extract and the soybean phosphatide are

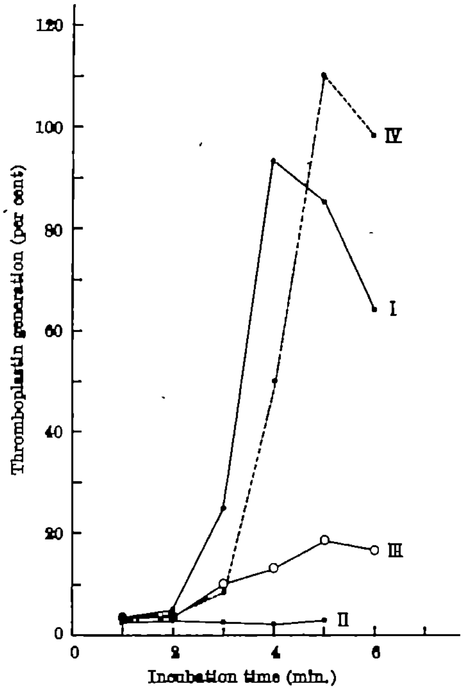
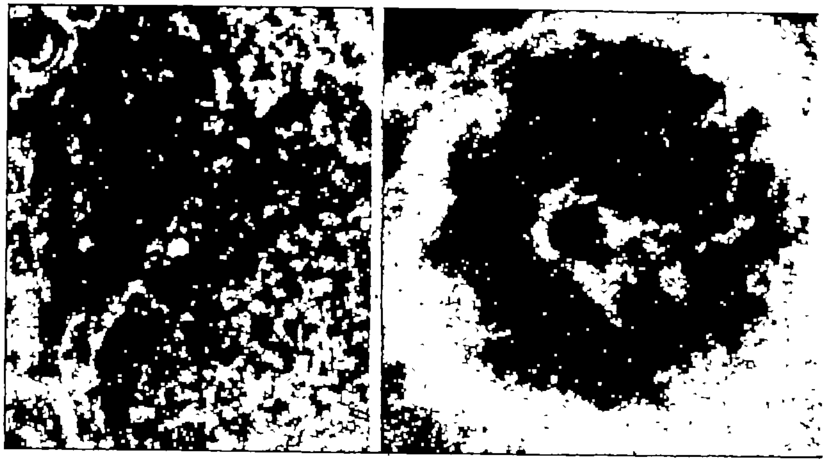


Fig. 1. Abnormal bloods in the thromboplastin generation test using soy phospholipid in place of platelet suspension. I, Normal plasma and serum; II, hæmophilic plasma and normal serum; III, Christmas disease plasma and serum; IV, Christmas disease plasma and normal serum



[Golgi bodies of: (1) *Schistocerca gregaria*, × 750; (2) *Laccotrephes rubra*, × 1,600

similar in nature. Further proof has been obtained by chromatographing the two materials on Whatman No. 3 paper impregnated with silicic acid. The papers were developed with 30 per cent methanolic chloroform by the ascending method, dried, sprayed with 0·2 per cent butanolic ninhydrin, heated at 120° for 7 min., and, after noting the position of the positive spots, treated with phosphomolybdic acid and stannous chloride. The extracts both contain a small amount of ninhydrin-positive material of $R_F$ c. 0·0 together with a large amount of choline-containing material of $R_F$ 0·90–1·00. A small amount of choline material stays at the starting point. Further work in progress is directed towards the identification of the active material. It is to be noted that it is very difficult to obtain papers with a uniform degree of impregnation with silicic acid. It is therefore necessary to compare compounds directly on the same paper.

Work with the thromboplastin generation test for a period of two years has confirmed its usefulness as a diagnostic test; but as a method of assay for phospholipid material it suffers from the defects of most biological tests—the degree of accuracy is never better than ± 20 per cent—together with a pronounced personal error in finding the exact moment of clotting. At the faster end of the scale a difference of one second causes considerable error. It has also been suggested elsewhere[4] that the degree of division of phospholipid material in suspension partially determines its biological activity. The effect of suspension-size has not yet been determined in this laboratory.

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## Golgi Bodies in Nerve Cells of Insects

Some time after the publication of Shafiq's papers[1] on the nerve cells of the locust, Prof. Vishwa Nath asked me to undertake a comprehensive study of the Golgi material in the nerve cells of invertebrates and vertebrates. I have just completed my investigations on the thoracic neurones of the locust, *Schistocerca gregaria* Forsk., and the local water-bug, *Laccotrephes rubra*. My observations are based on the study of neurones of the fifth instar and immature adults of locust and adult water-bugs.

*Schistocerca gregaria* Forsk. The Golgi bodies (lipochondria of Shafiq) of the living neurones of this locust, when examined under the phase-contras microscope, show a highly refractile dark cortex an an almost colourless medulla. Besides, there ar smaller, highly refractile, homogeneous Golgi sphere The Golgi bodies can be stained with the vital dye neutral red and methylene blue; but it is the medull of the Golgi body which alone takes up the dye From this it is concluded, in conformity with Shafiq and Roque[2], that the medulla of the Golgi body i a vacuole with acidic contents (Fig. 1).

In paraffin sections of Helly's fixed – post-chrome material and stained with sudan black, the Golg spheres present a thick outer blue-black cortex an an inner very lightly staining medulla. There ar also smaller homogeneously stained Golgi spheres In smears fixed with Flemming without acetic aci and stained with sudan black, the Golgi bodies show a homogeneous structure; but very rarely an incomplete investing rim is seen around a lightly staining medulla. In Helly's post-chromed-hæmatoxylin preparations the Golgi bodies appear exactly as in Helly's post-chromed fixation followed by sudan black. Hæmatoxylin stains the Golgi bodies as dark homogeneous spheres when preceded by chrome-osmium fixatives. They can be stained with acid fuchsin (Masson's triple stain).

In Kolatchev preparations the Golgi bodies appear as heterogeneous spheres showing an osmiophilic cortex and an osmiophobic medulla; but the osmiophobic substance becomes greatly swollen up and the spheres become flattened. A few Golgi crescents are also seen as optical sections of the Golgi spheres (Nath[3], Shafiq[1], Roque[2]). In Aoyama preparations also the Golgi spheres, showing a duplex structure, come up beautifully in finished sections; but invariably artefacts, in the form of black granules on or around the Golgi spheres, appear.

Regaud's post-chromed-hæmatoxylin preparations generally show duplex Golgi bodies; but these preparations also show neurofibrillae as described by Beams and King[4]. The Golgi bodies are completely washed out in Bouin's fluid.

Thus the Golgi bodies described by me appear to be identical with the lipochondria of Shafiq[1]. Similar osmiophil bodies (rings, semicircles, crescents and rods) have been described as Golgi bodies by Beams and King[4] and Beams *et al.*[5]. But Shafiq did not observe any neurofibrillæ.

*Laccotrephes rubra.* The Golgi bodies of the thoracic neurones of this water-bug are almost similar to the inary spheroids' of *Helix* (Thomas[6]). It has been served that in this material there is generally a anule or a crescent attached to a vacuole. The anule or the crescent appears as a dark, highly fractile component attached to the vacuole in the ving neurones examined under phase-contrast, hereas the vacuoles are seen as colourless bodies Fig. 2). The granular or crescent-shaped component f the Golgi body appears to be lipoidal in constituon, as it is stained by sudan black. It also reduces smium and silver. It is darkly stained by hæmtoxylin preceded by chrome–osmium fixatives. he vacuole can be stained with the vital dye, eutral red. When the vacuoles are homogeneously tained with this dye, it becomes difficult to see the poidal component. The optimum impregnations of smium or silver do not impregnate the vacuoles ; nd they are also not stained by sudan black. It is hus clear that the lipoidal cortical component of he 'binary spheroids' of Thomas[6] represents the Golgi material, and the vacuolar part of the spheroid he vacuome of Parat.

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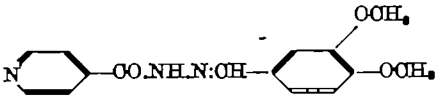
## Anti-Tuberculous Activity of Verazide (1-*iso*Nicotinoyl-2-veratrylidene Hydrazine)

THE high *in vitro* activity of 1-*iso*nicotinoyl-2-veratrylidene hydrazine (0·06 μgm. per ml.), henceforth referred to as verazide, has been previously reported by us[1] and others[2,3]. Fox and Gibas[4] report that 2 : 2-alkylidene derivatives of isoniazid (among which was included verazide) were markedly tuberculostatic in mouse tuberculosis. There is no reference, however, to the degree of activity of verazide or to its activity when given by intermittent dosage.

This report deals with the *in vivo* action of verazide and directs attention to its prolonged action and potential value in the treatment of tuberculosis. As verazide :



1-*iso*Nicotinoyl-2-veratrylidene hydrazine

is an insoluble derivative of isoniazid, it was decided to test its *in vivo* action by intermittent dosing at weekly, fortnightly and monthly intervals, using the healing ulcer technique previously described by one of us[5]. In addition, isoniazid was included for comparison. The results are shown in Table 1.

We have already shown[5] that a chemotherapeutically interesting anti-tuberculous agent is capable of scoring a healing ulcer value of 50 after 28 days treatment. Thus, verazide given in doses as low as 10 mgm./kgm. at weekly intervals exhibits a fair degree of activity, and at 30 mgm./kgm. is capable of effecting an almost complete healing of tuberculous ulcers with only three injections. At higher doses more widely spaced, for example, at 14–28-day intervals, the high degree of activity is maintained. Interestingly enough isoniazid, which is completely excreted in 24 hr. in animals[6] and man[7], is highly active (healing ulcer value 95) when 30 mgm./kgm. is given at weekly intervals. In the treatment of human tuberculosis, however, isoniazid is not given in doses exceeding 5–8 mgm./kgm. because of its toxicity.

Table 1. ANTI-TUBERCULOUS ACTIVITY OF VERAZIDE *in vivo*

| Drug | Dosage (mgm./kgm. body-weight) | Route | No. of doses | No. of animals | H.R. value* after 28 days treatment |
|---|---|---|---|---|---|
| Verazide | 5 mgm. weekly | Intramus. inject. | 4 | 4 | 15 (inactive) |
| Verazide | 10 mgm. weekly | Intramus. inject. | 4 | 4 | 58 (fair activity) |
| Verazide | 15 mgm. weekly | Intramus. inject. | 4 | 4 | 61 (fair activity) |
| Verazide | 30 mgm. weekly | Intramus. inject. | 3 | 4 | 98 (high activity) |
| Verazide | 30 mgm. weekly | *Per os* | 4 | 4 | 78 (moderate activity) |
| Verazide | 30 mgm. fortnightly | Intramus. inject. | 2 | 4 | 78 (moderate activity) |
| Verazide | 45 mgm. fortnightly | Intramus. inject. | 2 | 4 | 92 (high activity) |
| Verazide | 60 mgm. monthly | Intramus. inject. | 1 | 4 | 77 (moderate activity) |
| Isoniazid | 30 mgm. weekly | Intramus. inject. | 4 | 4 | 95 (high activity) |

* H.R. value = percentage cure of tuberculous lesions as measured by the healing ulcer technique (ref. 5).

Determination of acute toxicity by intraperitoneal injection of mice showed that the $LD_{50}$ of isoniazid was 200 mgm./kgm. body-weight, whereas the $LD_{50}$ of verazide was 700 mgm./kgm.

To summarize these results, verazide is highly active in the treatment of established tuberculosis in the guinea pig when given in intermittent doses either at 7-, 14- or 28-day intervals. It is active when given by mouth, but to a lesser degree than by injection. Finally, verazide is only one-third as toxic as isoniazid when measured by acute toxicity for mice. These findings will be reported and extended elsewhere.

We wish to thank Miss Janice Edgar and Mr. J. Buttifant for their assistance.

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Aug. 17.

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## Overcoming Cross-Incompatibility among some Mexican Diploid Species of *Solanum*

SPECIES of *Solanum* belonging to the section *Tuberarium* and occurring in Mexico have long been of interest to potato breeders, as several of them possess resistance to the late-blight caused by *Phytophthora infestans* de Bary. Like the tuber-bearing species of *Solanum* found in South America, the Mexican species also form a polyploid series comprising diploids ($2n = 24$), triploids ($2n = 36$), tetraploids ($2n = 48$), pentaploids ($2n = 60$) and hexaploids ($2n = 72$). These species have been classified

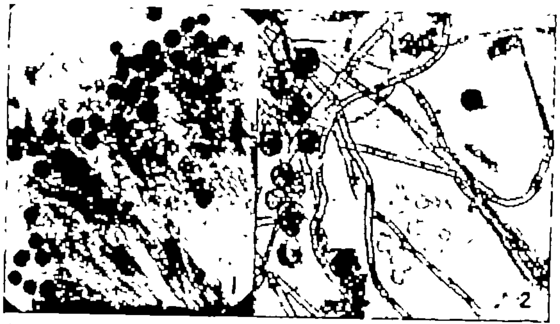

Fig. 1. Stigma and part of style of *S. pinnatisectum*, 72 hr. after pollination with *S. lanciforme* pollen. There is practically no germination of pollen

Fig. 2. Pollen of *S. bulbocastanum* germinated on an agar–sucrose–gelatin medium

in eight distinct taxonomic series, and our information concerning the cytogenetic affinities among them is still very fragmentary. As a preliminary towards gathering such data, a systematic survey of ability to cross among the diploid species occurring in Mexico was undertaken by me, during the summer of 1953, at the Inter-regional Potato Introduction Station, Sturgeon Bay, Wisconsin.

The following diploid species were used in the study: *S. pinnatisectum* (series *Pinnatisecta*), *S. bulbocastanum* (series *Bulbocastana*), *S. lanciforme* (series *Cardiophylla*) and *S. polyadenium* (series *Polyadenia*). In the first set of crosses made in the usual way (emasculation followed by controlled pollination), only the cross *S. pinnatisectum* × *S. polyadenium* succeeded. A study was then made of the causes for the failure of seed-setting in the crosses *S. pinnatisectum* × *S. bulbocastanum* and *S. pinnatisectum* × *S. lanciforme*. For this purpose, the ovaries with style and stigma were fixed in Carnoy's solution (alcohol, acetic acid, chloroform, 6 : 1 : 3), 24, 36, 48, 72 and 120 hr. after pollination, sectioned and stained with acid fuchsin and light-green. Examination of the slides revealed that in both crosses there was little or no germination of the respective pollen on the stigma even after 72 hr. from the time of pollination (Fig. 1). This duration is usually found to be sufficient to allow fertilization in compatible crosses. In the few germinated pollen grains the length of the tubes was only about three times the diameter of the pollen.

To overcome the pollen-stigma incompatibility, two techniques were tried, namely, smearing the stigmatic exudation from the pollen parent on the stigma of the pistillate parent, before pollination, and applying a suitable artificial medium for pollen germination on the cut surface of the style after removal of the stigma. An intermediate method described below led to the formation of berries and seeds in both crosses. The stigma, with a small portion of the style, was removed with a pair of fine scissors from the flowers of *S. pinnatisectum*, and a drop of an agar–sucrose–gelatin medium was applied to the decapitated surface of the style. This medium was prepared by dissolving 0·5 gm. of agar and 2·5 gm. of sucrose in 25 c.c. of distilled water to which 0·5 gm. of gelatin was added. The pollen grains of many species of *Solanum* were found to grow well in this medium (Fig. 2). After applying pollen to this medium on the cut surface of the style, the cut style was covered with a piece of moist cotton wool. From the crosses *S. pinnatisectum* × *S. lanciforme* and *S. pinnatisectum* × *S. bulbocastanum* thus made, four and three berries containing on average thirty-nine and eight seeds respectively we obtained. Seeds from these crosses were grown the Inter-regional Potato Introduction Statio Sturgeon Bay, in the summer of 1954 by Dr. R. V Hougas, who found that the plants were real hybrid

Such crosses have been attempted previously b several workers in different countries but withou success[1]. The hybrid between *S. pinnatisectum* an *S. bulbocastanum* may be of particular interest t potato breeders as a valuable breeding stock, sinc Niederhauser and Mills[2] have recently reported tha *S. bulbocastanum* is not only resistant to late bligh but is also probably the only species immune to i

This investigation was supported by a grant fro the Research Committee of the Graduate School wit funds provided by the Wisconsin Alumni Researc Foundation. I thank Drs. D. C. Cooper, G. H Rieman and R. W. Hougas for advice and help durin the course of the study.

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[1] Swaminathan, M. S., and Howard, H. W., *Bibliographia Genetica* 16, 1 (1953).

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## The Pogonophora

A report has recently been published in the daily Press alleging that Russian zoologists have lately discovered a new phylum of animals, the Pogonophora. This is, of course, a mistake, and in the paper by A. V. Ivanov, published in *Systematic Zoology*, 3, 69 (1954), and in *Dokl. Akad. Nauk S.S.S.R.*, 100, 175, 381, 595 (1955), acknowledgment is generously made to all previous workers on this interesting group. The animals have been known for some time; but Ivanov has created a new phylum for them, and this may have caused the misunderstanding.

Pogonophora are elongated tubicolous animals the body of which is composed of a short anterior portion bearing tentacles and a very long trunk. The anterior portion contains two pairs of coelomic cavities of which the first contain so-called nephridia and the second are continuous with the cavities of the tentacles. The trunk contains a third pair of coelomic cavities in which lie the gonads. The hinder part of the trunk shows repeated ring-shaped papillæ of chitinous platelets serving as adhesive organs. A dorsal nerve centre is present; but no trace has hitherto been found of gut, mouth or anus.

Although so much remains to be discovered in these animals, it is quite possible that Caullery and Ivanov are right in looking for their affinities among those groups which include the Enteropneusta. The tripartite arrangement of the cœlom and the dorsal nerve centre immediately suggest this. Details will be eagerly awaited regarding the structure of the so-called nephridium before it will be possible to compare it with the nephridium of the actinotrocha larva of *Phoronis*. Altogether, enough is known of these organisms to whet the appetite for more, and the results of Prof. Ivanov's further investigations will be awaited with interest.

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# FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

## Monday, November 7

University of London (at King's College, Strand, London, W.C.2), 5.30 p.m.—Prof. Charles Sadron (Strasbourg): "The Morphology Large Chain Molecules".*

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on Lagrange's Principle as the Basis of a Unified Treatment of the Action of Electrical Indicating Instruments".

Society of Chemical Industry, London Section (joint meeting with the Institute of Metals, London Section, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Mr. N. P. Inglis: "The Production and Properties of Titanium and its Alloys".

Society of Chemical Industry, Food Group (joint meeting with the Association of Public Analysts, at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. Charles Wesley Dunn (U.S.A.): "The United States Federal Food, Drug and Cosmetic Law".

Royal Geographical Society (joint meeting with the Alpine Club, at the Royal Festival Hall, London, S.E.1), at 8.30 p.m.—Mr. Charles Evans and Mr. George Band: "Kanchenjunga Climbed".

## Tuesday, November 8

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. P. J. Fensham: "Communications and Supervisory Organisation during a Period of Automatic Innovation".

Zoological Society of London (in the Mappin Refreshment Pavilion, Mappin Terrace, Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Meeting.

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. Arthur Gaitskell: "The Gezira Scheme".

University of London (at the Royal College of Science and Technology, South Kensington, London, S.W.7), at 5.30 p.m.—Prof. A. W. Skempton: "The Development of Soil Mechanics and its Place in the University" (Inaugural Lecture).

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. O. G. Edholm: "The Effect of Cold on Man". (Fourth of fifteen Lectures on "The Scientific Basis of Medicine".)*

Illuminating Engineering Society (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. F. Jackson, Mr. R. Molloy and Mr. K. Scott: "Efficiency of Fluorescent Lamps".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. M. Hurel: "High Aspect Ratio Wings".

Institute of Metals (at the Royal Institution, Albemarle Street, London, W.1), at 8.30 p.m.—Prof. Cyril S. Smith (University of Chicago): "The Shape of Grains in Single-Phase and Two-Phase Alloys".*

## Wednesday, November 9

Institute of Metals (at the Royal Institution, Albemarle Street, London, W.1), at 10 a.m.—Symposium on "The Mechanism of Phase Transformations in Metals".

University of London (at the Postgraduate School of Medicine, Ducane Road, London, W.12), at 2 p.m.—Dr. P. Fourman: "Salt and Water Metabolism".*

Physical Society, Colour Group (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Mr. E. H. Leach: "Structure of the Retina and Colour Vision"; Dr. W. A. H. Rushton, F.R.S.: "The Physical Measurement of Human Cone Pigments in the Normal and the Colour Blind".

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S W.1), at 5.30 p.m.—Mr. J. R. Hawkins and Mr. G. Nonhebel: "Chimneys and the Dispersal of Smoke".*

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p m.—Prof. F. H. Garner, Mr. G. H. Grigg, Prof F. Morton and Dr. W. D. Reid: "Preflame Reaction in a Diesel Engine".

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. G. B. B. Chaplin, Mr. R. E. Hayes and Mr. A. R. Owens: "A Transistor Digital Fast Multiplier with Magneto-Strictive Storage"

Society for Water Treatment and Examination (joint meeting with the Institution of Heating and Ventilating Engineers, at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 5.30 p m.—Symposium on "Corrosion".

University College London (in the Physiology Theatre, Gower Street, London, W.C.1), at 5.30 p.m —Prof. Sven Hörstadius (University of Uppsala): "On the Determination of the Bilateral Symmetry in the Sea-Urchin Egg".*

Society for Analytical Chemistry, Microchemistry Group (at The Feathers, Tudor Street, Strand, London, E.C 4), at 6.30 p.m.—Discussion on "The Determination of Carbon and Hydrogen".

## Thursday, November 10

Royal Society (at Burlington House, London, W.1), at 4.30 p.m.—Mr. R. A. Bagnold, F.R.S.: "The Flow of Cohesionless Grains in Fluids"; Mr. B. R. Morton, Sir Geoffrey Taylor, F.R.S., and Mr. J. S. Turner: "Turbulent Gravitational Convection from Maintained Sources".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. T. H. Kinman, Mr. G. A Carrick, Mr. R. G. Hibberd and Mr. A. J. Blundell: "Germanium and Silicon Power Rectifiers".

Society of Chemical Industry, Microbiology Group (joint meeting with the Agriculture and Pesticides Groups, at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. N. F. Robertson: "Disease Resistance in Plants".

## Friday, November 11

Physical Society, Acoustics Group (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Dr. E. G. Richardson: "The Acoustic Interferometer".

North East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre, Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Prof. L. C. Burrill: "The Optimum Diameter of Marine Propellers. A New Design Approach".

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Mr. A. R. Powell, F.R.S.: "The Procurement of Some Hitherto Rare Metals".

University of London (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Sir Mortimer Wheeler: "The Story of the Ancient Britons".*

## Saturday, November 12

British Psychological Society (joint meeting with the Social Psychology Section, in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 2 p.m.—Mr. W. A. Belson "Learning and Attitude Changes Produced by a Television Broadcast, with Special Reference to Research Method"; Mr. Alexander Mitchell: "The Content of Communication"; Mr. P. L. Short: "The Development of Some Experimental Techniques for Obtaining Viewers' Reactions to T.V. Films"; Dr. Eunice Belbin: "The Effect of Propaganda on Recall, Recognition and Behaviour".

British Interplanetary Society (in the York Hall, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Dr. J. M. K. Kooy: "Space Travel and Future Research into the Structure of the Universe" (Overseas Lecture).

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Lecturer or Lecturer (with teaching, research and/or industrial experience, preferably with research or industrial experience of electronic circuits) in Physics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (November 10).

Research Assistant (graduate in civil engineering) in Public Health Engineering, for work forming part of an extensive programme of research in aspects of public health engineering—The Registrar, King's College, Newcastle-upon-Tyne (November 12)

Lecturer in Pharmacology—Registrar, King's College, Strand, London, W.C.2 (November 15).

Lecturer in Fuel Technology and Chemical Engineering—The Registrar, The University, Sheffield (November 19).

Senior Research Officer (with laboratory experience in the diagnosis and investigation of diseases of equines, especially mares and new-born foals, and ability to organize a service covering diagnosis, investigation, research and advice on such diseases) at the Veterinary Research Laboratory, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (November 22).

Professor of Engineering at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Ceylon, November 24).

Director of the West African Institute of Social and Economic Research, University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1, Gordon Square, London, W.C.1 (November 30).

Lecturer (graduate, with special interest in surveying) in Civil Engineering—The Registrar, King's College, Strand, London, W.C 2 (November 30).

Lecturer in Geography—The Secretary of University Court, Glasgow (December 1).

Chair of Building Science—The Registrar, The University, Liverpool (December 10).

Lecturer in Metallurgy in the Faculty of Engineering—The Secretary and Registrar, The University, Southampton (December 15).

Chair of Bacteriology—The Secretary, The University, Edinburgh (December 31)

Assistant Experimental Officer (with training in agricultural science), for research work on the nutrition of grazing animals—The Secretary, Rowett Research Institute, Bucksburn, Aberdeen.

Chemist (with first- or second-class honours degree, or equivalent qualification, and at least three years general industrial experience, preferably with a knowledge of liquid fuels and lubricants), at the Central Laboratory, Chiswick—The Recruitment and Training Officer, London Transport, 55 Broadway, London, S.W.1, quoting F/EV.550.

Lecturer (graduate of a British university, preferably with an interest in electromagnetic theory and teaching experience) in Mathematics, to teach to final B.Sc. degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

PRODUCE OFFICER (with a university degree in commerce, economics or agriculture and with administrative ability, preferably with experience of inspection and grading of agricultural products) with the Government of the Western Region, Nigeria—Crown Agents, 4 Millbank, London, S.W.1, quoting MIB/35384/TA.

SENIOR LECTURER (with practical experience and extensive chemical knowledge of both thermo-setting and thermo-plastic resins) IN PLASTICS TECHNOLOGY—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS (with a first- or second-class honours degree in physics or electrical engineering, or equivalent qualification, preferably with experience in the field of spark and arc discharge phenomena, plasma research or particle acceleration; for senior posts at least three years postgraduate research experience is necessary), to study problems associated with the production and acceleration of charged particles—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 782/34.

# REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

## Great Britain and Ireland

*Planning*. Vol. 21, No. 384 (8 August 1955): Balance Sheet of the Press. Pp. 141–154. (London: Political and Economic Planning, 1955.) 2s. 6d. [108

Christendom or Christianity: Which One is "the Light of the World"? Pp. 32. (London. Paddington Congregation of Jehovah's Witnesses, 1955.) [108

Medical Association for the Prevention of War. Bulletin Supplement (July, 1955): Proceedings of the Annual Conference, 1955—Medical Effects of Radioactivity. Pp. 12. (London: Medical Association for the Prevention of War, 1955.) 1s. [108

Report by the Hydrographer of the Navy on the Surveys carried out by H.M. Naval Surveying Service, and of the work of the Hydrographic Department for the year 1954. Pp. 12. (H.D. 501.) (London: Admiralty, 1955.) [108

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1954. Scottish Division. By W. Widdas. Pp. ii+29+4 plates. (London: H.M. Stationery Office, 1955.) 2s. net. [108

*Journal of Electronics*. Vol. 1, No. 1 (July 1955). Pp. 102. (London: Taylor and Francis, Ltd., 1955.) 20s. (Subscription price per volume (6 parts), 110s.) [108

National Union of Journalists. Freelance Directory, 1955. Pp. 59. (London: National Union of Journalists, 1955.) [108

The Application of Nipa Products as Preservatives, Antiseptics and Antioxidants in the Cosmetic and Allied Industries. Pp. 20. (London: Nipa Laboratories, Ltd., 1955.) [108

British Electrical and Allied Industries Research Association. Technical Report L/T284: Self-energy of Electrons in Lattice Fields. By M. Gurari. Pp. 8. 9s. Technical Report L/T312. Electrons in Polar Materials. By M. J. Buckingham. Pp. 7. 6s. Technical Report Z/T86: Initial "Acceleration" and "Deceleration" in Novae and Solar Flares. By C. E. R. Bruce. Pp. 5. 4s. 6d. Supplement to Technical Report Z/T86: Initial "Acceleration" and "Deceleration" in Novae and Solar Flares. By C. E. R. Bruce. Pp. 7. 6s. (Leatherhead: British Electrical and Allied Industries Research Association, 1951–1955.) [108

Forestry Commission. Bulletin No. 25: Studies of North-West American Forests in relation to Silviculture in Great Britain. By R. F. Wood. Pp. iv+43+35 photographs. 6s. net. Thirty-fifth Annual Report of the Forestry Commission for the year ended September 30th 1954. Pp. 88. 3s 6d. net. (London: H.M. Stationery Office, 1955.) [108

Phenoxetol. Pp. 20. (London: Nipa Laboratories, Ltd., 1955.) [108

London School of Hygiene and Tropical Medicine. (The Ross Institute—Industrial Advisory Committee.) Bulletin No. 1 (Re-written June, 1955): Residual Insecticides. By G. Davidson. Pp. 31. Bulletin No. 10 (July, 1955): Water. By Dr. E. Ford Tredre. Pp. 31. (London: London School of Hygiene and Tropical Medicine, 1955.) [108

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology, for the year 1954, with the Report of the Geological Survey Board and Report of the Director. Pp. iv+88. (London: H.M. Stationery Office, 1955.) 3s 6d. net. [108

Transport. Pp. 15+4 plates. (London: Unilever Limited, 1955.) [108

Scottish Society for Research in Plant-Breeding. Scottish Plant Breeding Station Annual Report, 1955. Pp. 36+10 plates. (Roslin: Scottish Society for Research in Plant Breeding, 1955.) [108

Esso Petroleum Company Limited. Annual Review, 1954. Pp. 31. (London: Esso Petroleum Company, Ltd., 1955.) [108

Discovery Reports. Vol. 27, Pp. 293–302, plates 14–18: The Wax Plug in the External Auditory Meatus of the Mysticeti. By P. E. Purves. (Cambridge: At the University Press, 1955. Issued by the National Institute of Oceanography.) 10s. 6d. net. [108

## Other Countries

University of Illinois. Engineering Experiment Station. Circular No. 66: The Axial Variation of the Magnetic Field in Solenoids of Finite Thickness. By Prof. Dillon E. Mapother and Prof. James N. Snyder. Pp. 93. 1 dollar. Bulletin No. 428: Strength in Shear of Reinforced Concrete Beams. By Armas Laupa, Prof. Chester P. Siess and Prof. Nathan M. Newmark. Pp. 73. 1 dollar. Bulletin No. 429: Observed and Computed Settlements of Structures in Chicago. By Prof. B. Peck and Mehmet Ensar Uyanik. Pp. 60. 90 cents. Bulletin No. 430: Stresses around Mine Openings in Some Simple Geologic Structures. By R. D. Caudle and Prof. G. B. Clark. Pp. 42. 65 cents. (Urbana, Ill.: University of Illinois, 1955.) [10

Department of Agriculture, Ottawa. Report of the Director Science Service for the year ended March 31, 1954. Pp. 64. (Ottaw Queen's Printer, 1955.) [1

Meteorological Research Institute. Oceanographical Laborator Collected Reprints. Vol. 2: Nos. 24–34. (Tokyo: Meteorologic Research Institute—Oceanographical Laboratory, 1955.) [1

Publications de l'Institut National pour l'Étude Agronomique d Congo Belge. Série Scientifique No. 64 (1955): Observations sur Genèse des Nappes de Gravats dans les Sols Tropicaux. Par D. d Heinzelin. Pp. 37. (Bruxelles: Institut National pour l'Étude Agr nomique du Congo Belge, 1955.) 30 francs. [10

United States Department of Agriculture. Farmers' Bulletin N 2082: Commercial Production of Greenhouse Tomatoes. By William Porte and Floyd F. Smith. Pp. 30. 15 cents. Technical Bullet No. 1110: Studies of Airplane Spray-Deposit Patterns at Low Fligh Levels. By Joseph C. Chamberlin, Charles W. Getzendaner, Harold Hessig and V. D. Young. Pp. ii+45. 25 cents. (Washington, D.C. Government Printing Office, 1955.) [10

National Research Development Corporation of India. First Annu Report and Statement of Accounts for the period ending 31st Marc 1955. Pp. 17. (New Delhi: National Research Development Corpora tion of India, 1955.) [10

Fertilizing Flue-cured Tobacco. Pp. 12. (Salisbury: Tobacco Research Board of Rhodesia and Nyasaland, 1955.) [10

Proceedings of the California Academy of Sciences. (Fourth Series Vol. 28, No. 7: On the Pacific Sardine (*Sardinops Caerulea* Girard in Aquaria—Transportation, Handling, Maintenance, and Surviva By Anatole S. Loukashkin and Thomas C. Groody. Pp. 339–35 Vol. 28, No. 8: Notes on Australian Amphibians. By Joseph Slevin. Pp. 355–392. (San Francisco: California Academy of Science 1955.) [10

Indian Forest Records (New Series). Entomology. Vol. 8, No. 11 Immature Stages of Indian Lepidoptera. No. 9—Pyralidae, sub-famil Pyraustinae. By R. N. Mathur. Pp. 241–265+4 plates. (Delhi Manager of Publications, 1954.) Rs. 1/10/-; 2s. 6d. [10

Smithsonian Miscellaneous Collections. Vol. 128, No. 6: A Revisio of the Chiggers of the Subgenus Gahrliepia (Acarina: Trombiculidae) By Robert Traub and Mary Lou Morrow. Pp. ii+89. (Publicatio 4215.) (Washington, D.C.: Smithsonian Institution, 1955.) [10

Laboratoires de Biologie Marine des Côtes de France. Pp. 40 (Paris: Ministère de l'Éducation Nationale, 1955.) [10

Scientific Research Activities of Mellon Institute, 1954–1955. (Annua Report Series, No. 42.) Pp. v+53. (Pittsburgh: Mellon Institute, 1955.) [108

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Carte des Sols et de la Vegetation du Congo Belge et du Ruanda-Urundi. 5—Mosso (Urundi). A—Sols, B—Vegetation, C—Utilisation de Sols. Notice explicative de la Carte des Sols et de la Vegetation. Par G. Bourbeau, C. Sys, R. Frankart, G. Michel et J. Reed. Pp. 40+2 plates. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1955.) 200 francs. [10

Bibliographien des Deutschen Wetterdienstes. Nr. 2: Bibliographie "Klima und Mensch" 1950–1951. Bearbeitet von Hans Cordes und Gerhard Zimmermann. Pp. x+59. (Bad Kissingen: Deutschen Wetterdienstes, 1955.) 7 D. marks. [108

## Catalogues

American Library. Recent Additions. Pp. 88. (London: American Library, 41 Grosvenor Square, 1955.)

British Drug Houses Limited. Laboratory Chemicals and Testing Outfits Catalogue. (January 1955.) Pp. viii+260. (Poole: British Drug Houses Limited, 1955.)

Murphy Chemical Company, Ltd. Price List—Insecticides, Fungicides, Fumigants for horticultural and agricultural use. (Spring 1955.) Pp. 27. (Wheathampstead: Murphy Chemical Co., Ltd., 1955.)

List of Publications of the Commonwealth Scientific and Industrial Research Organization, Australia, to December 1954. Pp. 35. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1955.)

Michrome Biological Stains and Reagents. Pp. 52. (London: Edward Gurr, Ltd., 1955.)

Aluminium Development Association. List of Publications. Pp. 28. (London: Aluminium Development Association, 1955.)

Interchangeable Laboratory Glassware. Pp. 32. (Loughborough: Loughborough Glass Company, Ltd., 1955.)

Gurr's Biological Stains and Reagents, 1955. (Price List D.) Pp. 24. (London: George T. Gurr, Ltd., 1955.)

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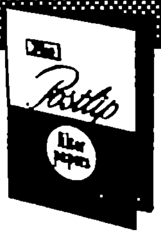

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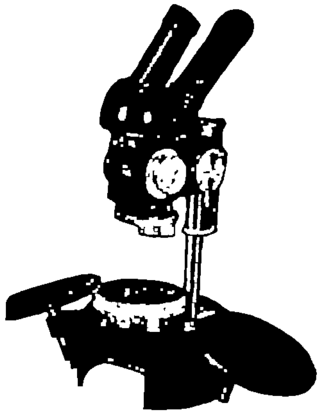

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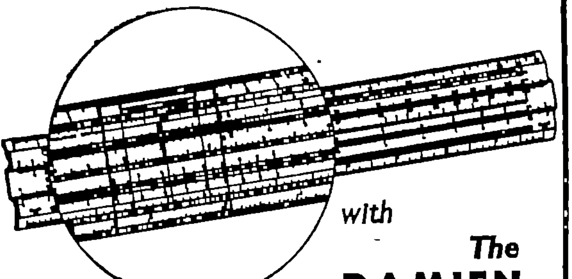

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JAMES HENDERSON,
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Further particulars may be obtained from the Director and Secretary to the Trustees, P.O. Box 61, Cape Town.

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K R PILLING,
Clerk to the Governing Body

# ATMOSPHERIC POLLUTION IN BRITAIN

THE Clean Air Bill that the Government pro- duced at the end of July to implement the ncipal recommendations of the Beaver Report, ich called for legislation, has just received a ond reading in the House of Commons. It is no sense a party measure, and while it conforms sely to the sense and purpose of the Beaver Report, e recommendations of which have won general ceptance, in its present form it may well be regarded a working draft. As such it has not only been dely discussed in the technical Press, but also at e annual conferences of the National Smoke Abateent Society during September 28–30 and of the nitary Inspectors' Association on September 30. oreover, while the Bill itself says nothing about lphur compounds, that aspect was emphasized in pers presented, for example, at the symposium on e prevention of atmospheric and water pollution in e chemical industry arranged by the London ction of the Society of Chemical Industry last pril and in Dr. A. Parker's Des Voeux Memorial cture at the National Smoke Abatement Society's nference on September 30.

In general, the Bill has been welcomed as likely to a long way towards implementing the views of the eaver Committee. Criticism has chiefly been that ere are too many escape clauses, and a resolution lopted at the Sanitary Inspectors' Association Conrence which welcomed and pledged support to the ill urged that the reservations or exemptions conmplated in respect of offences should not be allowed obstruct its aims. It was also suggested that the sponsibility for the control of smoke from the dustrial processes scheduled in Section 109 of the ublic Health Act 1936 should remain with the local thorities, and that it should no longer be necessary serve notices for smoke nuisance.

Commenting on the Bill at this Conference, Sir ugh Beaver regretted that the Bill omitted to tablish a Clean Air Council or to declare specifically at clean air was to be the national policy. Such a claration would force nationalized industries to ke due account of this matter; and the Clean Air ouncil would be invaluable in securing co-operation research, which is difficult to achieve without some ntralized body. The Beaver Report itself lists a umber of topics on which further research or evelopment work is required, including particularly e possibilities of reducing the amount of sulphur fuel, of preventing release of the sulphur in the el into chimney gases, of removing sulphur from e chimney gas before discharge into the air and of roviding more information on the dispersion of lphur compounds in flue gases after discharge from imneys of different heights and in all atmospheric nditions.

Matters such as these, and the study of the physiogical effects of air pollution in general on health in lation to respiratory diseases and particularly the fects of combinations of sulphur dioxide and smoke, clearly call for co-ordinated effort by a number of research bodies and institutions; one outcome of debate on the Bill in Parliament should be the provision of some satisfactory means of ensuring that concerted long-range research in such matters, and in others upon which the ultimate achievement of a clean air policy in Britain depends, is neither neglected nor starved of adequate resources. This is perhaps one aspect to which scientists might give particular attention. If the proposal for a Clean Air Council is rejected, Parliament should be left in no doubt where the responsibility for effective research in this field rests. If it is suggested that it should be left generally to the Lord President of the Council or the Advisory Council for Scientific Policy, the occasion should be used for a closer scrutiny of the proposed organization, to satisfy Parliament and responsible professional opinion that the organization is adequate and appropriately staffed and provided with funds on a scale and in a way sufficient to ensure continuity of effort. The importance of such co-ordination is further indicated by the announcement on October 7 by the Public Health Committee of the Western European Union that a preliminary study of air pollution is to be made in the seven countries of the Union (Belgium, France, Luxembourg, The Netherlands, the Federal German Republic, Italy and the United Kingdom).

The question of staff may be more formidable than appears to have been recognized in the discussions that have so far taken place. In the absence of a body specifically responsible for research on the many aspects of atmospheric pollution and its prevention, it may be difficult not merely to secure a reasonable balance of effort between those varied aspects and between the short-term and the long-term effort, but still more to ensure that such research effort is not deflected, particularly in the existing shortage of scientific and technical man-power, by the exigencies of other fields of research. Moreover, it is premature to expect local authorities to carry out their greater responsibilities which the Bill proposes to place upon them unless they have at their disposal a much larger and well-trained staff.

Sir Hugh Beaver emphasized this aspect at the Sanitary Inspectors' Association's Conference at Scarborough. He does not think that the magnitude of the task is as yet realized. Pointing out that there are 200,000 furnace chimneys to be watched in the 'black areas', as well as 20,000 steam engines, he emphasized that the sanitary inspector's burden would be greatly increased; in view of the shortage of man-power, he suggested the formation of an inspecting staff below the specialist grades, which would be competent to carry out 90 per cent of the routine work. Moreover, on the other side, the prevention of smoke itself requires the use of better trained staff, and in a discussion at the conference of the National Smoke Abatement Society there was agreement that all stokers of hand-fired furnaces should be trained and certificated. Mr. Gerald Nabarro, who withdrew his private member's bill on air pollution in favour of the Government's measure, stated that last year only 650 out of 75,000 boilermen employed in industry had been trained to a minimum standard; but he agreed with Mr. Alfred Robens that in two or three years it would be reasonable to insist that only a trained stoker should be in charge of a hand-fired furnace.

It is desirable that the escape clauses of the present Bill should be considered in the light of the demands which the Bill makes for trained staff and the problem of recruiting and training appropriate staff by industry and by the local authorities. There is much force in Mr. Nabarro's criticism that there are too many escape routes for the recalcitrant owner of an industrial chimney, and the three or five years limit suggested by Mr. Nabarro for the reduction of black smoke seems much more reasonable than the seven years proposed in the Bill as it stands. On the other hand, while there may be too many loopholes, there are clauses which promise to prove a nuisance to industry to no useful purpose. The requirement under clause 6 in regard to the measurement of grit and dust from furnaces burning ten tons an hour or more of solid fuel could well be unnecessarily burdensome and so unevenly applied by local authorities as to yield no useful result.

The Beaver Committee recommended that financial assistance should be provided by local authorities and by the Exchequer towards the costs incurred by house owners in converting appliances in smokeless zones and smoke-control areas. The provision in the Bill that the Government should pay 40 per cent, and the local authority at least half of the balance, of the cost of converting domestic grates in smoke-control areas is a reasonable distribution, and is also designed to stimulate local authorities to find out exactly what a smoke-control order will entail before they determine its scope and character. Sir Hugh Beaver, however, suggested at Scarborough that financial assistance to industry is also necessary, and that it could be combined with the elimination of some of the dubious escape clauses.

It will be noted that the Bill makes no distinction between smokeless zones, in which the emission of smoke from chimneys would be entirely prohibited, and smoke-control areas in which the use of bituminous coal for domestic purposes would be restricted. The Beaver Committee proposed the use of the latter term for areas in which the domestic consumption of coal containing more than 20 per cent of volatile matter would be prohibited. If there are valid reasons for regarding it as undesirable or impracticable to make this distinction, on psychological grounds it would be preferable to retain the term 'smokeless zone' rather than to introduce the new term.

In the first place, there is the well-attested success which has attended the introduction of such zones in Manchester and elsewhere. This has depended on the understanding and support of the public, and introduction of a new term could lead to confusion or misunderstanding to no fruitful purpose. More than this: if it is important that care should be tak not to move too far ahead of the financial and tec nical resources as well as of the man-power which campaign for clear air involves, it is still mo important not to move too far in advance of pub opinion. The Clean Air Bill is best regarded as o step in a concerted campaign throughout Britain be carried out on many fronts, the success of whi will depend above all not on legislation but on t understanding and co-operation of the public. T debates on the Bill will doubtless make clear the pa which local authorities, the nationalized fuel indu tries, the Department of Scientific and Industri Research, the Medical Research Council and oth research bodies or professional institutes, the Briti Standards Institution, business firms and the Gover ment itself will play, by voluntary action as well under the provisions of the Bill. Some of tho responsibilities appear to require further delineation

While there is need for further thought an clarification in this respect, the over-riding need for a sustained campaign of public education. Th is particularly important in regard to domest smoke; the desirability of flexibility in this fiel must not be permitted to encourage laxity. Whi it can be assumed that public opinion is now firml in favour of preventing atmospheric pollution, cannot safely be assumed that all individuals are ye prepared to accept all that is involved in preventin pollution, even from their own chimneys. Th practice of 'firing' a domestic chimney instead having it swept is still too common for that assump tion to be sound. Moreover, while most are probabl now willing to accept that personal responsibility provided they know it will be effective because th same obligation rests on all, their co-operation is a once endangered if they see others taking advantag of loopholes or defying the law with impunity.

One matter which calls for further examinatio here is the availability of supplies of smokeless fue particularly for the domestic consumer. The Beave Report has been criticized as unduly optimistic o this point, though it believes that the rate of progres will be set by administration limits and the replace ment of appliances for the next five years. It i important, however, that administrative action i the creation of smokeless zones should not mov ahead of the availability of supplies of smokeles fuels, as well as of technical staff and appliances Otherwise public co-operation will be hindered an frustration engendered—if indeed friction and dis appointment do not smother the existing good wil

It is impossible to overstress the importance c securing full public co-operation and understanding and the provisions of the Bill should be carefull scrutinized in Parliament from that point of view It bears, moreover, on a further point. The Bill doe not anticipate that the cost to the Exchequer of th recommended measures will exceed some thre million pounds per annum, or that the cost of th additional technical staff to be appointed by th Ministry of Housing and Local Government and th Department of Health for Scotland will be mor than some £40,000 per annum. No estimate is give the cost to the local authorities, and here particularly the support of public opinion is essential if e necessary expenditure is to be incurred. It annot yet be taken for granted that all local uthorities in Britain are concerned to prevent noke.

What stands out above all, however, is the trifling xpenditure required locally and nationally to secure or Britain so great a benefit to the national health s well as to industrial efficiency. The Beaver Report stimated that atmospheric pollution is costing the ountry as much as £250 million a year in direct osts and loss of efficiency. This is equivalent to £10 er head of population in the 'black areas' and £5 per ead throughout Great Britain, and it excludes a loss stimated at between £25 and £50 million a year hrough the imperfect combustion of coal which itself auses much of the pollution. Dr. Parker, in his Des Voeux Lecture, also stressed this material and conomic aspect; and apart from the implications or human health and happiness, when it is realized hat for a town of 50,000 inhabitants air pollution osts about half a million pounds annually, it is mpossible to dispute Sir Ernest Smith's contention t the National Smoke Abatement Society's Conference that reasonable expenditure of even £20,000 year on proper publicity and education to further ts prevention by securing public support for the ncreased expenditure required would be amply epaid. Nor should it be forgotten that a campaign or clean air is not only imperative as a matter of ational policy; it is also an essential element in the ational fuel policy which is long overdue, and which he prospect of nuclear power makes the more mperative.

# GUY'S HOSPITAL

## Mr. Guy's Hospital, 1726–1948

By Dr. H. C. Cameron. Pp. xiv + 520 + 36 plates. London: Longmans, Green and Co., Ltd., 1954.) 30s. net.

OF all the great London teaching hospitals, Guy's is the only one which is known by the name of ts founder, and, apart from the two ancient foundaions of St. Bartholomew's and St. Thomas's, none as a more interesting history. The story has been old on several occasions. Nearly all the accounts are hort, but in 1892 Sir Samuel Wilks and G. T. Bettany published a very sound history of the institution. The many changes which took place in the succeeding alf-century, and the complete break with the old order following the passing of the National Health Act in 1946, rendered a new history desirable. Dr. H. C. Cameron, who was an alumnus of Guy's in the arly years of the present century, and who was in harge of the Department for the Diseases of Children from 1911 until he retired in 1945, had greater opportunities than most for absorbing the spirit of he place, and in this work he has with detail and harm retold the earlier story and brought it up to late.

Thomas Guy was born in Tamworth in 1644 or 1645, and was apprenticed to a printer in Cheapside. He soon set up for himself and began to specialize in the printing of cheap Bibles. There followed complications with the Clarendon Press, Oxford, which was then run rather inefficiently; but Guy soon came to an arrangement with the Delegates, and in 1684 he and his partner Parker were formally appointed Printers to the University of Oxford. The appointment lasted only four years, but by then Guy was a highly successful man. He became a sheriff of London in 1694, and he represented Tamworth in Parliament from 1695 until 1707. During this period he had made many gifts to his native place, including a fine group of almshouses and a new town hall. When the electorate rejected him at the election in 1707, he was so annoyed that he threatened to pull down the town hall.

Guy made a very large fortune, and he increased it enormously by his dealing in South Sea stock. In three months in 1720 he made £180,000, which was slightly more than half his gross estate at his death. He had long been interested in St. Thomas's Hospital, had been made a governor in 1704, and was meticulous in the administration of his gifts to convalescents. By 1721 he had decided to found a new hospital and was then discussing the plans. Guy died in December 1724, and he did not live to see his hospital in action, for the first patients were received on January 6, 1726.

In his will, Guy left detailed instructions regarding his hospital. It was to be governed by a general court consisting of not more than sixty and not less than forty governors. The president and treasurer were to hold office for life—unless they resigned or were removed by a special court. Guy envisaged his hospital as a sort of annexe to St. Thomas's, which then stood adjacent to the present Guy's site; and, though he expressed great interest in 'incurables', it is obvious from his will that the governors could admit the same type of patient as was admitted to St. Thomas's, though he hoped that they would be able to remain longer in his hospital. Between 1728 and 1734 the average length of stay of a patient in the hospital was eighty days. By that time there were four hundred beds.

One of the two physicians first appointed to the hospital was the celebrated James Jurin, who was even more distinguished as a natural philosopher than he was as a physician. Of the early surgeons, the best known is Samuel Sharp. The early nineteenth century saw the rise to international fame of the surgeons Sir Astley Cooper and Aston Key. In 1820, Richard Bright was appointed physician, and he was soon followed by Thomas Addison and the pathologist Thomas Hodgkin. With these men Guy's reached the peak of its greatness; but the succession has been ably upheld by many other distinguished men since their time. On its foundation, the salary for a physician or surgeon was £40 a year. The apothecary got £80; but in 1738 this salary was reduced to £50. Richard Stocker became apothecary in 1793, and he and his son James held the post for eighty years. James was a veritable store-room of medical lore, of the type of observation which is not easily imparted to others. When asked to see a young girl who had been sent in as suffering from pyæmia, he shook his head and said that a patient with pyæmia never did up her hair in that manner. Stocker was virtually dean of the Medical School until Frederick Taylor was officially appointed the first dean. In its early years the hospital had wooden beds which were infested with bugs, and the official bug-catcher had the same salary as a physician or surgeon. Perhaps the most lasting and constructive contribution to the development of the hospital made by one man was that of Benjamin Harrison, jun., who from 1797 until 1848 carried out the exacting administrative role of treasurer with the greatest enthusiasm, firmness and ability.

The complicated early history of the Medical School is fully dealt with in this book. 'Pupils' seem to have been admitted to the wards about 1760, and the students of Guy's and Thomas's could attend operations in both hospitals. As a result of disagreements, new arrangements were entered into in 1769 whereby the lucrative teaching of surgery and anatomy was concentrated at St. Thomas's, while the teaching of medicine, materia medica and chemistry, which as yet did not exist, was to be carried on at Guy's. Thus arose the Medical School of the United Hospitals of the Borough. It was the custom for a teacher to nominate his successor on his retirement. Astley Cooper, a Guy's man, was appointed demonstrator of anatomy in the United Hospitals School at the age of twenty-one. The classes were, of course, held at St. Thomas's, and two years later Henry Cline, a St. Thomas's surgeon, appointed Cooper as joint-lecturer with himself. The brilliance of Astley Cooper as a surgeon, and his great popularity as a lecturer in anatomy and surgery, made the United Hospitals School renowned far and wide. All the lecturers in the School regarded the lectureships as individual to themselves and they retained the fees. When Astley Cooper was about to retire from the lectureship in anatomy in 1825, his nominee as his successor was turned down by the governors of St. Thomas's without reference to the governors of Guy's, and a St. Thomas's nominee was appointed to the post. This was the beginning of the break-up of the United Hospitals School. To make matters worse, the governors of St. Thomas's refused to hand over to Guy's the magnificent collection of anatomical and pathological specimens, personally built up by Sir Astley Cooper, which was housed in the museum at St. Thomas's. The Guy's governors took action, built a museum, dissection-room and lecture room, and Astley Cooper in his old age began to form his second great collection of specimens. The Guy's School was during 1768–1805 the only London school which had organized courses in the medical, chemical and physical branches of medicine.

This fine work could only have been written by someone with a long and intimate knowledge of the hospital. Half the book is devoted to the period 1885–1948. This period, which is practically all subsequent to that covered by the work of Wilks and Bettany, was one of increasing complexity, due to the expansion of the possibilities of medical and surgical treatment, the growth of laboratories, and of rising costs with their consequences. Dr. Cameron deals in great detail with the administrative changes during this period, with the continuous expansion of the School and the additions to its staff, and with the bequests made to the hospital, especially by Lord Nuffield. The great work carried out by Sir Cosmo Bonsor as treasurer during 1896–1910, and as president from the latter date until 1919, is fully dealt with. There can be few persons surviving who know more than Dr. Cameron about the services rendered to the hospital by Sir Cooper Perry. Perry, a classics don, was appointed assistant physician in 1887, and when Steele, the first superintendent, retired in 1893, Perry volunteered to take over his post. Perry later became principal and vice-chancellor of the University of London, and his successor as superintendent, S Herbert Eason, followed the same road. Dr. Camero discussion of the work of men like Hale-Whit Herbert French, Arthur Hurst and Arbuthnot La is very sympathetic and interesting.

This book is very well produced, lavishly illu trated, practically free from typographical erro and very inexpensive. It is a pity, therefore, that should be marred by minor errors, such as th attribution of the Bright portrait to "F. R. Fa instead of F. R. Say, and by the fact that, despi the many footnotes, the actual sources of statemen are infrequently given. It should also be said that D Cameron seldom gives a quotation, either from printed or a manuscript source, without changing th punctuation and the orthography. Examples ma be found even in the transcriptions of the documen reproduced in facsimile. On pp. 90–94 a transcrip is given of a very important document dealing wit teaching in the Medical School. Dr. Cameron sa that this document has survived; but he gives n reference. Wilks and Bettany also give this documen in full, with minor variations; they also state tha it has survived, but give no reference. What th student wants to know is where this documen and others, can be examined. Such matters coul be rectified in a new edition, and it is to be hope that Dr. Cameron will soon have the opportunity t do this, and thus to set the seal on his valuable worl

E. ASHWORTH UNDERWOOD

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# INTERNATIONAL CONTROL OF NUCLEAR WEAPONS

## The Bomb

Challenge and Answer. By Prof. Alexander Haddow Bertrand Russell, Lord Beveridge and Henry Usborne Edited by Gilbert McAllister. Pp. 160. (London B. T. Batsford, Ltd., 1955.) 25s. net.

IN announcing the publication of this book at th world conference of scientists to consider th effects of nuclear weapons, organized in London earl last August by the World Association of Parlia mentarians, its editor, Mr. G. McAllister, who i secretary-general of that Association, stated that it preparation had been rushed through in three month to enable publication to coincide with the Londo conference. There is little, if any, indication o hurried writing in the five essays constituting th book, though there is some padding that on reflexio might have been omitted. Mr. McAllister himsel contributes a brief introduction and an essay detailin previous proposals for world government including for example, those of Clarence Streit, Lionel Curti and others; but neither in his reference to the pas nor to the present does he justify his title, "Practica Steps for a World Authority". The longest of th other four essays is that by Prof. A. Haddow o "The Problem before Mankind", which is essentiall an amply documentated summary of present know ledge as to the effects and probable hazards, especiall biological, of nuclear explosions and radioactiv exposure in general; it ends with some remarks o the social responsibility of the man of science an the way in which that responsibility might b met.

The remarks lead to nothing more concrete than for example, the proposal for an international scienc

uncil which the late Lord Lindsay made nearly
n years ago in this connexion, and they offer no
sh suggestions for overcoming the practical diffi-
lties. Nor does Lord Russell's essay, "The Road
Peace", take the reader any further than the
gument of his earlier books or his broadcast appeal
the end of last year and the statement which he
d his co-signatories made public on July 9. Lord
ussell is realistic in his comments on the part which
e uncommitted nations must play in persuading
astern governments that it is futile to attempt to
cure merely an agreement not to use thermo-
uclear weapons. His essay is also useful for its
scussion of the limitations on the influence which
mocratic public opinion can exert; but he scarcely
ces the practical difficulties which the creation of
world authority would encounter. Much harder
nd more constructive thought than is manifest in
ny of these essays will be required if the technical
atement of the effects to be expected from a
ermonuclear war and its subscription, first by a
nall number of scientists of outstanding eminence,
nd then by scientists generally, followed by its
terpretation internationally into generally intel-
gible terms, are to have practical results.

Lord Beveridge's contribution, "The Conditions of
eace", restates the argument for disarmament, the
mitation of national sovereignty and establishment
f a supranational authority which characterize earlier
roposals for world federation without really gripping
he practical difficulties. He suggests that the British
overnment should draft and publish a considered
tatement of the conditions upon which Britain
ould be prepared to surrender the right to make
ar, including that of arming for war, and would
ake that surrender effective. Such a statement
ould be an advance on the nebulous renunciation
f war of the Kellogg Pact thirty years ago; but its
ormulation and approval in public debate could only
esult from the constructive thinking and facing of
ractical difficulties which for the most part these
ssays seem to burke.

Mr. Henry Usborne's essay, "The Approach to
Vorld Government", includes a similar suggestion;
ut his contribution is for the most part a rather
ambling review of earlier proposals for the inter-
ational control of nuclear weapons and of the stages
y which world federation should be achieved, and
e does not deal any more closely with the initial,
ntangible difficulties than either Lionel Curtis or
larence Streit. The claim that the book sketches
he outline of a world at peace and of those human
nd political institutions which are the essential
oundation and buttress of such a world can scarcely
e conceded without reservation. It presents a
hallenge and reveals how far in human understanding
ve have yet to go, but is far from providing an
nswer to the challenge. Its value is rather as a
eminder of how much thought has already been
iven during the past thirty years to the problem of
vorld government, and as a stimulus to the keener
hinking that is still required to bring such schemes
o fruition. Some of these earlier and more detailed
chemes, to which the book directs attention, may
vell merit re-examination in the changed conditions
f to-day. Nor should it be forgotten that the
nternational Conference on the Peaceful Uses of
tomic Energy, which met at Geneva in the weeks
mmediately following publication of this book, has
lready resulted in a great relaxation of secrecy
n this field and done much to re-establish the normal pattern of communication in the scientific world. The restoration of free communication of thought and ideas, as both Lord Russell and Prof. A. Haddow do not fail to note, is a first condition for the establishment of the climate of opinion and world understanding in which international political institutions can be evolved and rooted.

R. BRIGHTMAN

# THEORY AND PRACTICE OF NEUTRON DIFFRACTION

Neutron Diffraction

By G. E. Bacon. (Monographs on the Physics and Chemistry of Materials.) Pp. ix+299. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 35s. net.

ALTHOUGH neutron diffraction was demonstrated in the United States in 1936, it is only during the past ten years, through the advent of chain-reacting atomic piles, that neutron sources of sufficient intensity have enabled the technique to become of practical importance. Since, in contrast to X-rays, neutrons are scattered by nuclei instead of the electron clouds of atoms, neutron diffraction studies provide information about structure and the solid state that is complementary to the results of X-ray diffraction investigations. This point is particularly emphasized by the author in the present book.

The chief centres of active work in the field of neutron diffraction have been in Great Britain at the Atomic Energy Research Establishment, Harwell, and in the United States at the Oak Ridge National Laboratory, Tennessee, respectively. Many pioneering investigations in the subject have been carried out by the author himself at Harwell, and this first-hand account from so experienced a practitioner is most welcome. This is indeed the first general treatment in book form, though an excellent article by the author and Prof. Kathleen Lonsdale appeared in the 1953 "Reports on Progress in Physics", published by the Physical Society.

The chapters fall naturally into two groups. The first six chapters cover physical principles, experimental methods, and the derivation of the fundamental data required for structure investigations. In the chapter on experimental techniques, we are given a good insight into many of the special problems that have to be solved: for example, those of obtaining a monochromatic beam, of choosing the optimum size of specimen, and of recording the diffracted beams.

The second part, comprising seven chapters, deals with applications and is perhaps of most interest to the general reader. There is an instructive survey of the unique way in which the technique enables light atoms such as hydrogen to be located in structures where the X-ray method fails to give a solution. The author's own contributions to the development of Fourier synthesis technique, in clarifying details of the structure of potassium dihydrogen phosphate, for example, are described. Not the least of the achievements of neutron diffraction has been in the solution of structural detail in ferromagnetic and antiferromagnetic substances, and two chapters are devoted to this fascinating subject. Short chapters are included on small-angle scattering and diffraction by liquids and gases.

Some information valuable for reference purposes is presented in tabular form. Neutron and X-ray scattering data for the elements and isotopes are compared in Table 2, while the relations between the absorption characteristics of neutrons and X-rays are listed in Table 6. An interesting table on pp. 160–161 compares the properties of X-rays and neutrons for diffraction studies.

There are very few misprints or errors in the text, and the book is well bound and of a convenient size. The subject is a rapidly advancing one, papers reporting new developments appearing regularly month by month. It is therefore valuable to have this authoritative survey of the achievements to date. It should make a wide appeal to all those interested in the furtherance of knowledge about the solid state.

H. P. Rooksby

# NEW LIGHT ON AN OLD POLYMER

## Cellulose Nitrate

The Physical Chemistry of Nitrocellulose, its Formation and Use. By Dr. Frank Douglas Miles. Pp. xiii + 422 + 4 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1955. Published for Imperial Chemical Industries, Limited.) 45s. net.

THE theoretical and experimental background necessary for the understanding of high polymers is almost contemporary; the treatise of Staudinger was only published just over twenty years ago, and the modern entropy theory of their solutions is more recent still. Yet many of these substances, including nitrocellulose, have been major industrial products for a century or more. Workers in this field have therefore long felt the need for a treatise discussing, criticizing and interpreting, from a modern point of view, the great mass of experimental data and practical experience which has been acquired.

The treatise of Dr. F. D. Miles fulfils this need. His first chapter presents the X-ray and optical data on cellulose itself, and his second discusses the reaction of cellulose with nitric acid. Chapters 3–6 discuss the properties and applications of solid nitrocellulose and its gels (celluloid, leathercloth, cordite, etc.), and, finally, the last four chapters discuss the reactions of solid nitrocellulose, its fractionation, the properties of dilute solutions and the problem of solubility. The plan of the work is logical and orderly: the only criticism that can be made is that the presentation of data on solvent absorption and gelatinization in the fourth chapter, while the dilute solutions and general solubility are kept to the end, tends to hide their essential continuity.

In detail this book succeeds very well in holding the delicate balance between the old school who regarded such solutions and gels as uninterpretable except by special 'colloid-chemical' concepts, and the modernists who might consider there was nothing left to explain; in particular, Dr. Miles makes clear the importance of specific interactions between nitrocellulose and solvent molecules, although the last chapter does not tackle the difficult problem of the thermodynamic consequences of such interactions. The literature is very well covered—the long series of papers from government research establishments in France are given their proper importance, a Dr. Miles makes public for the first time much int esting work done in the laboratories at Ardeer Imperial Chemical Industries, Ltd. It would impossible in any reasonably sized book to disc all the literature on nitrocellulose: Dr. Miles h managed to include nearly all the important pape before 1954 and at the same time to exclude t enormous volume of unsound work which, before treatise, had to be ploughed through by those n to the subject.

This book can therefore be recommended to interested in work on high polymers, as well as those who specialize on cellulose and its derivative The book is well printed, and, for what it contains, very cheap.

# FURTHER STUDIES OF LAVOISIER' CHEMICAL DISCOVERIES

## Lavoisier

Théoricien et Expérimentateur. Par Maurice Dauma (Bibliothèque de Philosophie Contemporaine, Logiq et Philosophie des Sciences.) Pp. ii + 180 + 4 plate (Paris: Presses Universitaires de France, 1955 700 francs.

LAVOISIER has been the subject of many studie but some details of his life and works are st imperfectly known. M. Maurice Daumas, who h studied correspondence, notebooks and other unpu lished manuscripts preserved by the Paris Academ of Sciences, has re-examined several aspects Lavoisier's chemical works, and the present book w be of value to all who are interested in eighteent century chemistry.

A chronological account of Lavoisier's work beari on the theory of combustion, which has been con piled from many sources, shows that importa results were often read to the Academy long befor they were printed. The controversies over oxyge and water are briefly discussed, and it is conclude that Lavoisier did not himself claim priority fo either the isolation of oxygen or the combustion o hydrogen to form water, but that he did, with justic claim priority for the correct interpretation of th experiments. Many readers will agree with M Daumas that sentiment rather than impartial inquir has led to some opinions previously expressed o these topics.

M. Daumas also examines the origins of Lavoisier' "Traité Élémentaire de Chimie" (1789), showing tha it was first planned in 1780 or 1781, before the anti phlogistic theory was complete; and he gives a interesting account of Lavoisier's apparatus, much o which still exists. The accuracy attainable by scientist is limited by the quality of his apparatus a well as by his personal skill, and it was fortunat that Lavoisier could employ such excellent instrument-makers as Mégnié and Fortin.

After discussing Lavoisier's views on the nature o matter and on chemical affinity, M. Daumas concludes that, despite his genius, he could "act an think only as a man of the eighteenth century" However, he also directs attention to Laviosier' ability to "understand what was the problem of th hour, and to pursue it to its resolution"; that is rare quality which ensures greatness in any century

W. A. Smeaton

# ISTORTION OF THE *E* LAYER OF THE IONOSPHERE BY ELECTRICAL CURRENTS FLOWING IN IT

By SIR EDWARD APPLETON, G.B.E., K.C.B., F.R.S., A. J. LYON and MRS. A. G. TURNBULL

University of Edinburgh

T has long been known that the *E* layer of the ionosphere varies, both diurnally and seasonally, a fairly regular manner, in that its maximum nization density, $N_m$, is closely dependent on the lar zenith distance, $\chi$. In the earliest study of this gion, for example, Appleton and Naismith[1] found at, for the seasonal variation of noon maximum nization in south-east England, $N_m$ varied as os $\chi)^{1/2}$. Because of its substantially regular be-aviour, we have selected the *E* layer as a subject r more detailed study, to ascertain how far its roperties conform with those of an ideal ionized ayer, as classically expounded by Chapman[2]. We ave used, for this purpose, ionospheric data obtained y radio sounding from stations now operating all ver the world.

Chapman's well-known theory of ionized layer rmation is based on two simple specified assump-ions: the earth's atmosphere is considered to be othermal, and the process by way of which electrons lisappear is taken to be that of recombination. A urther tacit assumption is that there is no movement f ionization, electrons appearing, and eventually isappearing, at the same point in space.

We began our investigation by attempting to make careful comparison of the actual diurnal variation f $N_m$ in the *E* layer with that predicted by Chap-nan's theory. It can readily be seen physically, and ndeed is an essential result of the theory, that, due to he effects of recombination, the temporal variation of onization density in a given layer lags slightly behind he corresponding variation of the rate of electron roduction. Thus the day-time maximum value of $N_m$ s expected to occur after noon; while afternoon alues of $N_m$ are expected to exceed their correspond-ng forenoon values. Two well-known theoretical nethods of finding the value of the recombination oefficient $\alpha$ are, in fact, based respectively on these wo effects. For example, Appleton[3] has shown that he time delay $\Delta t$ of the maximum of $N_m$ relative to oon is given by $(2\alpha N_m)^{-1}$; so that, if the delay is neasurable, $\alpha$ can be determined, since $N_m$ is known. The other method of determining $\alpha$ is a little more omplicated, but depends essentially on the determ-nation of $\Delta N_m$, the difference between afternoon and orenoon values, for local times equally spaced elative to noon. Using the great wealth of iono-pheric data available for the Slough station, we ave used both the $\Delta t$ and the $\Delta N_m$ methods of nding $\alpha$, from the diurnal asymmetry of the *E* layer. The results obtained are very remarkable in indicating xtremely large variations of the *apparent* values of . Our problem has therefore been that of deciding whether, in fact, $\alpha$ really does vary in such a remark-ble fashion or whether the basic theory used is nadequate. In the latter case, if there were some dditional perturbing factor operative, one might ope that, as often happens in such cases, the nagnitude and nature of the discrepancy between heory and experiment would lead to the identifica-ion and measurement of the disturbing influence. As we shall see, such a hope has been, to a considerable extent, realized.

By extending our studies of the diurnal variation of $N_m$ to a range of latitudes other than that of Slough, we soon found evidence indicating that the values of *apparent* $\alpha$ obtained by the methods used could not possibly refer to the true recombination coefficient and were in fact being influenced by a perturbing factor. For example, while stations in the higher latitudes behaved like Slough, in that $\Delta t$ and $\Delta N_m$ were both found to be positive there, stations situated in a belt centred on the equator exhibited an inverse phenomenon, in that $\Delta t$ and $\Delta N_m$ were found to be negative. Evidently, then, for stations in low latitudes, the influence of the perturbing factor is so great that it can actually reverse the sign of the diurnal asymmetry and cause afternoon values of $N_m$ to be less than the corresponding forenoon values.

We were therefore led to examine afresh the whole basis of the theory of ionized layer formation, taking into account the possible influence of a likely perturbing factor. Now Chapman's theory is based on the simple continuity equation

$$\frac{dN}{dt} = q_0 \cos\chi - \alpha N^2 \qquad (1)$$

where $N$ is the electron density, $q_0$ the rate of electron production when the sun is vertical, and $t$ the time. If, however, we wish to take account of the possibility of electron transport phenomena, (1) must be written

$$\frac{dN}{dt} = q_0 \cos\chi - \alpha N^2 - \operatorname{div}(Nv) \qquad (2)$$

where the term div $(Nv)$ expresses the electron transport-rate out of the unit volume under consideration. Now, as Martyn[4] has suggested, vertical drift of neutral ionization is a type of electron transport likely to occur in the ionosphere; and Appleton and Lyon[5] have developed the Chapman theory so as to allow for the effects of such drift under conditions applicable to the *E* layer. The theory of Appleton and Lyon is, moreover, formulated directly in terms of the value of $N_m$ for a given layer, which is the quantity with which we are directly concerned in practice. From a practical point of view we are concerned with two effects of any vertical drift which may be operative, namely, the *alterations* it provokes in both the atmospheric level of the layer maximum electron density and in the magnitude of the maximum ionization density itself. We shall refer to these two departures from normality as $\delta h(N_m)$ and $\delta N_m$, respectively. The appropriate expressions for these quantities, given by Appleton and Lyon, are as follows:

$$\delta h(N_m) = \frac{v}{2\alpha N_m} \qquad (3)$$

and

$$\frac{\delta N_m}{N_m} = \frac{-\dfrac{\partial v}{\partial h}}{2\alpha N_m} - \frac{1}{4H^2}\left(\frac{v}{2\alpha N_m}\right)^2 \qquad (4)$$

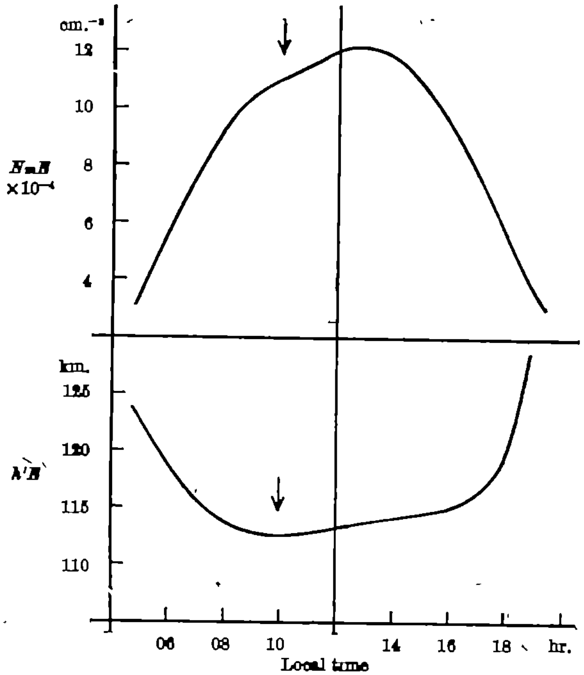

Fig. 1. Showing (upper curve) diurnal variation of Slough $E$ layer maximum ionization density, $N_m$; and (lower curve) diurnal variation of Slough $E$ layer height, $h'E$ In both cases abnormal variations (depressions) are to be noted in the forenoon when the ionospheric $S_q$ currents attain their maximum intensity

where $v$ is the velocity of vertical drift, $\frac{\partial v}{\partial h}$ is its vertical gradient (both measured positive upwards) and $H$ is the scale height of the atmospheric ionized component responsible for the $E$ layer. Equations (3) and (4) tell us, then, the corrections to the Chapman theory which are necessary to take vertical drift into account.

Now in looking for the possible intervention of vertical drift effects as a perturbing factor, we are naturally led to consider the $S_q$ overhead current system, which is responsible for the daily solar magnetic variations, as a likely origin, since there is ample evidence that this current system flows at or near the level of maximum ionization in the $E$ layer. We were additionally encouraged to do this since it is known that the $S_q$ currents flow in opposite directions in high and low numerical latitudes, and, as described above, our study of $E$-layer diurnal abnormalities suggests the intervention of some perturbing agent which has opposite influences in high and low latitudes. Now it is an important characteristic of the $S_q$ system that the overhead currents constituting it attain their maximum value, not at noon, but at about 1000–1100 h. local time. We were therefore led to look carefully for any abnormalities in $h(N_m)$ or $N_m$ at that period of the day, in view of equations (3) and (4). Unfortunately, values of $h(N_m)$ were not available, so we were obliged to use values of $h'E$, the height of the under-boundary of the $E$ layer, instead.

In Fig. 1 are shown the diurnal variations of $h'E$ and of $N_m$ for Slough over the summer months of the year. On the same diagram is marked the approximate local time when the overhead $S_q$ current (and the corresponding value of the horizontal north-seeking magnetic force, $X_q$) reach their maximum value. It will be at once apparent that, at this particular local time, the value of $h'E$ is abnormally decreased, while the value of $N_m$ is similarly reduce These results, we therefore submit, indicate that t $S_q$ current system can markedly influence $E$ lay phenomena and encourage us to count such an agen as likely to be one of the major perturbing facto responsible for the divergences we have identifi between $E$ layer behaviour and the Chapman theor

We may first note a very simple result of electr dynamical theory. Since, at Slough, the $S_q$ curre flows from east to west, athwart the northwar horizontal component of the earth's magnetic fiel we should expect the velocity of drift to be dow wards; and, as equation (4) indicates, we shou then expect the height of the layer (as measured l $h(N_m)$ or $h'E$) to fall in sympathy. We note th the abnormal variation of $h'E$, at the time of ma imum overhead east-to-west current, has just tl sign to be expected. It is, however, a novel resul which could not have been predicted, that $\delta N_m$ an $\delta(h'E)$ are of the same sense. Since only the fir term on the right-hand side of (4) is of numeric significance here, we can deduce, from (3) and ( together, that $v$ and $\frac{\partial v}{\partial h}$ are of opposite sign. In oth words, we find that, when the $S_q$ current flows fro east to west, both the velocity of drift and the laye height variation are downwards; while at the sam time the drift velocity falls off with increasing heigh leading to a reduction of the layer-ionization ma imum $N_m$. We have now only to assume that a these ionospheric changes are reversed in sense in lo latitudes (where, as we know, the $S_q$ current flow from west to east) to be able to explain the $E$ laye anomalies mentioned above. In low latitudes, fo example, due to the fact that the $S_q$ current syste is not situated symmetrically to the local noo meridian, the $E$ layer is subject to vertical drif effects which are different in the forenoon and after noon. Such vertical drift causes a marked enhance ment of $N_m$ in the forenoon, which so far disturb the natural diurnal asymmetry of $N_m$ as to caus both $\Delta t$ and $\Delta N_m$ to become negative, instead o positive, as simple theory would require.

Now although the $S_q$ system of overhead current is not situated quite symmetrically with respect t the noon meridian, its influence is generally exerte in the same sense over practically the whole of th middle of the day. Our study of abnormal diurna asymmetry in $N_m$, as described above, shows that a west-to-east $S_q$ current tends to raise the value o $N_m$, while an east-to-west $S_q$ current tends to reduc it. We can therefore see that the overall effect o such an agency of vertical drift is to influence the general level of $N_m$ in different ways in different latitudes; in low latitudes $N_m$ is increased, at the latitude of the $S_q$ current focus $N_m$ is sensibly un-altered, while in still higher latitudes $N_m$ is decreased. We are therefore encouraged to consider whethe this simple general result, obtained from a study o the abnormal diurnal behaviour of the $E$ layer, als explains any of the other abnormal features of the $E$ layer which have been described in recent years.

Now Appleton[6] has shown that, while the value of $N_m$ in the $E$ layer is closely dependent on the solar zenith distance, it is not uniquely dependent on $\cos\chi$. There is, additionally, a tendency for the value of $N_m$ to be high in low latitudes. For example, at the equinoxes, the contours of the geographical locations of constant $N_m$ are not circles, with the sub-solar point as centre, as would be expected if were uniquely dependent on cos χ. They are, stead, of elliptical shape, the major axis lying ong the equator. Again, in June and December at noon, it has been found that $N_m$ does not attain its maximum value at the sub-solar point but at a titude displaced therefrom by some 10° towards he equator. It will readily be seen that both hese anomalies are also explicable in terms of a erturbation which, *ceteris paribus*, causes $N_m$ to be greater in low latitudes than in higher latitudes. Moreover, a further study shows that these two anomalous features of $E$-layer morphology, namely, he abnormal diurnal asymmetry and the latitude dependence of $N_m$, are quantitatively reconcilable.

Finally, it may not be out of place to indicate hat we consider to be the significance of these sults in the general development of ionospheric tudies. Many years ago it was boldly suggested by Balfour Stewart[7] that the daily rhythmic variations f the earth's magnetic field might be due to circulating electrical currents in the upper atmosphere. The geomagneticians then indicated the intensity and configuration of the upper-atmospheric current system which would be required. The discovery of the ionosphere and the elucidation of its properties by radio sounding has shown that the upper atmosphere is, in fact, sufficiently conducting to be the location of such currents; and the work now described has confirmed the presence of ionospheric currents, of the type prescribed, by way of the distortion they engender in the medium in which they flow.

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# THE UNIVERSITY OF EXETER

By Prof. HUBERT T. S. BRITTON

Professor of Chemistry

ON October 28 the granting of the Royal Charter, reconstituting the former University College of he South West as the University of Exeter, was approved by an Order in Council at the meeting of he Privy Council, presided over by H.M. The Queen. The Charter appoints Mary, Duchess of Devonshire widow of the tenth Duke of Devonshire) as the first chancellor of the University of Exeter; Mr. B. G. Lampard-Vachell, deputy president of the College, as a pro-chancellor; and Dr. James W. Cook, principal of the College and formerly regius professor of chemistry in the University of Glasgow, as the first vice-chancellor.

This marks the culmination of the struggle to make Exeter the centre for higher education which began so far back as 1861, when Sir Stafford Northcote later the Earl of Iddesleigh) outlined his proposals for education at a meeting in Exeter in which he stressed the importance of making the city, "for which I believe it has natural and acquired advantages, a centre of Education for the West". A considerable sum was raised by subscription for the provision of premises for such an institution, and in 1862 a meeting was held to consider how this money could best be used to establish a memorial to the Prince Consort. It was decided that the memorial should be a museum with adjuncts for the study of art, science and literature, and the comments made by the Earl of Devon were prophetic in that the memorial would 'continue to future generations the special benefits for which the person to be honoured had in his lifetime devoted himself". In 1865 the erection of the Royal Albert Memorial was begun, and in it evening classes were held in preparation for the Science and Art Department examinations of South Kensington, and there were also extension lectures given under the auspices of the University of Cambridge.

This type of education developed, and a full-time principal, Mr. A. W. Clayden, was appointed in 1894, a part of his salary being paid by the Local Lecture Syndicate of the University of Cambridge. Extensions of the Royal Albert Memorial became necessary, and one of these was opened in 1895 by the Duke of Devonshire, chancellor of the University of Cambridge. In 1897 the foundation stone of yet another extension, known to-day as the York Wing, was laid by the Duke of York, later King George V. This is the only part of the Memorial Building that is still used by the College, the rest being occupied by the Museum, Art Gallery and College of Art.

The session 1901–2 was notable in the history of the College, for it was then that courses were first devised to prepare some students for the London external degrees of B.A. and B.Sc., and in that year the College was recognized as a day training college for women, Mr. Clayden then becoming principal of the Royal Albert Memorial Museum, Library and College. In 1903 the College was recognized as a day training college for both men and women.

In 1904 the Exeter City Council sought the advice of Prof. (later Sir) Michael E. Sadler, of the Victoria University of Manchester, on the best way of coordinating and developing the educational work of the City, and in his report he stated that "Exeter is the educational metropolis of the west", and ended by asking the question, "Can we feel surprise, therefore, that the Royal Albert Memorial College shows many signs of its capacity to become the University College of the West". He records that in July 1904 there were four students preparing for final B.A. and B.Sc., seventeen for intermediate arts and science, thirty-six for London matriculation, eight for preliminary medical examinations and a hundred for the teachers' certificate of the Board of Education.

The College grew and by 1906 more spacious premises were required, and they are the buildings now occupied by the Arts Faculty. Whereas the cost of the original buildings was defrayed almost entirely from public subscriptions made by people living in Devon and Exeter, the cost of this building (£25,000) was met by the City of Exeter, except for a contribution of £6,400 made by the Board of Education.

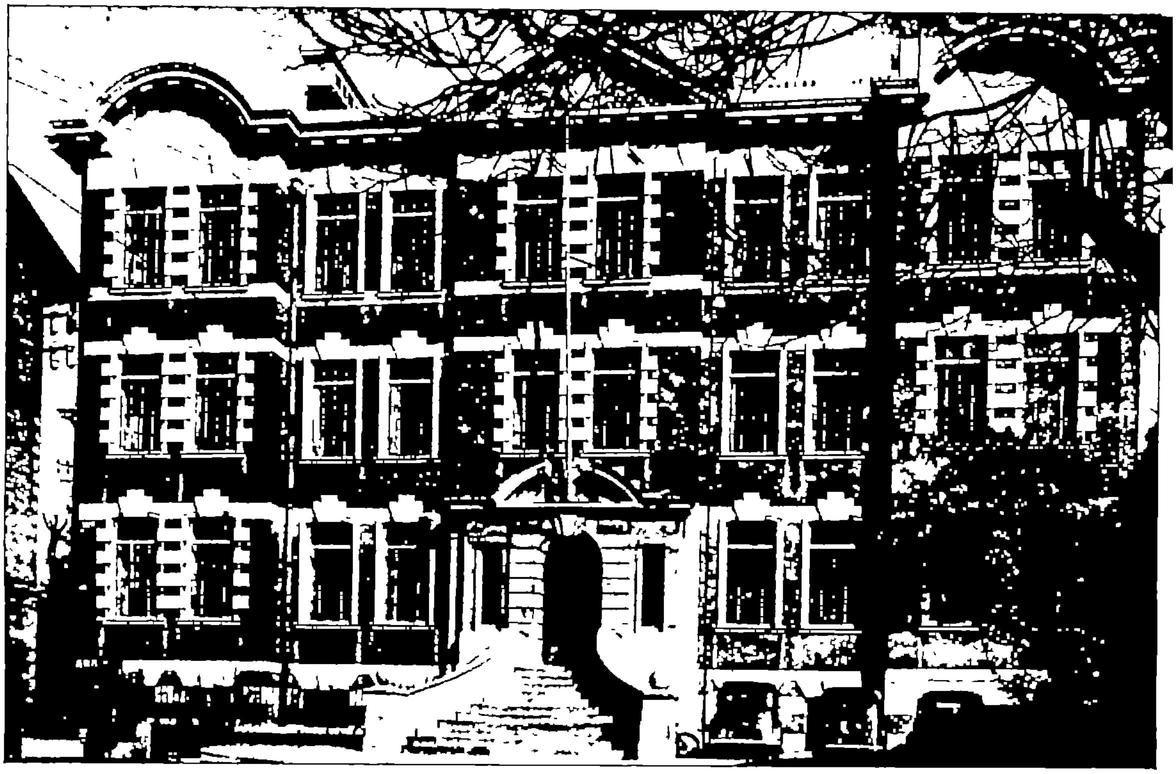

Fig. 1. University of Exeter: the Arts Faculty Building, Gandy Street

At this time the College was in straitened financial circumstances, and in 1912 an appeal for £30,000 for an endowment fund was launched; but the target was not achieved owing to the outbreak of the First World War.

In spite of repeated objections which were raised by the Board of Education, the City Council adopted the designation Royal Albert Memorial University College in 1908; but it was not until 1918 that it was recognized *de facto* as a university college, though it was not actually placed on the University Grants List of the Treasury until July 26, 1922. Principal Clayden (died 1944) retired in 1920 and was in April of that year succeeded by (later Sir) Hector J. W. Hetherington, who came from University College, Cardiff, where he had been professor of philosophy. He resigned in December 1924 to take the chair of philosophy at Glasgow, later to become vice-chancellor of the University of Liverpool, and is now vice-chancellor and principal of the University of Glasgow.

In its first two principals, University College, Exeter, has been twice blessed. Clayden was a man of vision who realized the need for university education in the south-west of England, and Hetherington, believing that the need was real, was able to persuade the Treasury to include the College at Exeter in the list of university institutions. In 1915, in his presidential address to the Devonshire Association, Principal Clayden forecast a University for the South West and described what he considered to be the scope of the University. Now that the University has become a reality, no doubt serious consideration will be given to his ideas.

From the time of its incorporation, the University College increased in numbers of students and staff and in academic attainment, due in no small measure to a succession of enthusiastic and energetic principals. They were Sir Walter Moberly (1925), who left in 1927 to become vice-chancellor of the University of Manchester, Dr. John Murray (1926–51), Prof. F. H. Newman (acting 1951–52), who died suddenly in 1952, Prof. S. H. Watkins (acting 1952), Sir Thomas Taylor (1952–53), who died suddenly in 1953, Prof. H. B. Garland (acting 1953–54), and the present vice-chancellor, Dr. James Wilfred Cook. The untimely deaths of Prof. Newman and Sir Thomas Taylor caused the submission of the petition for the grant of university status to be delayed until after Dr. Cook had assumed the office of principal.

The first president of the University College of the South West was H.R.H. the Prince of Wales; but on his accession to the throne as Edward VIII, Sir Henry Lopes (later Lord Roborough) was elected to that office, which he held until his death in 1938. Lord Cranborne (now Lord Salisbury) then became president, and it is a disappointment that, owing to the pressure of his other obligations, he was unable to allow his name to go forward as the first chancellor of the University of Exeter, towards the creation of which he has done so much.

Among the College benefactors may be mentioned Mr. E. J. Mardon, the late Lord Roborough, the late Mr. Washington Singer, the late Mr. C. V. Thomas, the late Mr. A. C. Ballard, the late Sir William Reardon-Smith, and the late Alderman W. H. Reed, at one time Mayor of Exeter. It was he who in 1922 gave to the College, Streatham Hall, a large mansion built in the Italian Renaissance style and now renamed Reed Hall, with its beautiful gardens and arboretum of eight acres, in the hope that the College would purchase the surroundings fields of more than a hundred acres to form the campus for the Univer-

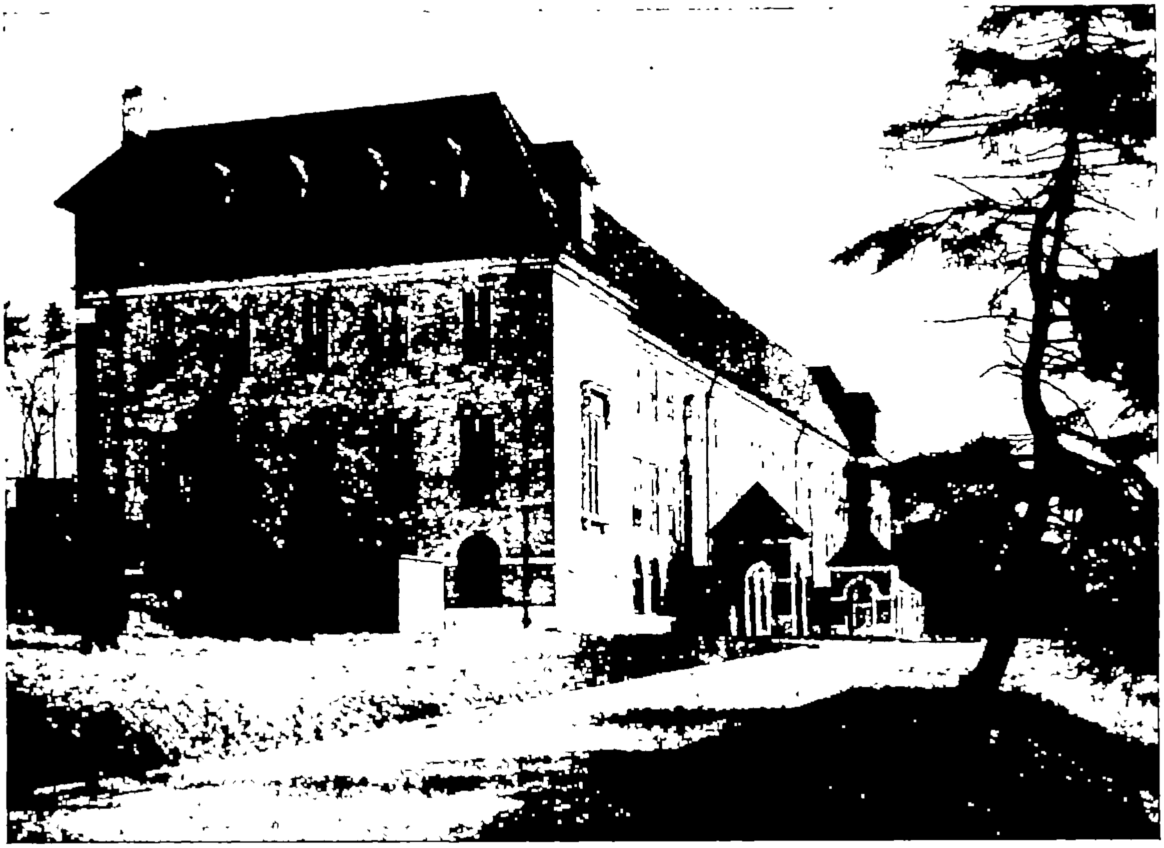

Fig 2. University of Exeter: Washington Singer Laboratories

sity. It is that provision which has placed the University of Exeter in such a pleasant setting.

Exeter is an ideal seat for a university. Several of the newer buildings of the University already occupy prominent positions on the University campus at Streatham, consisting of some 150 acres, which for beauty is probably unsurpassed by that of any other university institution in the United Kingdom. Its natural beauty is enhanced by the panorama of the varied Devonshire landscape that is to be seen from its slopes. It is situated about a mile north-west of the old buildings.

The original buildings are almost within a stone's throw of the Cathedral. Before the First World War they and the York Wing housed the entire College; but afterwards increased accommodation had to be found. This took the form of several rather unsightly ex-army huts, some of which were destroyed in the air raids of 1942. In 1931 the congestion in the Gandy Street buildings was partially relieved by the removal of the Departments of Chemistry and Physics to the new Washington Singer Laboratories on the University campus; but further relief did not come until 1939, when the library was transferred to the new Roborough Library, and again in 1953 when the Botany, Zoology and Geology Departments migrated to the new Hatherly Laboratories (see *Nature*, 171, 860; 1953). In consequence, it was found possible to allocate a few rooms in the old building to the Guild of Undergraduates; but there still remains a real need for more space for the social requirements of the students.

The increase in the numbers of students reading, and carrying out research, in chemistry and physics renders imperative the need for additional accommodation. The Roborough Library is filled almost

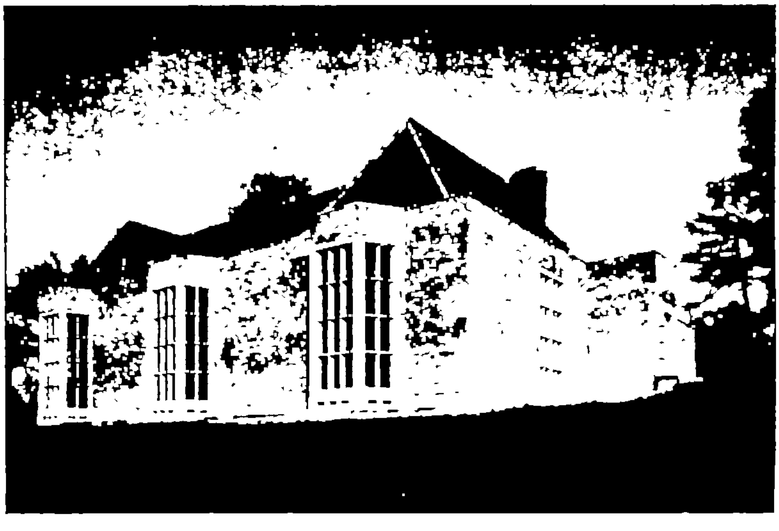

Fig. 3. University of Exeter: Roborough Library

Fig. 4. University of Exeter: Reading Room, Roborough Library

to capacity with nearly 100,000 volumes. The erection on a rather elevated site of a new block for the Faculty of Arts is imminent. The architect of the Singer and Hatherly Laboratories and the Roborough Library and two Halls of Residence, Mr. E. Vincent Harris, is giving the University a chapel, to be known as the Mary Harris Memorial Chapel. Building will shortly begin.

Situated still higher on the southern slope of University campus are the Mardon and Reed Halls of residence for men, while on the top of the hill, which since the War has been levelled, is located a large playing field. By its side is the Taylor Pavilion —a memorial to the late principal, Sir Thomas Taylor. The facilities for sport have just been extended by the erection of a boat-house at Countess Weir on the bank of the Exe canal.

Contiguous with the campus is Knightley, in which the Faculty of Law and the Overseas Students' and Extra-mural Departments are housed, and Thornlea, which, together with a new building close by, accommodates the Department of Education and Psychology and the Institute of Education.

An important policy of the College was to make it residential so far as possible, and in the years immediately prior to 1946 this aim was almost realized; but since then, despi substantial efforts made by t College to acquire suitable premise the influx of students has made necessary for some to live in priva lodgings for a part of their stay i Exeter. Of the 1,029 full-tim students, who come not only fro the south-west of England but al from London and elsewhere in Eng land and Wales and from man overseas countries, 558 live i College halls and the remainder liv either at home or in lodgings.

Since its incorporation as a University College, remarkable stride have been made in the training provided for the London externa degrees in arts, science, economic and law. The number and qualit of the degrees obtained serve as a indication of the high academi status which has been attained. No has this progress been confined t undergraduate training, for considerable attention ha been given to postgraduate training and research. In the sciences, research has been a strong feature, as may be seen from the number of original papers published in the scientific journals and the number of Ph.D.'s which have been gained by Exeter students. Facilities for research in astronomy are also available in the Norman Lockyer Observatory at Sidmouth, which for many years past has been closely associated with the University College. On the arts side, abundant material for investigation has been rendered available to the students by the recent agreement of the Dean and Chapter of the Cathedral to entrust the College Librarian with the care of the unique library of the Cathedral.

For the time being, the University of Exeter will develop and consolidate its existing Faculties of Arts (including Education), Science, Social Studies (including Economics, Social and Public Administration) and Law. Nevertheless, it is safe to say that the possibility of extending its usefulness in other fields of learning and research will always receive the constant vigilance and attention of the new University. Its aspirations and aims will always be to serve mankind, the United Kingdom and especially the inhabitants of the south-west of England.

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# INTERACTION OF SPRAY PROGRAMMES AND INSECT POPULATIONS

An open day at East Malling Research Station on September 21 provided an opportunity for some two hundred members to hear and discuss contributions by staff of the Entomology and Plant Protective Chemistry Sections on the interaction of spray programmes and insect populations. Following the usual custom, members of the official advisory services attended a similar programme on the previous day.

It was pointed out that the present investigations, which are devoted to a study of the fruit-tree red spider mite, *Metatetranychus ulmi* (Koch), its natural enemies, and the effect of spray chemicals on populations of both, are a collaborative project shared by entomologists, plant-protective chemists and plant pathologists. The entomologists are primarily concerned with the biological and ecological problems involved, the chemists with the mechanism of action by which the spray materials in common use affect the insects and mites and, since there is ample evidence to show that fungicides as well as insecticides sometimes prove harmful to the beneficial fauna, the plant pathologists also become intimately involved in such a project. At the present time only a progress report is possible; the causes leading to the appearance of *M. ulmi* as a pest are fairly clear, but much detailed work lies ahead before a spray programme can be devised by which beneficial insects are retained in the fruit plantation while ests and diseases not amenable to control by natural gencies are kept in check by the application of chemicals.

Historically, *M. ulmi* has been noticed as a pest in English orchards only during the past thirty years, its appearance coinciding with the use of tar distillate washes which became general from 1925 onwards. More recently, infestations have been ccentuated following the use of DDT and parathion s post-blossom sprays and, in some Kent and Essex apple orchards, the red spider mite, *Tetranychus telarius* L., has appeared as a pest for the first time following frequent applications of parathion during he summer months. Examples such as these clearly indicate that harmful side-effects may arise from the use of new spray chemicals ; and since such materials are often in the hands of growers before members of esearch institutions have time to evaluate their full effects on the orchard fauna, it is only prudent for hem to be used on a small scale at first, followed by close and frequent observation, so that remedial measures can be taken at the earliest moment should the need arise.

As a result of intensive surveys in both sprayed and derelict orchards, about a hundred species, comprising approximately equal numbers of insects, and spiders and mites, have been found that utilize in varying degrees *M. ulmi* as a source of food. Striking differences occur between the fauna of these two orchard types. In derelict orchards a large number of species occur, forming a continuous succession, so that predators are represented in strength throughout the year, attacking the mite during the whole of its active period and also feeding on the winter eggs. In sprayed orchards there is usually a total absence, or at least a very marked reduction, of predators until June ; for the remainder of the summer the species are much fewer, although individual insects such as the black-kneed capsid, *Blepharidopterus angulatus* (Fall.), are often present in considerably greater numbers than in unsprayed orchards. Only minor annual fluctuations of both species and total populations occur in the derelict orchard, whereas both show violent variations in the sprayed orchard. In part this can be accounted for by the direct effect of sprays, but alternative sources of food, other than phytophagous mites, readily available only in derelict orchards, must also be an important contributory factor.

Among the insect predators, those occurring most commonly include species of Miridae (*Psallus ambiguus* (Fall.)), *Campylomma verbasci* (M.-D.), *Atractotomus mali* (M.-D.), *Orthotylus marginalis* Reut., *Phytocoris* spp., *Malacocoris chlorizans* (Panz.), *Blepharidopterus angulatus* (Fall.)), Anthocoridae (*Anthocoris nemorum* (L.), *Orius majusculus* (Reut.)), Coccinellidae (*Stethorus punctillum* (Wei.)) and Coniopterygidae (*Conwentzia* spp.). Of the spiders, only members of the families Theridiidae and Linyphiidae readily feed on *M. ulmi* ; and the predacious mites are predominantly species of the genus *Typhlodromus*, of which only *T. tiliae* Oudms. becomes abundant in sprayed orchards.

The relative importance of each predator has not yet been fully assessed ; but field observations indicate that all the insects named possess the desirable character of being 'density dependent' in the sense that numbers increase in the presence of ample food, whereas the spiders, with at most one generation a year, increase their rate of feeding when food is plentiful. The latter group attack both beneficial and pest species indiscriminately, and are therefore of doubtful value except under conditions where the pest predominates. Judged by the usual standards, *Typhlodromus tiliae* is an inefficient predator, as its behaviour pattern both in respect to leaf preference and position on the leaf is not well integrated with that of *M. ulmi* ; furthermore, it has a low feeding capacity and can develop and reproduce on plant protein or other species of mites.

As an introduction to the orchard trials in progress at East Malling, the effects arising from two extreme ecological situations were described in very simplified form. In one example, a succession of natural enemies present in the same environment as the prey and attacking it throughout its life-cycle resulted in a continuous depression of prey population similar to that already observed in connexion with *M. ulmi* in derelict orchards. But under such conditions alternative sources of food are necessary if predator populations are to be maintained. As yet, relatively little is known about this aspect ; but experiments have demonstrated that the Mirids and Typhlodromid mites are partly phytophagous, and it is also clear that the much richer fauna, including pest species such as aphids and *Psylla mali* Schmid., occurring in the unsprayed orchard, can provide adequate food for the predators. In contrast to the above, the violent oscillations associated with the presence of only a single species of predator and prey were outlined. Examples of this type are rarely documented in Nature except in specialized ecological niches, but it appears that man may have created such a situation in sprayed orchards between *M. ulmi* as prey and *B. angulatus* as predator. A composite picture from the records of two experimental orchards over the past three years has shown one complete oscillation, two stages of which were available as a visual demonstration. In one orchard, where the population of *M. ulmi* was approaching its peak and predator populations were increasing annually but not yet large enough to cause suppression, the foliage was markedly bronzed, whereas in another orchard, where mite populations suffered a severe reversal in 1954, the fresh green foliage bore no evidence of injury, even in the absence of any acaricidal sprays.

Investigations concerning the effect of spray chemicals on populations of *M. ulmi* and its predators are still in the analytical phase, being concentrated on elucidating the harmful effects of insecticides in general use during the pre-blossom period, together with a similar study of fungicides when applied throughout the spraying season. Sufficient data have been obtained to demonstrate that, by ovicidal or contact action, DNC(dinitrocresol)-petroleum applied at the delayed dormant stage destroys practically all the predators which would normally be present before June ; DDT, by contact or residual action, has a similar effect when applied at the mouse-ear stage ; lime-sulphur drastically reduces Typhlodromid mites and causes a slight reduction of Mirids. Studies of the age structure of certain Mirid species following the use of captan (*N*-trichloromethylthio-*cyclo*hex-4-ene-1 : 2-dicarboxyimide), a fungicide considered non-toxic to these insects, have indicated that even the physical effect of sprays applied at high pressure by the conventional hydraulic equipment may seriously affect predator populations.

The very harmful effect on beneficial species of certain insecticides used for controlling pests during the pre-blossom period has therefore been clearly demonstrated; it can also be deduced from indirect evidence that chemicals in current use against the apple sawfly, *Hoplocampa testudinea* Klug, will produce similar results. In addition, it has been shown that the range of predators occurring from June onwards is unable to prevent large oscillations in the population of *M. ulmi*. The aim, therefore, is to modify the spray programme in order to allow the establishment o one or more efficient predators early in the season Further advances along these lines will be largel dependent on the chemical studies now in progres concerning the fate of materials after depositio on the tree. By increasing knowledge in thi sphere, it may be possible to achieve rather mor selective action by choice of chemical and variations in its time of application, concentration o formulation.

# METABOLISM OF NITROGEN IN PLANTS

A SESSION on the nitrogen metabolism of plants, under the chairmanship of Prof. M. Skene, was held at Bristol on September 2 by Section K (Botany) of the British Association. Problems of the assimilation of nitrogen and the synthesis of amino-acids and proteins in plant tissues formed one of the central themes of the discussion. Three speakers gave accounts of some of the work in progress in the Department of Botany of the University of Bristol, and Prof. H. E. Street (University College of Swansea) discussed the potentialities of the aseptic culture of excised roots as a means of studying the assimilation and metabolism of nitrogen.

The part played by different cellular structures in the synthesis of proteins was dealt with by Prof. E. W. Yemm (Bristol). Earlier views, derived chiefly from genetical considerations, have suggested that the nucleus is the most important centre of protein synthesis in the cell, and this hypothesis has been developed particularly by Caspersson. The conspicuous changes of nucleic acids associated with protein synthesis in some animal cells and in micro-organisms provide the chief support for the hypothesis. During recent years several lines of evidence have been advanced which are difficult to reconcile with the view that protein synthesis is entirely localized in or on the surface of the nucleus. For example, Brachet and his collaborators have shown that non-nucleated fragments of some plant and animal cells continue to synthesize proteins actively. In addition, experiments with isotopically labelled amino-acids indicate that they are rapidly incorporated into particulate structures of the cytoplasm. Ultramicroscopic particles, which may be separated by differential centrifugation and which contain most of the ribonucleic acid of the cytoplasm, are especially active in the incorporation of radiocarbon-labelled amino-acids. It has therefore been suggested that these cytoplasmic microsomes are the chief centres of protein synthesis in cellular metabolism.

There are, however, several difficulties in the interpretation of data based solely on the incorporation of labelled amino-acids into cell proteins. The study of proteinases and other plant enzymes has shown that they promote exchange reactions, such as transpeptidation and transamidation, so that replacement of amino-acids does not necessarily imply a new synthesis of protein. Experiments with detached leaves and roots of barley have shown that, even under conditions in which a net loss of proteins occurs in the tissues, there is nevertheless appreciable incorporation of the isotope nitrogen-15 into the cytoplasmic proteins. On the other hand, under conditions in which an active synthesis of new proteins occurs, such as in young seedlings, it i possible to detect the incorporation of nitrogen-1 into all the cell components separated by differentia centrifugation within a few hours of supplying th isotope as an ammonium salt. The results so fa obtained from a study of the assimilation of nitrogen-15 by barley seedlings suggest that the primary synthesis of new protein is not confined to microsomes but may also take place in nuclei, plastids and mitochondria of the cells.

Dr. A. J. Willis (Bristol) discussed the assimilation by plants of simple inorganic forms of nitrogen, such as nitrates, nitrites and ammonium salts, and gave an account of experiments in which an attempt was made to trace the early stages of the assimilation process and to determine the nature of the primary products formed in young roots of barley. Under conditions favouring a rapid uptake of nitrates, nitrites or ammonia by excised roots, it was found that a marked increase of glutamine, accompanied by smaller quantities of asparagine, occurred in the tissues. During short periods of assimilation more than 90 per cent of the nitrogen metabolized could be recovered as amides, chiefly glutamine. By using nitrogen-15 as a tracer it was possible to obtain decisive evidence that the amides were primary products of assimilation. When the roots were supplied with an ammonium salt containing about 30 atom per cent excess of nitrogen-15, the isotopic abundance in the amino- and amide-groups of glutamine rapidly approached that of the ammonia supplied. Some differences were apparent in the amount of amides formed when different sources of nitrogen were provided: nitrite and ammonia were more rapidly metabolized in the young roots than nitrate, the step nitrate to nitrite being a slow one. All the data support the hypothesis that nitrite, hydroxylamine and ammonia are intermediates in the assimilation of nitrate and that glutamine is a primary product of synthesis.

Other metabolic activities of the roots are closely associated with the assimilation of nitrogen. The rate of respiration, measured by the uptake of oxygen and the production of carbon dioxide, is greatly increased when a suitable source of nitrogen is provided. The most rapid responses are obtained with ammonia and nitrites, and there are many indications that the rise in respiration is coupled with synthetic activities in the tissues rather than with salt uptake. An extensive breakdown of carbohydrate sustains the assimilation processes in excised roots for a limited period, and analytical data indicate that both the respiratory carbon dioxide and the carbon skeletons for the synthesis of amides are mainly upplied by glycolysis. Some recent evidence sug-ests that the close coupling between respiratory ctivity and the metabolism of carbohydrates and trogen may occur within the mitochondria, which ppear to be the chief centres of the metabolism of utamic acid and glutamine in the cell.

Somewhat similar experiments carried out on the ssimilation of ammonium salts by food yeast (*Torulopsis utilis*) have given results in many respects imilar to those outlined above. The rate of respira-on and carbohydrate breakdown show a marked ncrease, while glutamine and glutamic acid, together ith smaller amounts of alanine, have been identified s the chief products of assimilation accumulating at irst in the cells. Here again, the key position of glutamic acid and glutamine in the assimilation of itrogen is indicated.

The metabolism of amino-acids, and particularly their relation to protein synthesis, was discussed by Dr. B. F. Folkes (Bristol). In plant tissues, most of the nitrogen is combined in complex proteins which contain an array of some eighteen different amino-acids. Analyses of different proteins show that, lthough similar amino-acids are generally present, heir proportions vary widely. This is particularly evident in the analyses of reserve proteins found in seeds and other storage organs, although the cyto-plasmic proteins appear to be relatively constant in composition throughout the plant kingdom. A systematic study of the proteins of barley grains and their changes during germination has thrown some light on the metabolism of amino-acids in the young seedling.

With regard to the relation between amino-acids and protein synthesis in plants, two distinct types of hypothesis have been advanced: the so-called amino-acid hypothesis suggests that amino-acids are first formed and are then combined into the polypeptide structures of proteins; alternatively, it is suggested that proteins are synthesized by complex condensations of metabolites without the intervention of amino-acids. The results obtained from an investigation of the nitrogen metabolism in barley seedlings are consistent with the amino-acid hypothesis. If the grains are germinated without external supplies of nitrogen, the formation of new proteins in the embryo is entirely at the expense of the reserve proteins of the endosperm. Analyses show that 75 per cent of the amino-acids required for protein synthesis in the developing embryo could be derived direct from the endospermic proteins; but, on the other hand, certain amino-acids show large changes as germination proceeds. An increase of aspartic acid, alanine, lysine and arginine occurs at the expense of glutamic acid, amide and proline, which are present in large amounts in the reserve proteins. These results strongly suggest that glutamic acid and glutamine are the chief precursors in the synthesis of other amino-acids, and in this regard the data offer a close parallel to those obtained during the assimilation of external supplies of nitrogen. The presence of transaminases which promote the interconversion of glutamic acid and at least six other amino-acids has been demonstrated in young barley embryos. These and other enzymes which bring about the interconversion of glutamic acid and proline appear to occur mainly in the mitochondria, and the mechanisms underlying the transformation of amino-acids may in part determine the close relation between nitrogen metabolism and cellular oxidations.

Evidence from several other directions now gives support to the amino-acid hypothesis. It has been shown, for example, that isotopically labelled amino-acids may be incorporated into tissue proteins of plants and animals while, particularly in micro-organisms, amino-acids may act as specific nutrients. The close connexion between nitrogen metabolism and respiration in plants, which has generally been regarded as favouring the alternative hypothesis, can be more simply interpreted in terms of the synthesis and interconversion of amino-acids and the energy requirements of peptide formation.

In a discussion of the nitrogen nutrition of excised roots, Prof. H. E. Street directed attention to the advantages which may be gained from the use of aseptic organ cultures. Metabolic interrelations between the separate parts of the plant body may be studied, thereby enabling sites of synthesis to be identified. The aseptic conditions of culture permit critical feeding experiments with organic or inorganic forms of nitrogen under closely controlled conditions in which experimental responses can be assessed in terms of both biochemistry and growth. In addition, the use of clonal material, readily multiplied, ensures genetic uniformity. At the same time, excised organ culture can expose genetic characters obscured in work with whole plants, making available tissues with distinctive metabolisms.

Some of these potentialities are being exploited in current researches into the nitrogen nutrition of aseptically cultured excised roots. For the first time, experimental conditions have been defined for the growth of excised roots on nitrate, nitrite and ammonia. Ethylenediamine tetracetate at an appropriate concentration is used to ensure availability of iron, and sparingly soluble calcium phosphates and calcium carbonate are employed as buffers. In the media used, there are sharply distinct *p*H optima for growth with each different inorganic nitrogen source: *p*H 7·0–7·5 for ammonium, *p*H 4·3–5·0 for nitrate and *p*H 5·5–6·5 for nitrite. These optima do not seem to be explicable simply in terms of a direct effect of *p*H on either the absorption or assimilation of nitrogen.

Roots grown on different inorganic nitrogen sources show characteristic differences in the composition of their alcohol-soluble nitrogen. Ammonium roots are rich in ammonium, amide and free amino-acid nitrogen and low in 'other' or 'residual' nitrogen, the relative magnitude of these fractions being reversed in roots grown in nitrate. Nitrite roots contain nitrite nitrogen, but otherwise resemble ammonium roots in composition. When extracts are examined chromatographically, clear-cut differences, depending upon nitrogen source, are revealed in the range and relative amounts of the individual amino-acids present. These investigations are being extended to study the effects not only of nitrogen source but also of carbohydrate and mineral status on the nitrogenous composition. The influence on nitrate-reducing ability of prolonged culture of roots in ammonium nitrogen is being studied, and the nitrate-reducing abilities of excised roots from different species and genetic strains are being compared.

The growth of excised roots from certain species has been found to be markedly stimulated by amino-acids. For example, stimulations of growth of different geographical strains of excised groundsel roots are observed with amino-acids of the ornithine cycle. With the roots of other species, externally supplied amino-acids are toxic. Individual amino-acids differ markedly in their toxicity, and in some instances the relations between toxicity and concentration are complex. Use of amino-acid mixtures has revealed 'amino-acid antagonisms', the mixtures being usually less toxic than their constituents. Very strong antagonisms have been shown between certain pairs of amino-acids of similar chemical structure.

Investigations of the nitrogen nutrition of excised tomato roots have revealed that dimethylaminoethanol, ethanolamine, glycine, choline and certain other nitrogenous compounds can replace the growth requirement of the roots for pyridoxine (vitamin $B_6$). These replacement effects throw some light on the part played by the vitamin in the metabolism of the roots and further illustrate the ability of the technique to expose new topics in plant physiology.

# OBITUARIES

## Dr. L. C. Thomson

THE untimely death on October 10 of Lewis Charles Thomson in his forty-third year comes as a shock to his many friends and colleagues; for Thomson was a model of vigorous health, and the illness to which he succumbed was, mercifully, brief.

Thomson entered Guy's Hospital from Sherborne in 1932. As a medical student he gained several distinctions—the Hilton Prize for dissection in 1933, the Michael Harris Prize for anatomy and the Junior Proficiency First Prize in 1934—and held demonstratorships in histology, anatomy, bacteriology and pathology. He qualified M.R.C.S., L.R.C.P. in 1937, and M.B., B.S. in the following year.

While at the Hospital, Thomson held in succession the complete series of appointments from clinical assistant to house surgeon. But Thomson was not destined for an ordinary medical career. His interests were teaching and research. Consequently, in 1940, he joined the staff of the Medical School at Guy's, first in the Anatomy Department, and then, between 1942 and 1947, in the Department of Physiology.

During this period he worked on a number of problems, among which was the preparation of an inorganic solution which had an equal optical density for all wave-lengths within the visible spectrum (Thomson's Grey Solution). In after years he took pleasure in mystifying the uninitiated with this smoky-looking solution and was highly delighted if asked how the carbon was kept in suspension. His main contributions at Guy's, however, were to vision, and in 1948 he received his Ph.D. for a thesis on the part played by the nervous system in visual adaptation.

With such a background it was natural for Thomson to join, in 1947, the Vision Research Unit. This had just been formed at the Institute of Ophthalmology by Prof. H. Hartridge under the auspices of the Medical Research Council. In 1945, Prof. W. D. Wright had invited Thomson to collaborate on problems concerning the colour vision of small areas within the fovea. This fruitful association was continued after he had joined the Vision Research Unit and ceased only in 1951 when he assumed, on Hartridge's retirement, the directorship of the Unit, renamed the Group for Research in the Physiology of Vision.

In spite of his close attention to administrative detail, Thomson continued to prosecute his own researches with vigour, and at the time of his death had published more than twenty papers on visual topics. His more important contributions concerned the colour sensitivity and intensity discrimination of the central fovea, the influence of the light history of the eye upon the course of its dark adaptation, binocular summation within the nervous pathways of the pupillary light reflex, and the variations of hue discrimination with change of luminance level. Thomson also directed attention to the irregularities of shape in the equal-energy luminosity curve.

As a long-term project, Thomson had constructed apparatus for electro-physiological researches. He mastered the many technical problems involved in such work; but, just when it seemed that his labours were to be crowned with success, he had to lay down his tools. In the year of his death honours were coming fast to Thomson. He obtained his D.Sc. early in 1955; he delivered the twenty-seventh Ettles Memorial Lecture, and was to have been the first Edridge-Green Memorial Lecturer.

Thomson was a first-class administrator. He organized the British delegation to the Nineteenth International Physiological Congress in Montreal in 1953, and was chairman of the Colour Group of the Physical Society during 1953–55.

In spite of his intense pre-occupation with research and administration, Thomson had a number of other interests. He loved sailing, and navigated his boat across the North Sea and the Channel; he was also a keen photographer and an interested student of geology.

Thomson was a most likeable character; he was quiet, unassuming and possessed the rare blend of humility and steadfast purpose. He was a devout Christian and his life was guided by his deep religious beliefs. He will be sadly missed by his colleagues and friends. The deepest sympathy is extended to his widow, his two young sons and his widowed mother.

H. J. A. DARTNALL

## Mr. Alexander Gow

ALEXANDER GOW, who died on October 13, in his eighty-seventh year, performed a noteworthy service to the cause of scientific and technological education in Great Britain by reason of his administrative work as the first secretary of the then newly constituted Imperial College of Science and Technology, serving during the period 1908–34, which bore the first fruits of the fusion of the three constituent colleges, the Royal College of Science, the Royal School of Mines and the City and Guilds College, into an academic unit. An aspirant to the teaching profession, he was educated at the Borough Road Training College and Caius College, Cambridge. His early appointments were scholastic, and he served as principal of the Municipal Technical and Secondary School, Warrington, and as director of education for Blackburn, before undertaking his *magnum opus*, the permanent value of which was signalized by his election to honorary fellowship of the Imperial College in 1946.

Then, as now, no secretary of a college could escape the continuous pressure on reserves of knowledge, of divination, of judgment, and even of sheer physical effort which a responsible share in the shaping of its educational policy exercises. So far as those then associated with him in a less authoritative position uld penetrate an exterior reserve, it appeared that ow took such responsibilities easily in his stride. lways unruffled, precise, even pontifical in manner, e held in firm grasp the controls of a machine of teadily growing complexity, while maintaining xcellent relations with those responsible for the irection of academic studies and from time to time isclosing the warmth of sympathetic understanding hich characterized his unofficial relationships with llow members of the College. He served under four rectors: Dr. Henry Bovey, Sir Alfred Keogh, Sir Thomas Holland and Sir Henry Tizard. During his retirement, in which until recently he continued to enjoy the devoted companionship of his wife, he retained his interest in the affairs of the Imperial College through occasional correspondence with his former colleague and successor in office. The expansion of the College, now in progress, rests on foundations well and truly laid by men among whose names that of Alexander Gow occupies a worthy place.

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# NEWS and VIEWS

### Royal Society Medals: Awards for 1955

THE following awards of medals have been made y the President and the Council of the Royal ociety:

*Copley Medal* to Sir Ronald Fisher, Arthur Balfour rofessor of genetics in the University of Cambridge, or his distinguished contributions to developing the heory and application of statistics for making uantitative a vast field of biology.

*Davy Medal* to Prof. H. W. Melville, Mason professor of chemistry in the University of Birmingham, for his distinguished work in physical chemistry and in polymer reactions.

*Sylvester Medal* to Prof. E. C. Titchmarsh, Savilian professor of geometry in the University of Oxford, for his distinguished researches on the analytical theory of numbers, and other branches of pure mathematics.

*Hughes Medal* to Prof. H. S. W. Massey, Quain professor of physics at University College in the University of London, for his distinguished contributions to atomic and molecular physics, particularly in regard to collisions involving the production and recombination of ions.

### Royal Society of Edinburgh: Officers for 1955–56

THE following have been elected officers and members of council for 1955–56 of the Royal Society of Edinburgh: *President*, Prof. James Ritchie; *Vice-Presidents*, Dr. A. H. R. Goldie, Prof. C. M. Yonge, Prof. Norman Feather, Prof. J. Norman Davidson, Principal H. B. Nisbet and Prof. Meirion Thomas; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Dr. T. R. Bolam and Dr. A. W. Greenwood; *Treasurer*, Mr. A. W. Young; *Curator of Library and Museum*, Dr. Douglas Guthrie; *Councillors*, Dr. J. M. Cowan, Dr. David Jack, Prof. J. M. Robertson, Prof. D. Whitteridge, Prof. E. M. Wright, Prof. E. L. Hirst, Dr. D. E. Rutherford, Dr. D. A. Allan, Prof. G. H. Bell, Dr. D. N. McArthur, Dr. A. G. MacGregor and Prof. C. H. Waddington.

### Electrical Engineering at Birmingham: Prof. D. G. Tucker

DR. D. G. TUCKER, who succeeds Prof. A. Tustin at Birmingham (see *Nature*, 175, 148; 1955), has spent several years at the Post Office Research Station, where he was engaged on research and development work on telephone transmission, including the war-time development of special carrier telephone systems; in 1946 he was head of the Post Office Transmission Measurements Research Group. In 1950 he joined the Royal Naval Scientific Service at H.M. Underwater Detection Establishment at Portland, and he has resigned his post as a senior principal scientific officer at this Establishment in order to take the chair of electrical engineering in Birmingham. Dr. Tucker has had wide experience in telephone transmission research and in the development of very advanced types of under-water acoustic equipment. In addition, he has been engaged in applied research in electronics, acoustics, oceanography and operator problems. He holds the degrees of D.Sc.(Eng.) and Ph.D. in the University of London, and he has published a large number of papers dealing with electronic and transmission problems. He takes to Birmingham wide experience of applied research in the field of communications and electronics. In addition, he is a keen student of natural history, and he has published several papers on bird population studies in the *London Naturalist*, the journal of the London Natural History Society.

### Foundry Metallurgy at the Massachusetts Institute of Technology: Prof. H. F. Taylor

A NEW chair, the American Brake Shoe Company chair of foundry metallurgy, has been established at the Massachusetts Institute of Technology, and Prof. Howard F. Taylor, already professor of metallurgy and director of the Institute's Foundry Laboratory, has been appointed its first holder. Prof. Taylor graduated in chemical engineering and metallurgical engineering at Michigan State College and went in 1937 to the Naval Research Laboratory in Washington, D.C., where he later became head of steel casting research. He joined the staff of the Massachusetts Institute of Technology in 1945 and in 1952 became a full professor. Partly in consideration of his work during the Second World War, Prof. Taylor was awarded the Peter L. Simpson Gold Medal in 1946 by the American Foundrymen's Society and the Army–Navy Distinguished Civilian Service Award in 1948. The American Brake Shoe Company, which has more than fifty plants and is one of the leading foundry companies in the United States, has supported metallurgical work at the Institute with grants-in-aid, a graduate fellowship and undergraduate scholarships. During recent years the Institute's Foundry Laboratory has been greatly expanded, and it now provides some of the best facilities for research in this field in the United States.

### Zoology at Lucknow: Dr. M. B. Lal

THE Lucknow School of Zoology made great advances under the late Prof. K. N. Bahl (*Nature*, 174, 16; 1954), and good wishes for its continued progress will follow his recently appointed successor, Dr. Makund Behari Lal. Most of Dr. Lal's training has been at the University of Lucknow, where he graduated M.Sc. in 1928 and D.Sc. in 1937, and where as demonstrator in zoology (1929) and lecturer in the Department (1937) he showed his ability as a teacher and research worker. At the end of the Second World War he went to Great Britain and spent two years in the Zoology Department of the University of Edinburgh, developing his knowledge of the life-histories of various helminths in order to further this line of investigation in India. He was awarded the D.Sc. degree of Edinburgh in 1947, and on his return to Lucknow was appointed reader in zoology. Recently he represented India at the General Assembly in Rome of the International Union of Biological Sciences. He was elected this year a member of the Zoology Committee of the Union. Dr. Lal's main line of investigation has been helminthological, but that has not prevented him from making useful contributions in other fields of invertebrate and experimental zoology. Under his conscientious care, zoology in Lucknow should continue to flourish.

## Textile Institute

HONORARY life membership of the Textile Institute, Manchester, has been conferred on Mr. Fred Scholefield, formerly head of the Department of Textile Chemistry, Manchester College of Technology, in recognition of the long and valuable services given by him to the Institute. Mr. Scholefield has been a member of its Examinations Board for twenty-five years, being chairman of the Board in 1938, and received the Institute Medal in 1951.

The first formal lecture to be given on the Continent of Europe under the auspices of the Textile Institute will be delivered by Mr. J. R. Whinfield at the Swiss Federal Institute of Technology, Zurich, on November 25. Mr. Whinfield gave the Emsley Lecture at Institute headquarters on October 14, and will speak on the same subject at Zurich, namely, "Textiles and the Inventive Spirit".

## British Museum (Natural History): Appointments

THE Principal Trustees of the British Museum have appointed Dr. George Taylor, keeper of the Department of Botany in the British Museum (Natural History), to be a deputy chief scientific officer on the retirement of Mr. N. D. Riley, who has held that office in conjunction with the keepership of entomology; and Dr. William Edward China to be keeper of the Department of Entomology in succession to Mr. Riley.

Dr. Taylor (who will continue to be keeper of the Department of Botany) entered the Museum in 1928 after graduating with first-class honours at the University of Edinburgh. During his service in the Museum Dr. Taylor has been concerned mainly with flowering plants, and has taken part in collecting expeditions to East Africa and Tibet. Apart from his Museum work, he is a general secretary of the British Association for the Advancement of Science and president of the Botanical Society of the British Isles, and takes an active part in the affairs of the Royal Horticultural Society.

Dr. China was a scholar of Trinity Hall, Cambridge, where he graduated with second-class honours in zoology in 1920 (Sc.D., 1948). He entered the Museum in 1922 and throughout his career has specialized on the Hemiptera–Homoptera (the 'true' bugs). He has published some two hundred papers on these insects and is general editor of the World Catalogue of Hemiptera (published in the United States).

## Water Resources and Water Requirements in Britain

THE Central Advisory Water Committee has decided to institute inquiries into the growing demand for water and into the collection of information about the water resources of Britain. It appointed members to form the nucleus of two sub-committees which will report back to the main committee; they have power to co-opt, so that the inquiries will be widely representative. The terms of reference of the sub-committees are: (a) Sub-Committee on the growing demand for water (*chairman*, Alderman R. C. Yates). "To consider the extent to which the demand for water for domestic, industrial, agricultural and other purposes is increasing and is likely to increase; to consider the problems involved in meeting these demands, including, in broad terms, the cost; to consider whether there are any substantial economies in the use or cost of water which could be made without reduction in standards of hygiene or in industrial or agricultural efficiency; and to make recommendations". (b) Sub-Committee on information on water resources (*chairman*, Prof. J. Proudman). "(i) To review the current activities which contribute to our knowledge of the nation's water resources; (ii) to define the additional work needed to make a balanced survey of the quantity and quality of surface and underground water available for domestic, industrial and agricultural use; (iii) to advise on ways of collecting and interpreting the necessary information, correlating it with information from other sources and publishing it".

## Society for Visiting Scientists: Report for 1954–55

THE annual report of the Council of the Society for Visiting Scientists, presented to the eighth general meeting on September 27, welcomes an additional grant of £1,500 from the British Council, which has enabled the Society to undertake necessary repairs and improvements to its house at 5 Old Burlington Street, London, W.1. Prof. W. Wardlaw has succeeded Prof. F. J. M. Stratton as joint honorary secretary. Though a small increase has been made in the charges, the facilities offered to scientists staying at the Society's house have been considerably improved. The information service has also been extended, as well as the use made of it, and has proved useful in Britain as well as overseas for locating individual scientists or obtaining particulars of their special fields. It has been necessary, for financial reasons, to reduce to a minimum the receptions given to special groups of scientists or to distinguished individual scientists from abroad, and it has also been decided to concentrate on a limited number of discussion meetings in each session. Those held during the past session dealt with nuclear energy in industry and medicine; recent research on speech; colour from the point of view of the painter and the scientist; and current concepts of allergy. The home British membership of the Society has increased to three hundred and twenty (including sixty temporarily abroad), and the total membership exceeds two thousand five hundred. Personal contact still seems to be the most effective form of publicity for the Society.

## Publicizing the Chemical Profession

UNDER the title "Public Relations for the Chemical Profession", the American Chemical Society News Service has issued a handsome brochure, replacing the booklet "Publicizing the Chemical Profession" and the volume "The American Chemical Society News Service—Voice of the Chemical Profession", issued in 1951. The objectives of this News Service are stated to be: to increase public understanding of the meaning and importance of chemical progress; to encourage sound development of chemical science and industry, thereby promoting the welfare and security of the nation; to improve the professional, economic and community status of the chemist and chemical engineer; to enhance the public recognition and prestige of the American Chemical Society, its divisions, local sections and individual members; and to acquaint well-qualified young men and women with the nature of opportunities for careers in the chemical profession. The News Service makes full use of the press, radio, television and other media in disseminating information about the chemical profession and also co-operates closely with other organizations. The account of its activities, and perhaps particularly the use being made of broadcasting and television, should be of considerable interest to British readers concerned with the promotion of the public understanding of science. Both in the brief historical review of the development of the News Service and in the account of the work done in this field by local sections of the American Chemical Society and other agencies of the Society, the brochure contains material which is relevant and suggestive in the context of the dissemination in Britain of accurate information on scientific and technical matters generally; and the concluding remarks about the responsibilities of the individual member of the American Chemical Society apply almost equally to the scientist in general, in Britain as well as in the United States.

## Inland Fisheries Training Centre in Java

An international centre for advanced training of government officers in the development of inland fisheries and fish culture, organized by the United Nations Food and Agriculture Organization in co-operation with the Government of Indonesia and the Indo-Pacific Fisheries Council, has been opened in Java, and the first course, lasting until December 10, has been started, the participants coming from Australia, Burma, Ceylon, Hong Kong, India, Indonesia, North Borneo, Pakistan, Philippines, Sarawak and Thailand. Instruction is given at the Centre in the basic principles of limnology, the operation of small, controlled bodies of water maintained simply for fish production, and the wider field of improving fish production in natural fresh- and brackish-water areas. Methods of management such as the addition of nutrients to the waters, the control of predators and water weeds and the introduction of new species of fish are reviewed. The participants will spend about half their time attending lectures and working at the laboratory and experimental ponds of the Indonesian Inland Fisheries Service at Bogor, and the remainder of their time will be devoted to field trips throughout Java. The Food and Agriculture Organization is applying considerable efforts to the development of fish farming, and has engaged, as a short-term consultant, a senior farm-management specialist of the United States Department of Agriculture, who is at present studying the economics of fish culture in West Germany, Israel, India, Thailand and Malaya. He will lecture on his conclusions at the centre in Java. The staff for the centre has been recruited from Belgium, China, France, Holland, India, Indonesia and the United States. Indonesia has been chosen by the Organization because of the importance of inland fisheries as one of the country's primary industries. There are large areas of inland water, both fresh and brackish, swiftly flowing and still. Many of the varieties of fish are indigenous; but a number have been introduced from abroad, including most notably carp and tilapia. There is a well-developed inland fishery administration and a highly organized and competent fishery research and extension service.

## Geology of Rockall

At a meeting of the Geological Society of London at Burlington House on November 2, Dr. P. A. Sabine exhibited, on behalf of the Geological Survey and Museum, rock specimens collected on Rockall by Mr. James Fisher during the recent visit there by the Royal Navy. Dr. Sabine directed attention to the small size of the island, the visible portion of which, he pointed out, would fit inside the Geological Museum. A portion of a specimen collected in 1862, on one of the three previous landings, was also exhibited, as well as air photographs. The new specimens of rockallite, an ægirine granite, already known to be unusually rich in zirconium and cerium, are being examined by officers of the Geological Survey. Mr. James Fisher, who was present at the meeting, then gave a graphic account of the landing. The Rockall specimens are now on view to the public in the Geological Museum.

## Photoelectric Measurements at Kvistaberg Observatory, Sweden

A description of the photoelectric instrument at the Kvistaberg Observatory is given in an article by Åke Wallenquist (*Kungl. Svenska Vetenskaps-akademiens Handlingar*, Fjärde Serien, Band 5, Nr. 5; 1954), in which all the parts are very carefully explained with the aid of a number of diagrams and photographs. Kvistaberg Observatory, which forms part of the University of Upsala Observatory, is situated at Bro, Uppland, on the slope of a hill on the northern shore of an arm of Lake Mälaren, long. 17° 36·4′ E., lat. 59° 30·1′ N. The photoelectric instrument is a 41-cm. Cassegrain telescope, the primary parabolic mirror of which is of 'Pyrex' glass and was refigured at Upsala after it had arrived from the United States. The mounting of the instrument is of the German equatorial type, and the axes, which originally belonged to an old 9-in. refractor at Upsala Observatory, are made of steel and are heavy; the system of axes was modernized in the Observatory workshop and furnished with ball-bearings. Owing to rather unfavourable weather conditions at Kvistaberg for photoelectric photometry—like many other places in Sweden—differential observational programmes are generally undertaken with the object of eliminating the effects of sudden variations in the transparency of the atmosphere. For this reason, photoelectric determinations of the colours of the stars and determinations of differences in the magnitudes of the components of double stars form the main programme at the Observatory, though under good seeing conditions it is possible to carry out more absolute photometric photometry, with the determination of magnitudes of individual stars. Two colour-filters are used for the determinations of colours and magnitudes of the stars—a blue filter of type *BG* 12 and a yellow filter of type *GG* 11, supplied by Schott und Gen., Jena. The article contains a table with the final values of the $m_{pg}$ magnitudes and colours of fourteen north polar sequence stars as measured photoelectrically at Kvistaberg.

## Copals and their Botanical Origin

THE study of fresh copals of known botanical origin has shown that, with some exceptions, their discrimination by the usual characteristics is imprecise and hazardous. On the other hand, it has now been shown that the infra-red spectrographs of their extracts are characteristic and specific (L. Hellinck, *Publ. de l'Inst. Nat. pour l'Étude Agron. Congo Belge* (I.N.É.A.C.); Sér. Tech. No. 44, 1955). When the spectrographic method was applied to the study of 'fossil' copals, it was concluded that these had been produced by the same species that yield fresh copal, *Guibourtia demeusei* and *Tessmannia anomala* being the most important two in that order. It has also been confirmed that, in the course of a few months, freshly exuded copals possess the collective properties of 'fossil' copal. Hence it has not been possible to study the ageing of copal or to assign precise ages to fossil materials.

## Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: R. F. Cumpston and R. B. Royle (agricultural supervisors, Nyasaland), principal agricultural supervisors, Nyasaland; C. E. Moore (agricultural officer, Gold Coast), senior soil conservation officer, Gold Coast); J. D. Tallantire (senior agricultural officer, Federation of Nigeria), principal agricultural officer, Federation of Nigeria; I. T. Twyford (soil scientist, Fiji), chemist, Department of Agriculture, Fiji; D. H. Welch (principal agricultural officer, Western Region, Nigeria), deputy director of agriculture, Western Region, Nigeria; W. M. C. Bagshaw (assistant conservator of forests, British Guiana), deputy conservator of forests, British Guiana; J. D. Scott (specialist forest engineer, Nigeria), conservator of forests, Sierra Leone; J. L. J. Vinson (curator, Mauritius Institute), director, Mauritius Institute; A. C. Evans, assistant director (research), Tanganyika; S. Gray, senior agronomist, Uganda; C. Harkness, plant breeder (botanist), Northern Region, Nigeria; F. M. Spencer and J. V. Webdale, agricultural officers, Tanganyika; D. P. Taylor, agricultural officer, Kenya; D. D. Thornton, pasture agronomist, Uganda; P. A. Board, fisheries officer, Eastern Region, Nigeria; M. H. D. Dowell, assistant conservator of forests, Nyasaland; P. J. Fogg, assistant conservator of forests, British Honduras; P. A. Skott, assistant conservator of forests, Tanganyika; P. E. Brown and R. Halligan, geologists, Tanganyika; R. T. Gittins, field officer (geology), Uganda; B. Hitchon, geologist, Northern Rhodesia; G. Surtees, research entomologist, West African Council for Medical Research, Nigeria; J. Lamb, director, West African Cacao Research Institute, Gold Coast; K. C. Sleep, scientific officer (chemist), Tanganyika; K. Horlyck, veterinary officer, Northern Region, Nigeria.

## Announcements

THE Royal Swedish Academy of Technical Sciences (IVA) has conferred its highest mark of distinction, the IVA Grand Gold Medal, on Dr. K. H. Gustavson, of the Swedish Tanning Research Institute, Stockholm, in recognition of his pioneering contributions to the chemistry and reactivity of collagen, and for his investigations of the mechanism of tannage, pa ticularly his research on the reaction of chromiu compounds with hide protein in chrome tanning Dr. Gustavson is president of the International Unio of Leather Chemists' Societies.

SIR RAYMOND PRIESTLEY has temporarily bee appointed director of the Falkland Islands Depend encies Scientific Bureau during the absence of th permanent director, Dr. V. E. Fuchs, who is to lea the forthcoming trans-Antarctic Expedition.

DR. R. K. SCHOFIELD, head of the Chemistry Department, Rothamsted Experimental Station (*Nature* 175, 283; 1955), has been appointed reader in soi science in the Department of Agriculture, University of Oxford, in succession to Dr. E. Walter Russell who is now director of the East African Agricultur and Forestry Research Organization (*Nature*, 175 1065; 1955).

DR. D. E. TRIBE, lecturer in animal husbandry i the University of Bristol, has been appointed to a readership in the physiology of domestic animal in the University of Melbourne.

THE University of Sheffield has appointed Dr. T. R. Kaiser and R. C. Curran to be senior lecturer in physics and pathology, respectively. The following have been appointed lecturers: Dr. R. C. Cass (chemistry), Dr. T. P. H. McKellar (psychology), Dr. V. A. Phillips (metallurgy) and Dr. A. N. Stroh (physics).

DR. K. P. BISWAS, formerly superintendent of the Indian Botanic Garden (*Nature*, 176, 239; August 6, 1955) has been appointed, as from August 1, director-in-charge of Medicinal Plants Schemes in India to develop the vegetable wealth of the country. The work is being done under the auspices of the Medicinal Plants Committee of the Indian Council of Agricultural Research, Government of India, and Medicinal Plants Committee of the Government of West Bengal, of which Dr. B. C. Roy is chairman and Dr. Biswas secretary.

THE Industrial Section of the Royal Microscopical Society is arranging a symposium and exhibition on "Fibre Microscopy", to be held at the Royal Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1, on November 16 (2–9.30 p.m.). The exhibition will consist of fourteen displays from government laboratories, research associations and private firms. Further information can be obtained from the Assistant Secretary, Royal Microscopical Society, Tavistock House South, Tavistock Square, London, W.C.1.

THE National Coal Board has decided to change the titles of its Central Research Establishments: the Central Research Establishment I, at Stoke Orchard, near Cheltenham, will now be known as the Coal Research Establishment, and Central Research Establishment II, at Isleworth, as the Mining Research Establishment. The changes have been made to indicate the character of the work carried out at the two Establishments.

REFERRING to their advertisement in *Nature* of October 15, supp. p. iii, of "The Geneva Series on the Peaceful Uses of Atomic Energy", Messrs. Macmillan ask us to point out that each volume of the series will probably be priced at 55*s*. and that the subscription terms inadvertently included in the advertisement will not apply.

# IMPORTANCE OF LARVAL CHARACTERS IN CLASSIFICATION

A MEETING of Section D (Zoology) of the British Association was held at Bristol on September 5, with Prof. F. W. R. Brambell in the chair, to consider the importance of larval characters in classification. Dr. F. I. van Emden, who opened the discussion, said that in wingless insects such as the silverfish adult and larva are much alike. In winged insects this is not so, and it is clear that adult and larva must have evolved along quite different lines. It follows that neither adult nor larval characters have over-riding importance for taxonomy: theoretically they are of equal importance. Where a resting pupal stage intervenes, many characters are quite unrelated in adult and larva. Where such a stage is absent, larva and adult have often evolved in such different environments that their classification has to be based on entirely different criteria. In practice, either stage may chance to exhibit better taxonomic characters.

In most insect groups our knowledge of the larvæ is still exiguous, but a fair number of cases are already known in which the larvæ are easier to distinguish than the adults, for example, among sphingid moths, mosquitoes, *Culicoides* midges, meloid beetles; and further examples doubtless await discovery. As a rule, however, the adults show a greater degree of differentiation than the larvæ, and consequently their characters are likely to remain more important for species determination. Larval characters, on the other hand, are likely to retain greater importance for classification than for identification. Thus the major divisions of winged insects are named with reference to larval development (Exoptergota, Holometabola, etc.). Larval characters are used extensively in the classification of Diptera, Hymenoptera, Coleoptera and Aphioidea, and they are almost as important as those of the adult for subdividing Odonata and Neuroptera. Examples of changes that have been made mainly, or entirely, with reference to larval characters are: inclusion of the order Strepsiptera in the Coleoptera; removal of the Aphaniptera (fleas) from the Aptergota to a position among winged orders near the Diptera, a step first advocated by Lamarck in 1801. Since classification attempts, at least to some extent, to summarize phylogeny, it follows that larval characters have a similar part to play in phylogenetic studies. Thus acceptance of Chapman's order Zeugloptera implies agreement with the assumption that this group must have separated from the Lepidoptera sooner than did the Trichoptera. Revision of the systematic position of the Archostemata implies a revision of our ideas concerning the evolution of the coleopterous larva. At a lower level, larval characters afford clear evidence regarding the evolution of stridulating organs, armature of the teeth ventrite and other structures.

Finally, larval identification is important not only for taxonomy *per se* but also for all those branches of biology which taxonomy subserves. For example, the results of quantitative ecological research would be incomplete if larval forms had to be neglected because they could not be identified.

Dr. Isabella Gordon then discussed the systematic position of the Euphausiacea, a small but economically important group of Crustacea Malacostraca once placed with the Mysidacea in the old order 'Schizopoda'. The best-known member of the single family Euphausiidae is undoubtedly *Euphausia superba*, the krill or whalefeed. Larval development and adult structure indicate close affinity with the lower Decapoda, especially the Penaeidea, and for the past fifty years Euphausiacea has been considered an independent order of the division Eucarida coordinate with Decapoda. Some twenty years ago the late Dr. Stanley Kemp, then director of the *Discovery* Investigations, was convinced that Euphausiacea are true Decapoda related to the Sergestidae. Unfortunately his views, though fully endorsed by Calman, were never published, and Gurney (1942) was the first definitely to place Euphausiacea in the Decapoda. His suggested classification is little, if any, improvement on the old one; but his comparison of Euphausid development with that of the Penaeidea is excellent.

Most Eucarida incubate their eggs, which are attached to the abdominal pleopods; but neither Euphausiacea nor Penaeidea do this—their eggs are either shed freely or adhere for a brief period to the posterior thoracic appendages. Moreover, Euphausiacea and Penaeidea are the only Malacostraca with free nauplius larvæ. Penaeidea would appear to be more primitive than Euphausiacea; for example, there is no compression of the thoracic somites such as occurs in all other Eucarida, and the Penaeidae have elongated pear-shaped nauplii. In Euphausiacea there is extreme compression of the thorax and the appearance of the second and subsequent thoracic appendages is long delayed, except in *Euphausia superba*, which acquires precociously the swimming and feeding habits of the adult. Euphausid development, though gradual as in many Penaeidae, is remarkably close to that of the Sergestidae, where there is abrupt metamorphosis at the end of each phase. In Sergestidae also, there is the same tendency to reduction or loss of the last two pairs of thoracic appendages (post-larva, *Lucifer*) and, in some species at least, to enlargement and modification of one pair of maxillipeds. Then there is general similarity of such adult structures as the male copulatory petasma and spermatophores, the female sperm receptacle (thelycum) and the photophores. The resemblances far outweigh the differences, chief of which is that in Euphausids the gills, which are specialized podobranchs, are exposed, not concealed by the carapace—but *Lucifer* has no gills at any stage.

Calman, in a letter dated May 27, 1948, suggested making the Euphausiidea co-ordinate with Penaeidea, Caridea, etc.; Gurney was in favour of uniting the two groups with free nauplius-protozoea development in one suborder as against the rest of the Decapoda (letter dated February 12, 1949). At present the writer is undecided as to the best course to adopt. The classification of the Decapoda is a very difficult problem, and none of the schemes hitherto proposed is entirely satisfactory. (See also p. 934 of this issue of *Nature*.)

A review of recent work on larval characters in helminths by Dr. Sheila M. Willmott followed. Many helminths are highly pathogenic parasites of man and animals and, in the case of some nematodes, also of plants. All have complex life-histories including several larval stages. In the three main groups of helminths—the nematodes, trematodes and cestodes—the larvæ may show a combination of adult and larval characters. For example, in cestode larvæ the head is identical with that of the adult, but the form of the cyst is a purely larval character; in the nematodes, the gut of the larva may take the form that it shows in the adult. In the digenetic trematodes, the body of the cercaria shows such adult characters as the arrangement of the head and collar spines in the echinostomes, the absence of an œsophagus in the schistosomes and the position of the ventral sucker in the amphistomes; the tail is purely larval, although its form is frequently characteristic of the group to which the adult belongs. The character now most used in the classification of the cercariæ is the basic formula of the excretory system. This frequently resembles the arrangement found in the adult, and the fundamental flame-cell pattern forms a basis for a 'natural' classification.

Hydatid disease, which is widespread throughout the world and is more common in Great Britain than is generally realized, is caused by a larval cestode. Whether one species is responsible for the two types of hydatid disease or whether two species are involved has long been a matter of controversy. Careful investigation of the types of larvæ and the life-cycle have now led to the conclusion that two species of *Echinococcus* are involved.

Recently much work has been done on larval nematodes, particularly the Spiruroidea, with the result that a scheme of classification proposed twenty years ago and based on the morphology of the head has been confirmed. As many nematodes are free-living, it is concluded that the parasitic mode of life has been more recently acquired in this group than in the trematodes and cestodes. The degrees of adaptation of nematode larvæ to the intermediate hosts are probably better indications of phylogenetic relationships than are the relations of the adult to the definitive hosts. Four main types of larvæ are recognized: (1) the most primitive, that is, free-living larvæ; (2) larvæ developing to the third stage before hatching; (3) larvæ which develop in a vertebrate intermediate host but which act as ecto-parasites rather than as endoparasites; and (4) the most specialized, that is, those which develop in a vertebrate intermediary with a strongly marked degree of 'seclusion' within it, or which have secondarily lost the intermediate host.

The last paper was entitled "The Classification of Nematodes parasitizing Horses, using Larval Characters". Mr. D. Poynter said that to-day the horse commonly harbours large numbers of various species of nematodes, and these are often the cause of retardation in growth, illness and sometimes death. The effects of parasitism have undoubtedly been aggravated by domestication. The typical horse nematode lives as an adult in the intestines of its host and lays eggs which are passed out, with the fæces, on to the pasture. The eggs hatch and give rise to third-stage infective larvæ which live on the herbage and are ingested by the host. Equine nematode parasites all belong to the superfamily Strongyloidea; but the eggs of the various genera and species are indistinguishable from each other. Since the adults are inaccessible within the host, it is essential to obtain the free-living larval stages, and this is done by means of a special culture technique. After seven days at 28° C. in a fæces–charcoal culture, development has proceeded as far as the third-stage larvæ, which have definite diagnostic character These larvæ have been described for some of th genera and species, and a key published in 194 facilitates the determination of the larvæ obtaine from equine fæces. Unfortunately, this key is no illustrated. But a plate has now been prepare showing the various larvæ drawn to the same scal It is possible, therefore, by identifying the larvæ in given culture, to obtain knowledge of the types nematodes in the host. A survey has been under-taken using many horses, and information has bee obtained as to the incidence of the different nematode in hosts of different ages.

This culture procedure has also an importan practical application. Parasites of the famil Strongylidae are all affected to some extent b phenothiazine, a common anthelmintic which has n effect on *Trichostrongylus axei*. For this parasite copper sulphate and nicotine must be used. An rational treatment, therefore, must include a prio determination of the larvæ. A careful comparison o larval cultures obtained before and after dosing wil indicate the effectiveness of a new anthelminti against the different nematode species. For example when testing the efficiency of piperazine adipate, i was noted that every adult horse dosed showed an immediate and sharp rise in the number of eggs o *Strongylus edentatus* being passed. Subsequent critica tests proved the compound to be only 0–6 per cen effective against this species.

The general discussion which followed not unnaturally centred around the insects. Prof. G. C. Varley emphasized the practical importance to the ecologist of correlating observations on the behaviour of the adults with their life-histories, giving examples from his work on parasitic Hymenoptera. Mr. P. F. Mattingly referred to recent immunological work on mosquito taxonomy, the discovery in mosquitoes of some of the evolutionary anomalies discussed by de Beer in his book "Embryos and Ancestors", and Wigglesworth's recent brilliant exposition of the concept of insect metamorphosis as a special case of the more general phenomenon of polymorphism. He also stressed the need for comparative genetical studies on the inheritance of adult and larval characters.

ISABELLA GORDON

# INSTITUTE OF PHYSICS

## REPORT FOR 1954

THE thirty-fifth annual report of the Board of the Institute of Physics*, covering the work of the Institute during 1954, was presented to the annual general meeting of the Institute, held at the Institute's house in London on May 17. The report records that the membership in the several grades of the Institute continues to mount steadily, and the total membership has increased by 154 to 4,749. The newly established examination for entry to the graduateship grade of membership of the Institute was held during June 21–25 at centres in London, Birmingham and Paisley, and nineteen of the fifty-four candidates were successful. The numbers of candidates for the final examinations for National Certificates in Applied Physics were 206 for the Ordinary level and 75 for the Higher Certificate, compared with 151 and 55, respectively, in 1953. A one-day conference, consisting of representatives of teachers in technical colleges offering courses for National Certificates in Applied Physics, the Institute, the Joint Committee for National Certificates in Applied Physics, and industry, was held on April 12, 1954, and eight papers were read.

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* Thirty-fifth Annual Report of the Board of the Institute of Physics, 1954. Pp. 25. (London: Institute of Physics, 1955.)

About half the total work of the Institute is now occupied by the production and distribution of its publications. The Institute publishes two monthly journals, the *Journal of Scientific Instruments* and the *British Journal of Applied Physics*, and, in addition, a monthly *Bulletin* which is circulated to members only. For the 1954 volume of the *Bulletin*, an entirely new format was introduced, its contents consisting of twenty articles, either invited contributions or based on lectures given to the Education Group of the Institute, and Institute news. A new edition of the pamphlet entitled "The Scientific Education of Physicists", giving up-to-date information regarding institutions where physics may be studied, and a revised edition of the thirty-two page pamphlet, "Notes on the Preparation of Contributions to the Institute's Journals and Other Publications", were issued during the year. A third selection of 'Laboratory and Workshop Notes" from the *Journal of Scientific Instruments* was compiled and edited by Dr. Ruth Lang and published in book form.

The report states that the Institute has continued to take an active part in discussions on higher technological education, but has not departed from its original view expressed in its 1948 report on this subject. For the second year in succession an inquiry was addressed to all new graduates in physics of the universities in Great Britain to obtain information as to their present occupations, or, where appropriate, the source of any maintenance grant. The survey is to be continued during the next few years so as to determine how, and to what extent, the services of physics graduates are being utilized. Reports were received during the year that there were several vacancies for undergraduates in physics departments in some universities and large technical colleges, and the Board's inquiries on this subject are to be issued shortly.

Details of the activities of the sixteen local branches and specialist subject groups of the Institute are listed in the report. The Australian Branch, with 415 members and four separate divisions in New South Wales, Queensland, South Australia and Victoria, respectively, held thirty-two meetings. Dr. A. C. Menzies and Prof. J. H. Bhabha visited the Victoria Division and delivered addresses, and this Division also held an exhibition of scientific apparatus in March and a conference on the teaching of physics in August. Joint meetings were held by the Electronics Group of the Institute with the Manchester and District Branch in Manchester and with the South Wales Branch in Swansea, and two conferences were also organized: the first, on luminescence, was held in April at the Cavendish Laboratory, Cambridge, and the second, on fluctuations and the limits of measurement, in September at the Institute's house in London. The proceedings of the former conference have since been published (*Brit. J. App. Phys.*, 6, Supp. 4; 1955). Following discussions with the Physical Society, a joint committee for electron physics was set up to co-ordinate activities of the two bodies in the field of electron physics, defined as "the physics of the free electron and phenomena associated with it". The Electron Microscopy Group was host to an international conference of the recently established Joint Commission on Electron Microscopy, which was held during July 16–21 in London and attended by about four hundred people; the X-ray Analysis Group held its spring conference in Cambridge on the subject of "New Developments in Structure Analysis" and its autumn conference in London on "Structure of Metals". Also, in addition to the specialist conferences held by its branches and groups, the Institute held a conference on "The Physics of Particle Size Analysis" in the University of Nottingham during April 6–9. Thirty-three papers were presented and discussed, and the proceedings have been published (*Brit. J. App. Phys.*, 5, Supp. 3; 1954).

At the general meeting of the Institute, the following were elected to take office on October 1: *President*, Sir John Cockcroft; *Vice-President*, Dr. W. H. Taylor; *Honorary Treasurer*, Dr. S. Whitehead; *Honorary Secretary*, Dr. B. P. Dudding; *New Ordinary Members of the Board*, Dr. M. R. Hopkins, Dr. J. M. A. Lenihan and Dr. J. Taylor. In addition, Prof. W. E. Curtis and Dr. C. Sykes (*past-presidents*), Mr. O. W. Humphreys, Mr. G. R. Noakes and Prof. F. A. Vick (*vice-presidents*), and Dr. H. Barrell, Dr. P. H. S. Henry, Dr. K. A. G. Mendelssohn, Mr. A. T. Pickles and Mr. H. P. Rooksby continue to serve on the Board.

# IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON

IN his inaugural address for the new session of the Imperial College of Science and Technology, London, the rector, Dr. R. P. Linstead, after reviewing briefly the history of the College, referred in some detail to certain aspects of the expansion which is planned to bring the total number of students to three thousand by 1962 without sacrifice in quality. The College is already, Dr. Linstead stated, the largest postgraduate college in Great Britain, providing in technology about one in nine of those trained in the country, while the proportion of higher degrees to total degrees is nearly 40 per cent. New senior posts at the level of professor or reader have already been or are being established in soil mechanics, statistics, instrument technology, applied geophysics, aeronautical structures, applied science, biochemistry, inorganic chemistry, light electrical engineering, parasitology, physical metallurgy, applied geochemistry, nuclear power and other subjects; but it is not intended to multiply new departments. The latest demands all call for sound fundamental training in mathematics and in the basic sciences or the main divisions of engineering, and to meet this demand the academic staff has already been increased by more than a third. At the same time, the College is providing, from its old students and staff, men and women for senior academic appointments elsewhere.

Dr. Linstead anticipates no difficulty in finding sufficient undergraduate students: he thinks that the danger of a breakdown in school science teaching had been exaggerated and is being removed, and that the post-war bulge in the school population will of itself more than meet the 17 per cent increase in annual intake of undergraduates required to maintain a total of three thousand students (including about sixteen hundred undergraduates). The College is concerned, however, to improve selection and to make the best possible use of the students who have been selected, so as to reduce the present wastage; about a hundred of the present intake of five hundred freshmen fail to go forward to the second year. In this connexion, Dr. Linstead said the College hopes soon to reintroduce an optional preliminary year which would not demand a knowledge of science and would thus provide a special means of access for the gifted non-scientist. This scheme is related to one invented by Sir Henry Tizard during his rectorship, but the majority of the first-year entry would continue to have had a sound science training at school.

Last year there were 631 full-time postgraduate students, or rather more than a third of the total, and it is intended to raise this proportion to 45 per cent. Most of the postgraduate students are taking advanced courses designed to train technologists of the highest quality. Postgraduate research is a first charge on the College, and Dr. Linstead stressed the proportion of postgraduates from overseas—at present about three hundred from forty-nine centres, mainly in the Commonwealth. Nearly two hundred of the postgraduate students came from posts in industry and in government, and in this connexion Dr. Linstead is less confident about maintaining the supply of postgraduate students, unless maintenance support is forthcoming on an adequate scale.

The College aims to produce engineers and scientists who are at the same time well-educated men and women, and Dr. Linstead thinks that this is being achieved. As regards residence, however, the College is in the worst position of all major colleges or universities in Great Britain, only 8 per cent of its students during 1953–54 being residential. It is proposed to increase this to 16 per cent, or about five hundred students, by the end of the expansion period and also to provide general amenities for all its students on the lines of what is commonly called the Ashby plan. In his address, Dr. Linstead made no specific statement on the building plans, but expressed the opinion that the decisions taken in 1953 were wise and also paid tribute to the co-operation of all concerned, not least of the 1851 Commissioners.

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# ONTARIO RESEARCH FOUNDATION

## REPORT FOR 1954

IN his annual report for 1954 to the chairman and governors of the Ontario Research Foundation*, the director of research, Dr. H. B. Speakman, notes that, in spite of a recession in some branches of industry, there was no marked reduction in the demands made on the Foundation but rather an increase in developmental work. The Biochemistry Department was very active, work under the Rice Mills Fellowship centring largely on the development of a new milling principle designed to reduce drastically the amount of broken rice that is normal with present equipment. In the utilization of municipal waste, progress has been made in partial conversion into sugars such as xylose and certain volatile organic acids. In a fundamental study of the continuous production of protein by fermentation of yeast, it has been established that there is practically no waste of sugar and that a higher percentage yield of yea on the sugar consumed is obtained by feeding sug at low rather than at higher concentrations. Th basic study of the deterioration in flavour of edib oils continued, and substantial progress was made i the group fellowship working on the evaluation o new tanning materials.

In the Department of Chemistry, the balanc between basic research, long-term sponsored fellowship projects and short-term investigations submitte by smaller industrial units is emphasized. Filte paper chromatographic techniques have demonstrated that normal sodium phosphate glasses, rapidl quenched from the molten state and dissolved i water, show only linear polymers with a reproducibl distribution of molecular weight, depending only o the sodium/phosphorus ratio, and the technique ha been improved so that small amounts of ring o linear polymers can be determined in the presence o large amounts of the other kind. Two surveys of ai pollution, at Maitland and Millhaven, were concluded, and the laboratory is developing new apparatus and methods for the accurate determination of air contaminants. A study of the productio of grafted polymers continued, and one of method for the production of alkyd resins has indicated tha straight-chain alkane sulphonic acids may be suitabl catalysts in the condensation. Definite progress i reported in the study of the chemistry of wast sulphite liquors; a number of lignin compounds hav been examined as dispersing agents for use in drillin oil-wells, while others may be useful in treatin boiler feed water to prevent scaling, and a condensat of lignin and phenolic compounds was found t possess tanning properties.

In the Department of Engineering and Metallurgy investigations on the production and properties o steel of controlled density have led to strikin improvements in the product, and the study of th causes and the detection of faults in wire ropes has le to some progress in the design of an instrument which can be used at the mines under operating conditions

The Department of Parasitology continued its work on tapeworms found in carnivorous animal as well as a survey of animals infected with th larval or adult forms of the parasites. Work on flie of the genus *Protocalliphora* continued, as well a the investigation of the filariid nematodes in birds and the extensive researches on two species of fluke of the genus *Alaria*, occurring in foxes, are almos complete. Further data on the epizootiology, transmission and development of *Leucocytozoon* in duck confirmed the conclusion that asexual parasites occur in the blood of infected ducks during their cycle o development.

The Department of Physiography finished the mapping between North Bay and Sault Ste. Marie and made differential thermal and X-ray analyses on the clay, less than 1 micron in diameter, from all main types of glacial till in southern Ontario. A new installation for evapo-transpiration studies was set up at Kapuskasing Experimental Station, and an unbroken daily record was secured for the summer months; a study of soybean growth and development was commenced on five varieties with a range of maturity.

In the Textiles Department, besides research on nylon, the optimum temperature at which fabrics from different synthetic fibres can be ironed has been studied, as well as factors affecting the photochemical degradation of viscose rayon.

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* Ontario Research Foundation. Annual Report, 1954. Pp. 30 + 4 plates. (Toronto: Ontario Research Foundation, 1955.)

# THE STRUCTURE OF COLLAGEN

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VERY recently, Ramachandran and Kartha[1] have made an important contribution by proposing a coiled-coil structure for collagen. We believe this idea to be basically correct but the actual structure suggested by them to be wrong.

Their structure consists of three polypeptide chains, each having approximately a three-fold screw axis. In addition, the chains slowly wind around each other to form a coiled coil, thus reproducing the observed non-integer screw axis[2]. The major helix is right-handed, the minor one left-handed. Each chain is held to its neighbours by *two* sets of systematic hydrogen bonds.

The allowed sequence of residues is

—*G*—*R*—*P*—*G*—*R*—*P*—, etc.,

where *G* implies glycine only, *R* implies any residue except proline or hydroxyproline, and *P* implies any residue, but usually proline or hydroxyproline.

We believe this structure to be wrong for two reasons. (1) It is stereochemically unsatisfactory. In particular, there is a very short $C_\alpha$—$C_\alpha$ contact of 3·3 A. (normally 3·6–4·0 A.) and an extremely short $C_\alpha$—O contact of 2·6 A. (normally 3·2–3·5 A.). In addition, the hydrogen bond angles are on the outside limit of the values usually found. (2) It is not compatible with recent work[3] on the amino-acid sequence, which shows that

—gly—pro—hypro—

is a common sequence in collagen.

On the other hand, Dr. Pauline Cowan and her co-workers[4] have informed us that a preliminary optical diffraction pattern of this structure agrees qualitatively with the observed wide-angle X-ray pattern of collagen. They have also pointed out to us that the configuration of the backbone of the polypeptide chain is similar to that found by them for polyproline[5]. These facts suggest that the structure, though incorrect, is on the right general lines.

Our own work on collagen has sprung from our recent structure for polyglycine II[6]. We have taken a compact group of three adjacent chains out of the polyglycine lattice (space group $P\,3_1$) and twisted them, as in the Ramachandran–Kartha structure, to form a similar coiled coil. Such a group can be selected in two different ways, since the symmetry is trigonal, not hexagonal. We have called the two resulting arrangements structure I and structure II. Both have a right-handed major helix and a left-handed minor helix, arranged to fit the observed non-integer screw. Both have only one set of systematic hydrogen bonds linking neighbouring chains. In structure I the NH-groups point anticlockwise when viewed from the carboxyl ends of the chains; in structure II clockwise.

These two structures are thus similar to that of Ramachandran and Kartha in being three-chain coiled-coil structures; but they differ in having only one set of systematic hydrogen bonds instead of two. Moreover, they are both stereochemically completely satisfactory.

Both structure I and structure II will accommodate the sequence

—gly—pro—hypro—

but they do so in a different manner. In structure II the glycine position is near the axis, and every third residue must be glycine. The proline and hydroxyproline positions, on the other hand, are far removed from the axis. Either proline or hydroxyproline can go into either position—there seems to be no preference—and in neither case can the OH of hydroxyproline make a hydrogen bond with a CO group of an adjacent chain within the same set of three chains.

Structure I will also accommodate the above sequence; but when the hydroxyproline is in the expected position (that is, previous to glycine) its OH group can form a hydrogen bond to one of the adjacent chains within the same set. Careful structure building has shown that not all the possible positions for hydroxyproline can be occupied if the structure is to fit together comfortably. This is compatible with the amino-acid analyses of collagen, which show that the amount of hydroxyproline present in bovine collagen[7] would fill about one-third of these sites. The polypeptide backbones, being held together by only one set of hydrogen bonds, have a certain amount of flexibility. In the undeformed structure, only glycine can be accommodated in the glycine sites. However, if the structure is deformed somewhat, these sites can accommodate other residues, though only to a limited extent. This may explain certain minor features of the amino-acid sequence data.

We have made an exhaustive study of all possible structures (using topological enumeration, similar to that of Bragg, Kendrew and Perutz[8]) of this general type which are compatible with the observed screw axis—that is, with three parallel chains linked by at least one systematic set of hydrogen bonds—and we find that: (1) no structure with *two* systematic sets of hydrogen bonds is stereochemically possible; (2) no other structure with *one* systematic set of hydrogen bonds is stereochemically satisfactory except the two described above derived from polyglycine. Neither were we able to add occasional backbone hydrogen bonds to structures I and II in a convincing manner.

All the above findings are independent of arguments about the side-chain arrangements. We therefore conclude that structures I and II, though making few hydrogen bonds systematically, are the best that can be achieved along these lines. Note that, as in polyglycine II[6], it is not impossible that the direction of one of the three chains may be reversed.

Preliminary work on the optical transforms of these two structures (carried out with Dr. A. Elliott on his optical transform machine) show both structures to give rough agreement with the X-ray pattern, though structure II shows a discrepancy on the fourth layer-line. Both structures are also compatible with the infra-red[9] observations. Further work will therefore be required to decide between them. We are at the moment inclined to favour structure I, because it makes effective and systematic use of the hydroxyproline residues. Gustavson[10] has presented extensive evidence suggesting that this unusual amino-acid stabilizes the collagen structure. We feel that this is more likely to take place by formation of hydrogen bonds within a group of three chains than between different groups of chains[1]. In addition, structure I explains in a natural way the amino-acid sequence data. Thus while the peptide hypro—gly is common, gly—hypro is not found. Similarly, gly—pro is common, whereas pro—gly is rare. In structure I this preference is explained in terms of the hydroxyproline-hydrogen bond between the chains.

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Although we cannot at the moment make a final decision between the two structures, we think it very probable that one of them is correct (or, less likely, both). The general agreement with the X-ray pattern, the close resemblance to polyproline and to polyglycine II, and the ability to explain the major features of the amino-acid sequence data all suggest that collagen is a structure of this type; that is, a three-chain, coiled-coil structure, with one set of systematic hydrogen bonds.

Full details of our findings together with co-ordinates of both structures will be presented elsewhere.

We should like to thank Dr. A. Elliott for hi assistance in obtaining the optical transforms.

[Oct. 10

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# LANGMUIR'S PARADOX

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A LITTLE more than thirty years ago, Irving Langmuir and Harold Mott-Smith carried out an important series of investigations on low-pressure mercury discharges[1], on which they based their theory of the positive column in electro-positive gases. They distinguished two regions in the discharge: the almost neutral arc plasma, and the thin boundary sheath which separates it from the tube wall. In the plasma the motion of the ions is regular and mostly radial, whereas the electron motion consists of a regular longitudinal drift, with a superimposed random, Maxwellian component. The random motion corresponds to 'electron temperatures' of the order of several 10,000 deg., many times higher than the gas temperature. The boundary sheath enables the plasma to remain neutral, by maintaining a potential well of such depth that most of the electrons are repelled, and only a small fraction reaches the wall, together with an equal number of positive ions.

This theory was highly successful in all respects except one; but this exception, as Langmuir showed in a number of important papers[2,3], presented one of the worst discrepancies known in science. Once the existence of electron temperatures was accepted, the theory of Langmuir and Mott-Smith could account for all observations, but this phenomenon itself remained not only unexplained but also inexplicable. Maxwellian energy distributions have been observed, in discharge tubes of a few centimetres in diameter, at mercury pressures so low that the mean free path was several times the tube diameter; and, moreover, at such small electron densities that it would take an electron, in the average, a path of the order of 10 m. to exchange amounts of the order of the mean energy with other electrons. The tube wall eliminates all the time electrons above a certain energy limit, and an electron collides, on the average, some thousand times with the boundary sheath before it has a chance to pick up energies of this order. Yet probe measurements fail to reveal any deficit of fast electrons among those returning from the wall, even at a distance of only a few millimetres from it.

Though the existence of electron temperatures has become a well-established part of our knowledge of low-pressure discharges, the fact that this phenomenon persists in a region in which it has theoretically no right to exist appears to have been largely ignored, in spite of Langmuir's emphasis. Our investigations, which started five years ago, have now led to the elucidation of what we propose to call 'Langmuir's paradox'.

The first step was to clear up the question whether the discrepancy between theory and experiment could not be ascribed to faulty theory. Interaction between electric charges in plasmas is very complicated, as the Coulomb forces extend appreciably over spheres containing thousands of other charges; hence there was some reason to distrust the simple theories which considered short-distance interaction between pairs of electrons only. But experiments by two of us (E. A. A. and D. G.[4]) have shown that the scattering and energy exchange of electrons in plasmas and in electron clouds in thermal equilibrium, with densities of the order as they occur in low-pressure discharges, exceed the predictions of the theory based on binary collisions at most by a factor of 2–5. The rather large margin of uncertainty is due to the smallness of the interaction, which makes the measurements very delicate. A theory afterwards developed by one of us (D. G.[5]) indicates that the collective interaction which is neglected in the binary collision theory amounts in fact to a correction of a few per cent only. Thus the mechanism responsible for Langmuir's paradox must arise in some way from the fact that the discharge plasma is not

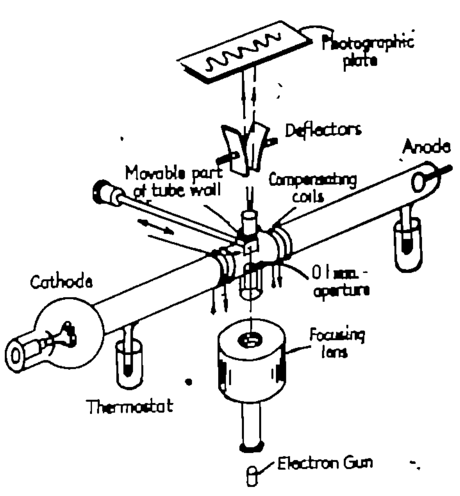

Fig. 1. Apparatus for the measurement and oscillography of plasma-boundary oscillations in a low-pressure mercury arc

in thermal equilibrium, and we started a search for organized oscillations.

Several devices were used in turn in this search, but they mostly had in common the use of electron beam probes for the exploration of the discharge. The principle of the method is illustrated in Fig. 1. A long d.c. mercury arc is maintained in a discharge tube, from which all residual gases are eliminated, while the mercury pressure is maintained by saturation in several carefully temperature-controlled side arms. (The pressures investigated were in the range 0·5–3 microns.) A finely collimated electron beam of 1–20 kV. is shot at right angles through the discharge. It is limited to about 0·1 mm. diameter by an aperture at the entry side, while at the exit side the aperture is made large enough to pass a slightly deflected beam. By pumping vigorously at both sides it was assured that the electrons suffer no collisions except in the discharge space. A section of the wall of the discharge tube, about 2 cm. square, was made movable so that the beam could pass outside or inside the boundary sheath. So long as it passed outside the sheath, that is to say, through the arc plasma, it was found that the beam was neither deflected nor appreciably diffused, which proved the absence of significant oscillatory fields in the plasma.

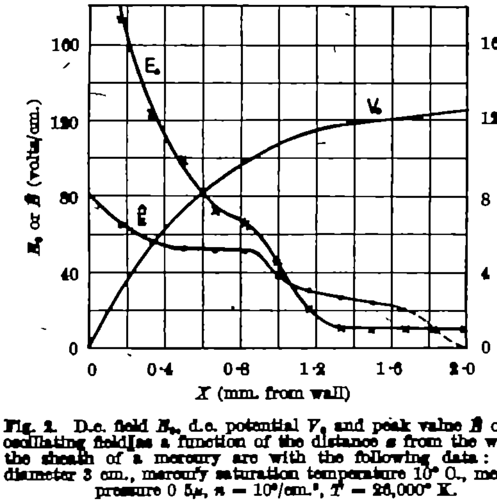

Fig. 2. D.c. field $E_0$, d.c. potential $V_0$ and peak value $\hat{E}$ of the oscillating field as a function of the distance $x$ from the wall in the sheath of a mercury arc with the following data: tube diameter 3 cm., mercury saturation temperature 10° C., mercury pressure 0·5μ, $n = 10^9$/cm.$^3$, $T = 26,000$° K.

On the other hand, when the electron probe passed through the boundary sheath, which in these experiments was 1–2 mm. thick, it was deflected and appeared diffused, but only in the direction at right angles to the wall. The mean deflecting field was measured by compensating the deflexion locally by a weak magnetic field parallel to the wall. This ensured that the beam passed at a constant distance $x$ from the wall, and enabled us to plot the d.c. field-intensity $E_0$ as a function of $x$. An example of such measurements is shown in Fig. 2. From the field $E_0$ it was possible to plot the d.c. potential profile $V_0(x)$ in the sheath, which corresponded approximately if not exactly to that calculated from the theories of Langmuir and Mott-Smith and Langmuir and Tonks.

After eliminating the static deflexion, the cathode-ray spot retained its elongated shape, which could scarcely be interpreted otherwise than as revealing the presence of an oscillating field, with a peak value $\hat{E}$, which is also plotted in Fig. 2 as a function of $x$. These observations were made in 1951 (E. A. A.[6]); but all attempts to prove the correctness of this interpretation failed until the end of 1954. It appeared an evident suggestion to detect the oscillations by passing the electron beam through a slit at right angles to the deflexion, catching it in a collector, and amplifying the oscillatory current. However, all that could be detected in this way was a low-frequency component in the oscillations, extending up to about 100 kc./sec., which could account only for a small fraction of the amplitude inferred from the deflexion. In the high-frequency region, which we explored up to 600 Mc./sec., it was impossible to detect any signal above the noise-level of the amplifiers, owing to the poor matching of the electron beam to ultra-high-frequency broad-band devices.

It was finally decided to try recording the oscillations directly on a photographic plate. This, as we realized beforehand and confirmed later, was an undertaking with only a marginal hope of success, because the exploring electron beam had to be kept very narrow (0·1 mm.) and was therefore very weak, with a current of about 0·1 μamp. The energy could not well be raised beyond 20 keV. if the deflexion sensitivity was to be kept at a reasonable level. A compromise was struck, at which the deflexion amplitude was a few spot diameters, and a record could just be obtained with the most sensitive plates available at sweep speeds of about $10^8$ cm./sec. Thus we succeeded at last in demonstrating the existence of very-high-frequency oscillations in the boundary sheath, at least in arcs at 0·5–1μ pressure, where conditions are most favourable.

Some of the results are shown in Fig. 3. These oscillograms were taken in arcs with an electron concentration of $n = 3 \times 10^9$, electron temperature $T = 26,000$°. It is seen that in this case the phenomenon consists of a very-high-frequency oscillation of 100–120 Mc./sec., modulated by a noise-like band in the range 10–100 kc./sec. The first two oscillograms (Fig. 3a) show the envelope of the oscillation, as it appears on a long time-base; the irregular character of the modulation is well in evidence. Fig. 3b shows the very-high-frequency oscillation at maximum sweep-speed. The wave-form is not quite sinusoidal; its basic frequency is about 100 Mc./sec., which is not quite constant. It differed by about 20 per cent in oscillograms taken in rapid succession, but it is evident that the frequency is more nearly a constant than the amplitude.

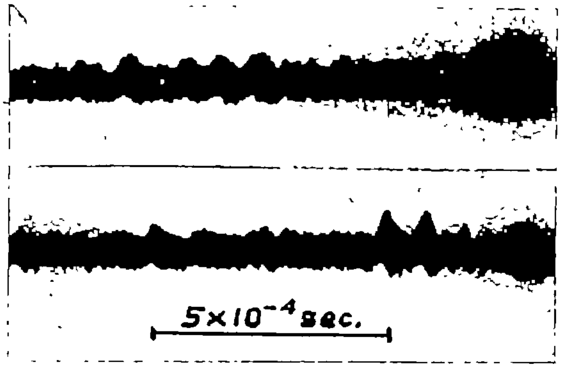

Fig. 3a. Two records of plasma-boundary oscillations on a long time-scale, showing the irregular character of the envelope

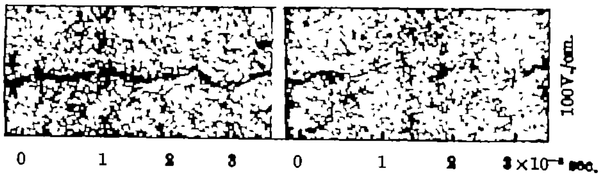

Fig. 3b Two records of plasma-boundary oscillations on a very short time-scale, showing the basic frequency of about 100 Mc./sec.

In the gas-discharge field, it is often more expedient to ask first about the purpose of a phenomenon rather than for its causes. Gas discharges strike us as highly viable phenomena. In particular, it has been often remarked that the plasma tries to occupy as much of the discharge space as possible, and to secure its survival by a remarkable variety of mechanisms. For its survival the plasma of the positive column requires a certain small proportion of fast electrons, to replace by ionization the ion pairs lost at the wall. We see now that at pressures and at electron concentrations which are too low to produce the fast 'Maxwellian tail' by collisions, this is produced by interaction with the oscillating boundary sheath. The frequency of these oscillations is such that an electron diving into the sheath and emerging from it will spend just about a full cycle in it. This can be seen by approximating the part of the $V_s(x)$ curve near the sheath edge, which contains the major part of the electrons, by a parabola. It is well known that electrons in a parabolic potential trough oscillate with a frequency which is independent of their energy. In the case shown in Fig. 2, this works out to about 60 Mc. Hence during the time in which the electron dives into the sheath and returns again into the plasma, that is to say, performs one half-cycle of oscillation in the parabolic trough, the very-high-frequency field of 100–120 Mc./sec. goes nearly through a full cycle. Thus an electron diving into the sheath in the appropriate phase will gain energy both ways, and it can be seen from the data in Fig. 2 that this gain will be of the order of several electron volts. These electrons form the fast 'Maxwellian tail'. Their gain is balanced by the loss which other electrons suffer—those which dive into the sheath in the opposite phase. On balance, the electrons must lose a little energy to the oscillating sheath, because a certain amount of power is required to cover the losses; these, however, are very small because the boundary sheath is a resonator with small damping. As the oscillations are longitudinal, they do not radiate outwards, into the glass or metal envelope, nor are they propagated inwards, into the plasma, because their frequency is well below the critic plasma frequency ($f_p = 9{,}000\, n^{1/2}$). In the case show in Fig. 3, the electron concentration was $n = 3 \times$ $10^9$/cm.$^3$; hence the plasma frequency was $f_p =$ 500 Mc./sec. Thus the plasma-boundary frequenc and its harmonics up to the fourth or fifth were we below it. Some losses are bound to arise, thoug by the imperfect coherence of the boundary oscillations, that is to say, by their not vibrating in the sam phase over large areas of the envelope.

Thus the oscillating boundary sheath is a ver efficient energy exchanger, and there are good reason for believing that it is this mechanism which maintain all low-pressure arcs in mercury and in other electropositive gases until the collision mechanism take over. The experimental evidence regarding the poin where the change-over takes place is not yet conclusive. Fig. 4 is a record of the various discharg data, $n$, $T$, the gradient $G$ and the oscillating pea intensity $\hat{E}$, over a pressure range 0·5–3μ in mercury It is seen that $\hat{E}$ falls gradually and becomes zer at the upper end of the pressure-range. This, however we suggest interpreting as the failure of the electro-probe method rather than a real fade-out of th boundary oscillations. In all our experiments th length of the movable wall was 2 cm., and it is ver likely that, at the higher concentrations, and consequently thinner sheaths and higher frequencies, th boundary oscillations were no longer coherent ove this length. In all probability they persist up t appreciably higher pressures and concentrations than those recorded in Fig. 4.

Turning now from the teleological to the causal interpretation of these oscillations, they appear to be of the 'reflex klystron' type, that is to say, they maintain themselves by the slight energy given up in the mean to the oscillating sheath by the returning electrons. (One could think that this energy is perhaps supplied by a slowing-down in the mean of the electrons which reach the wall, but we have found that the oscillations persist unaltered if the wall is made so strongly negative that not one electron in a million can reach it.) It is not so easy, though, to account for the remarkable fact that, unlike man-made klystrons which operate with

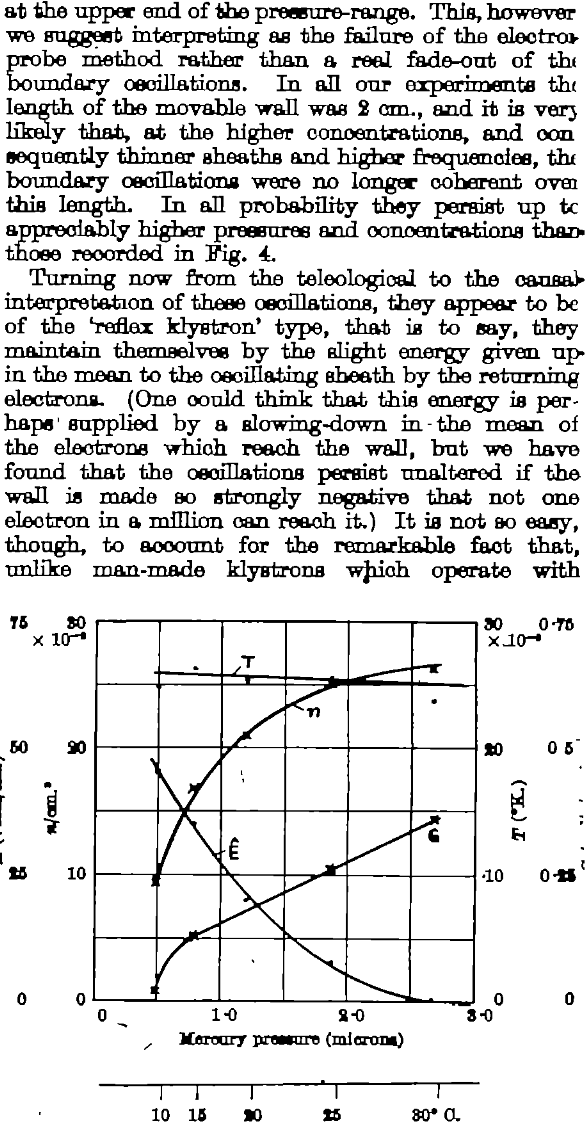

Fig. 4. Electron concentration n, electron temperature T, gradient G and oscillating peak field-intensity $\hat{E}$ in a mercury arc with 100 m.amp. current, at various pressures

electrons of almost uniform energy, this oscillator operates so extremely near a thermal equilibrium that it is not easy to distinguish the electron energy distribution from the Maxwellian. In fact, the high-energy tail is so nearly Maxwellian that it cannot account for the oscillations; we attribute these to the small deficiency in slow electrons which we have regularly observed in probe measurements.

Though a detailed theory of this highly complicated and non-linear process is still being sought, its outlines are clear enough for venturing a generalization which may serve as a heuristic guide in searching for new phenomena: plasma-boundary oscillations are likely to arise at almost any boundary, not necessarily abrupt or permanent, which is in contact with a plasma however slightly off equilibrium. These oscillations constitute a powerful mixing, entropy-increasing mechanism, and as a by-product they might produce some radiation in all but cases of exceptional symmetry or regularity. What part, if any, they play in the generation of cosmic radio noise phenomena it is as yet too early to say.

[May 25.

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# EFFECTS OF GAMMA-RAYS ON SOLUTIONS OF SODIUM DEOXYRIBONUCLEATE

## POSSIBLE CHEMICAL MECHANISM FOR THEIR BIOLOGICAL EFFECTS

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IT is well established that degradation of aqueous solutions of sodium deoxyribonucleate by ionizing radiations is an indirect effect due to radicals ($OH^{\bullet}$ and $HO_2^{\bullet}$, in the presence of oxygen) formed by the breakdown of water[1–4]. Such radiations cause a decrease in the molecular weight[5] of the deoxyribonucleate with a consequent drop in the viscosity of the solutions. Previous viscosity studies[1,6–8] have been mainly confined to measurements of specific viscosity ($\eta_{sp}$) at one concentration and, over a limited range, log $\eta_{sp}$ has often appeared to be a decreasing linear function of dosage[1,4]. From this it has been inferred[4] that the radicals attack the products of degradation; but strictly speaking it is only changes in the intrinsic viscosity $[\eta]$ ($=(\eta_{sp}/c)_{c\to 0}$) which are of significance in the estimation of molecular size and shape. Charlesby[9] has shown that such changes in $[\eta]$ can be related to characteristics of both the radiation process and of the polymer irradiated. The aim of the investigation now reported was twofold: to measure the intrinsic viscosity $[\eta]$ of deoxyribonucleate degraded by γ-rays in order to apply these theoretical considerations[9]; and to study more closely the chemical effects of dosages lower than those which previous workers[10–12] have shown to disrupt the constituent nucleotides of the deoxyribonucleate. There appears to be little knowledge concerning changes in this dose-range which is likely to be biologically more important. The latter problem was investigated by titration and other techniques. Titration studies are of particular value[13,14] in following the disappearance of the specific hydrogen bonds which cross-link the two constituent helices of sodium deoxyribonucleate in the solid state[15] and in solution[14].

Sodium deoxyribonucleate was prepared from herring sperm by water extraction of soft roes, and protein was completely removed from a saline solution (1 *M* sodium chloride) of the nucleoprotein by means of sodium dodecyl sulphate[16] followed by the method of Sevag[17]. Aqueous solutions of deoxyribonucleate (20 ml., 0·17–0·43 per cent) were subjected under standardized conditions to the radiation from a 100-curie cobalt-60 source (γ-rays, 1·25 MeV). After the irradiation, sodium chloride was added (to 0·1 *M* sodium chloride) and the solution left at 0° C. for a period sufficiently long (usually 24–30 hr.) for most of the 'after-effect'[1,6,7,8] on the viscosity to be complete. The flow times of this deoxyribonucleate solution in an Ubbelohde[18] viscometer were then measured at a series of dilutions. The solutions were Newtonian, and the viscosities obeyed the equation

$$\eta_{sp}/c = [\eta] + k'[\eta]^2 c$$

where $c$ is concentration of deoxyribonucleate in gm./ml. and $k' = 0{\cdot}77$ (cf. the values of 0·77 and 0·73 predicted for extended chains[19] and rigid rods[20]).

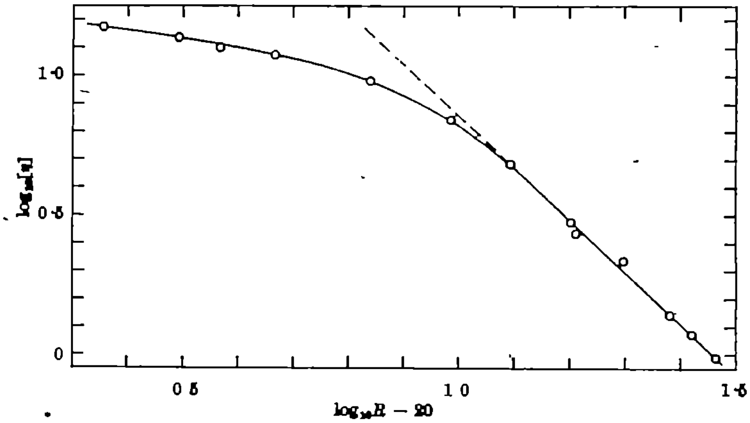

Fig. 1. Effect of γ-radiation on the intrinsic viscosity of herring sperm sodium deoxyribonucleate. Concentration of deoxyribonucleate during irradiation = 0·0043 gm./ml. Ordinate, $\log_{10}[\eta]$, where $[\eta]$ is intrinsic viscosity in dl./gm. Abscissa, $\log_{10}R$, where $R$ is radiation dosage in eV. gm.$^{-1}$. Dose-rates employed in the range 1·1 to 1·3 × $10^{16}$ eV. min.$^{-1}$ ml.$^{-1}$. Slope of straight part of graph = − 1·86

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The viscosities of the irradiated samples were independent of rate of dose for a given dosage. They depended only on the ratio (denoted by $R$ in eV. gm.$^{-1}$) of radiation dosage (in units of eV. ml.$^{-1}$ = $1 \cdot 72 \times 10^{-14}$ röntgens) to concentration of deoxyribonucleate (gm. ml.$^{-1}$) during irradiation, which again suggests an indirect effect (cf. ref. 21). The eventual linearity of a plot of log $[\eta]$ against log $(R)$ (see Fig. 1) shows that the breakage must be random[9]. The slope of this linear portion of the curve is $-1 \cdot 86$ and, on the hypothesis of random cleavage of a single chain[9], is equal to the negative of the index $\alpha$ in the equation $[\eta] = KM_v{}^{\alpha}$, where $K$ and $\alpha$ are constants for homologous polymers and $M_v$ is the viscosity-average molecular weight. This relation arises because the probability, $p_s$, of a break in a single chain is $p_s \propto (R+R_0)$ and, when the molecular weight distribution is random, $M_v \propto (R+R_0)^{-1}$, that is, $M_v \propto R^{-1}$, when $R \gg R_0$, which applies over all the linear part of Fig. 1 (for definition of $R_0$ see ref. 9).

The value of 1·86 for the index $\alpha$ in the equation relating $[\eta]$ and $M_v$ is improbably high, being greater than the values expected[22] either for rigid rods (1·7) or random coils (0·66), and indeed synthetic polymers rarely have $\alpha$ greater than 1. The basis of this interpretation is that every break in a monomer–monomer linkage leads to a change in molecular weight, and hence in $[\eta]$. In a cross-linked double helical structure such as the deoxyribonucleate, cleavage of a *single* monomer–monomer linkage (that is, an internucleotide bond) would not be expected to lead to an immediate change in molecular weight and intrinsic viscosity, $[\eta]$. Such changes would only happen if two breaks occurred in opposite positions, one in each of the two polynucleotide strands of the double helix (*B* and *B′*, Fig. 2). It is of interest that the fragments so produced (*B′* in Fig. 2) are not unlike the interrupted double helical model suggested by Schachman and Dekker[13]. The joint probability, $p_D$, of such a complementary double break is $p_D = p_s{}^2 \propto (R+R_0)^2$. Hence $M_v \propto (R+R_0)^{-2}$ and the slope of the plot of log $[\eta]$ vs. log $R$ will be $(-2\alpha)$ at $R \gg R_0$, which applies over all the linear part of Fig. 1. This gives a value for $\alpha$ of $1 \cdot 86/2 = 0 \cdot 93$, which is more feasible and is intermediate between the values for a rigid rod and for a random coil[22], in agreement with other observations on sodium deoxyribonucleate[14].

The evidence that, over the range of the viscosity studies, hydrogen bonds are still present holding the two helices together comes from titration studies, which show that, at the highest value of $R$ in Fig. 1, 57 per cent of the hydrogen bonds are still present. In Fig. 3, curves I and II represent respectively the forward and back titration curves to and from *p*H 2·5 of the original deoxyribonucleate; (I) is the irreversible titration curve of a deoxyribonucleate with its adenine and cytosine amino-groups hydrogen-bonded, and (II) is the reversible titration curve of these same groups in 'denatured' deoxyribonucleate containing no hydrogen bonds[14]. Curves *A*, *B*, and *C* are the *forward* titration curves of various irradiated samples of deoxyribonucleate and show that γ-rays gradually destroy the hydrogen bonds. The back titration curves of the original (curve II, Fig. 3) and irradiated deoxyribonucleate (not shown in Fig. 3) indicate that acidic groups titrating at *p*H 4·5–5·5 and at *p*H 6·5–7 are released (for example, 0·22 group/4 moles of deoxyribonucleate phosphorus at $R = 1 \cdot 11 \times 10^{22}$ eV./gm.). These groups must comprise secondary phosphoryl end-groups, but may also include carboxyl groups at the $C_5$ of the suga moiety produced by radical attack[15]. Curves *A*, *I* and *C* of Fig. 3 have all been corrected for thes acidic end-groups, so that direct comparison can b made between them and (I) and (II).

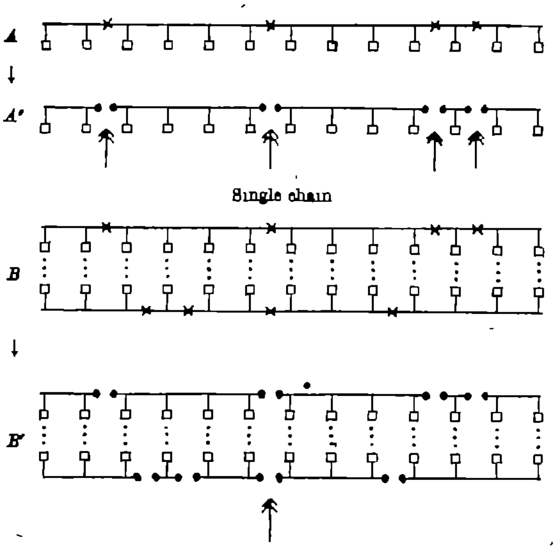

Fig. 2. Schematic diagram of the effects of random fracture of internucleotide linkages in sodium deoxyribonucleate according to two different models. (*A*) Single polynucleotide chain giving (*A′*). (*B*) Two polynucleotide chains cross-linked by hydrogen bonds, giving (*B′*).
One nucleotide, the square denoting the purine or pyrimidine base; . . . , hydrogen bond systems cross-linking purines to pyrimidines; —●, new ends formed by the internucleotide breaks; ×, positions of fracture of internucleotide linkages; ⟶, positions of breaks which alter the molecular weight and contribute to the decrease in $[\eta]$.
Both diagrams ($A \rightarrow A'$ and $B \rightarrow B'$) are drawn for a probability of rupture of an internucleotide linkage of 1/3. (Note bigger change in molecular weight for $A \rightarrow A'$)

An important feature of the titration curves (whic is also clear from the lower part of Fig. 3) is tha irradiation does not displace the forward titratio curves uniformly from (I) towards (II) and withou regard to the *p*H range, as would be expected fo random breakage of all hydrogen bonds involvin the titratable groups. In the early stages of irradiation, it is the lower part of (I) which is fir displaced towards (II). This *p*H region correspond chiefly to the titration of adenine amino-groups[1] in the intact molecule. (For clarity, Fig. 3 show neither the five titration curves between (I) and *A* which accurately confirm the unsymmetrical character of this displacement, nor other curves betwee *A* and *C*.) As the irradiation proceeds (for example curve *B*) the upper part of the curve is displace towards (II), until eventually (for example, curve *C* most of the hydrogen bonds are ruptured. It coul be concluded from this that the adenine–thymin hydrogen bonded system[15] is broken down mor rapidly than is the guanine–cytosine system and ther is indeed no *a priori* reason why these two system should have the same stability. However, it woul contrast with the random breakage of the internucleotide bonds. Alternatively, the titration curve could be explained if the internucleotide breaks o Fig. 2 facilitated the irreversible denaturation of th deoxyribonucleate double helix so that fewer group had to be ionized before complete denaturation. On the double helical model, breakage of hydroger bonds by γ-rays would not lead to a change in molecular weight until the majority of such bond

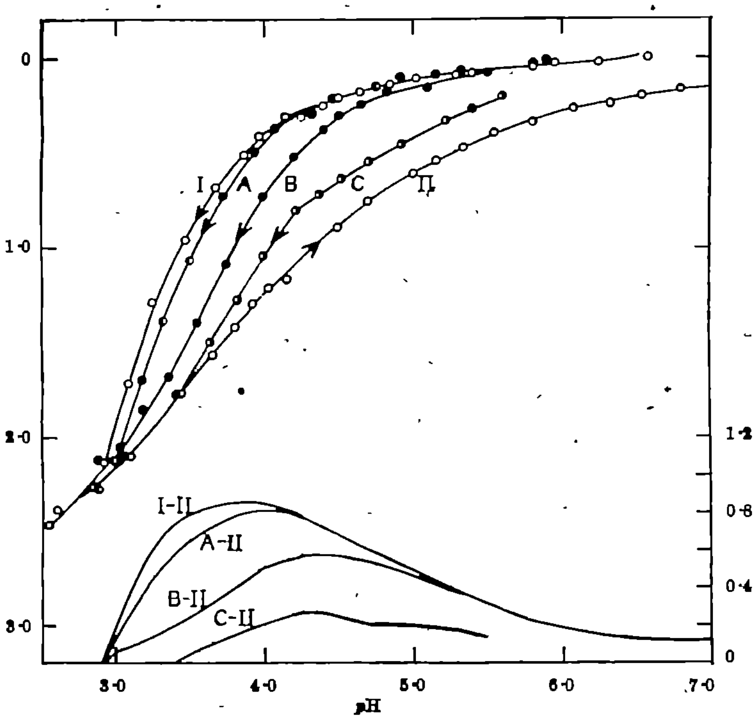

Fig. 3. Titration curves of original and $\gamma$-irradiated herring sperm sodium deoxyribonucleate. Titration conditions: 25° C., ionic strength = 0·05, concentration of deoxyribonucleate, 0·14–0·18 per cent.

*Upper Figure.* (I) and (II) forward (pH 6·0 to 2·5) and back (pH 2·5 to 7) titration curves of the original sodium deoxyribonucleate. *A*, *B* and *C*, forward titration curves (pH between 5 and 6 to pH 2·5) of deoxyribonucleate irradiated with $\gamma$-rays to different extents. Dosages, in units of (*R*): (*A*) 0·87 × $10^{20}$ eV. gm.$^{-1}$; (*B*) 2·9 × $10^{20}$ eV. gm.$^{-1}$; (*C*) 11·5 × $10^{20}$ eV. gm.$^{-1}$ Ordinate scale on the left.

*Lower Figure.* Difference curves obtained by subtracting the base bound along curve (II) from the other curves. Ordinate scale on lower right

ad been ruptured, and this justifies the interpretation f changes of [$\eta$] in terms of rupture of internucleotide onds over the range of *R* shown in Fig. 1.

As with other modes of degradation[26] which upture hydrogen bonds, there is an increase in ultra-iolet absorption of the sodium deoxyribonucleate t 258 mμ. It may be expressed as a percentage of he maximum increase in extinction, $\epsilon$, observed with high dosage ($R = 411 \times 10^{20}$ eV. gm.$^{-1}$) large nough to break all hydrogen bonds but not to lecompose the purine and pyrimidine rings, and able 1 shows that this quantity is approximately qual to the total percentage of hydrogen bonds roken (as deduced approximately from the titration urves). This is further evidence[27] that it is rupture f hydrogen bonds in the double helix which causes n increase in the ultra-violet absorption.

able 1. EFFECT OF GAMMA-RAYS ON THE ULTRA-VIOLET ABSORPTION OF DEOXYRIBONUCLEIC ACID AT 258 mμ

| | | | | |
|---|---|---|---|---|
| $0^{-20}$ *R* (eV. gm.$^{-1}$) | 23 | 29 | 35 | 111 |
| er cent increase in ultra-violet absorption, $\frac{\Delta\epsilon}{\Delta\epsilon\,\text{max.}} \times 100$ | 40 | 50 | 45 | 78 |
| r cent hydrogen bonds broken (from titration) | 33 | 42 | 43 | 80 |

It would appear that, as with some other studies f sodium deoxyribonucleate[14,24,26], the present results re best understood in terms of the existence of the ouble helical structure in aqueous solutions of deoxy-ibonucleate. The action of $\gamma$-rays consists of: ) random cleavage of internucleotide phosphate ster bonds, a decrease in molecular weight and [$\eta$] esulting when two such breaks occur at opposite positions in each polynucleotide helix; and, (*b*), rupture of cross-linking hydrogen bonds, those which link the adenine–thymine pair of bases perhaps being broken more rapidly than those linking the guanine–cytosine pair. This rupture of hydrogen bonds begins at lower dosages than those causing appreciable changes in intrinsic viscosity and the even larger dosages causing degradation of the bases[10–12].

It has been suggested[27] that there is a relationship between the pairing of the bases linked by hydrogen bonds, the complementary nature of the two helices of the deoxyribonucleic acid that this implies, and the genetic self-duplicating role of deoxyribonucleic acid in biological systems. The effects of ionising radiation on hydrogen bonding reported here show a possible chemical mechanism for the biological effects of low dosages of such radiation (and possibly also for mutational changes), since the rupture of a few hydrogen bonds would presumably impair the duplication of the deoxyribonucleic acid at that point but not elsewhere along the molecule.

We are indebted to Prof. M. Stacey for his interest and encouragement in this work and for making available the source of gamma-rays. We acknowledge also the co-operation of Dr. G. A. Gilbert in the viscosity measurements, and the receipt of a maintenance grant from the Department of Scientific and Industrial Research by one of us (R. A. C.). [Aug. 12

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## New Records in Human Power

UNDER this heading Robinson, Edwards and Dill[1] published in 1937 results of investigations of five young men of international renown in distance running. Lash, who held the world's record for the 2-mile race, running on a treadmill at 21·6 km./hr. with no gradient, attained an oxygen intake of 5·35 l./min. or 81·5 ml. per kgm. of body-weight per min.[2].

In this laboratory, studies have been carried out on oxygen intake (aerobic capacity) during severe muscular work by normal, healthy children, men and women and championship athletes. Methods and results of examinations of about 260 subjects have been described by Åstrand[3,4]. In some cases an oxygen intake of 5 l./min. was obtained.

Table 1 gives the aerobic capacity and some other results for three international standard milers. Determinations of pulse-rate, pulmonary ventilation and oxygen intake were carried out during the last minutes of a 6-min. run at a speed of 20 km./hr. on a treadmill set at an angle of 1°. The highest value for oxygen intake was obtained with J. Landy, who broke the world's record in 1954 for the 1,500-m. race, that is, the same summer as that during which the present determinations were carried out. He reached an oxygen intake of 5·04 l./min. or 76·6 ml./kgm./min.

When testing the Swedish national ski-team for physical condition, submaximal work-loads were performed on a bicycle ergometer. Applying a nomogram[5], aerobic capacity was estimated from pulse-rate attained during this work. By this procedure, values of oxygen intake as high as 6·1 l./min. were estimated. As these figures far surpassed the earlier maximum, it was of great interest to obtain direct measurements of those subjects' aerobic capacity. Arrangements were therefore made to carry out some tests during the Swedish ski championships hel during 1955.

To get 'warmed up', the subjects covered a distanc of about 10 km. at a fairly high pace. Then a specia 'rucksack' carrying a Douglas bag was attached. Th skiing now continued at almost maximum speed o a horizontal track. After 3 min. the subject stoppe for a few seconds and then started to breathe vi the valve. The maximum rate of work proceede for another couple of minutes. During the las minute he was skiing uphill and the expired air wa collected in the bag. It should be emphasized tha only one experiment was carried out with each subject, for which reason the recordings are minimum values. On the other hand, the high figures for th concentration of blood lactic acid suggest an oxyge intake very close to the maximum which is attainable[3].

Table 1 summarizes the results of the experiments The highest figure recorded for oxygen intake wa 5·88 l./min. or 81·7 ml./kgm./min. The femal subject reached an intake of 3·97 l./min. or 68· ml./kgm./min.

Five of the subjects were tested performing work-load of 1,200 kpm./min. on a bicycle ergometer and the nomogram mentioned was applied. In three cases the estimated aerobic capacity diverge less than 4 per cent from that determined. For the female subject the estimated figure was 15 per cent too high. The nomogram is made up with different scales for men and women. When using the male scale for this very well-trained female skier, the estimated aerobic capacity, however, equalled that determined (4·0 l./min.).

In Table 1, values are included from an investigation of capacity for hard muscular work of eighty-six healthy, well-trained students of physical education[6]. None of those subjects, however, was of the championship class in events calling for endurance. The most striking difference between those students, on one hand, and the middle-distance runners and skiers, on the other, is found when comparing the capacity for oxygen intake. Values for vital capacity, maximum heart-rate, pulmonary ventilation and concentration of blood lactic acid were of the same order. It is probable that a high aerobic capacity

Table 1. RESULTS OF MEASUREMENTS ON SUBJECTS PERFORMING SEVERE MUSCULAR WORK

| Subjects | Body | | Vital capacity* (l.) | Heart-rate | Pulmonary ventilation* (l./min.) | Oxygen intake | | | Blood lactic acid (mgm per cent) | Work | Best result |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | height (cm.) | weight (kgm.) | | | | (l./min.)† | | ml./kgm./min. † determined | | | |
| | | | | | | determined | estimated‡ | | | | |
| Runners | | | | | | | | | | | 1,500 m. |
| ♂ Landy, J. | 179 | 66 | 5·8 | 194 | 133 | 5·04 | — | 76·6 | 108 | Running 20 km /hr 1° uphill | 3 41·8 |
| ♂ Karlsson, S. | 172 | 62 | 5·7 | 200 | 119 | 4·53 | — | 73·0 | 102 | | 3·44·2 |
| ♂ Ericsson, I. | 177 | 60 | — | 200 | 96 | 4·87 | — | 72·4 | 80 | | 3·45·2 |
| Skiers | | | | | | | | | | | 15 km.§ |
| ♂ Jernberg, S. | 177 | 72 | 8·1 | 179 | 146 | 5·88 | 6·1 | 81·7 | 92 | Skiing | 1 |
| ♂ Larsson, L. | 174 | 67·5 | 5·8 | 182 | 111 | 5·49 | 6·1 | 81·3 | 81 | | 2 |
| ♂ Larsson, P. H. | 176 | 67 | — | 190 | 119 | 5·38 | 5·6 | 80·3 | 78 | | 8 |
| ♂ Samuelsson, G. | 183 | 68 | — | 182 | 150 | 5·34 | — | 78·5 | 122 | | 10 |
| ♂ Gunnarsson, S | 175 | 67 | 5·7 | 179 | 130 | 5·30 | 5·4 | 79·1 | 82 | | 4 |
| ♀ Eriksson, A. L. | 160 | 58 | 4·1 | 188 | 105 | 3·97 | 4·6 | 68·4 | 110 | | 10 km §<br>2 |
| ♂ 42 normal well-trained students | 176·7±1·0<br>6·0‖ | 70·4±1·0<br>6·2 | 5·7±0·2<br>0·8 | 194±2<br>11 | 122±3<br>15 | 4·11±0·06<br>0·37 | — | 58·6±0·7<br>4·1 | 112±4<br>20 | Running or cycling | |
| ♀ 44 normal well-trained students | 165·8±0·8<br>5·1‖ | 60·3±0·9<br>5·7 | 4·2±0·1<br>0·5 | 198±2<br>10 | 92±2<br>11 | 2·90±0·04<br>0·25 | — | 48·4±0·5<br>3·2 | 104±3<br>18 | | |

* Volume at body temperature, ambient pressure and saturated.
† Volume at standard temperature, pressure and dry.
‡ From nomogram (ref. 5).
§ Swedish championship, 1955.
‖ Standard deviation (σ)

an essential characteristic of people with a high ndard of physical fitness with regard to endurance[6].

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June 1.

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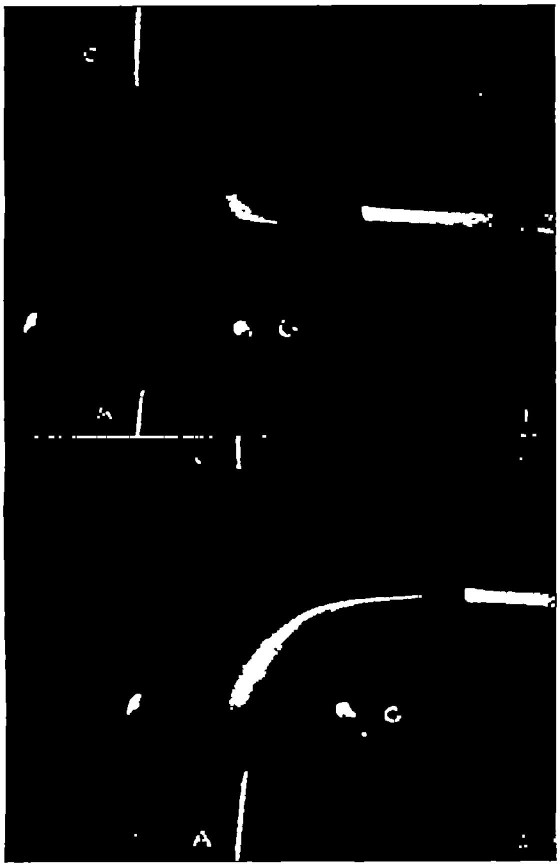
## Corona Wind Loud-speaker

Experiments made with a pair of electrodes, one arp and one blunt, show that a corona wind moves way from the sharp point independent of its polarity. the needle is positive, the wind is stronger than hen it is negative.

The wind may be controlled by placing a blunt ng or 'grid' around the sharp electrode: if this ng is maintained at the same order of voltage as ne sharp electrode, then there is a position of the tter at which comparatively small changes of the rid potential produce a maximum effect on the tensity of the corona wind and hence on the corona current. This may be explained on the assumption that lines of force which otherwise would terminate on the tip of the needle are deflected to the grid ring to an extent dependent on the relative potentials of the electrodes. Thus although the grid takes no current itself, variations of its potential can control the corona current over a wide range. An extensive experimental study of this phenomenon has been made and will be published elsewhere.



(1) Strong positive wind from needle *A*; $V_{AC}$ = 17·5 kV. and $V_{GC}$ = 8·5 kV. (2) Strong negative wind from needle *C*; $V_{AC}$ = 18·5 kV. and $V_{GC}$ = 15·2 kV.

With two sharp electrodes *A*, *C* (Fig. 1) opposed to each other, the strong positive wind greatly exceeds the negative. The interaction of the two winds causes an injected smoke stream from the region of the positive needle to avoid the negative one in an umbrella-shaped form (not shown) near the negative needle. If now the ring electrode *G* is placed around the positive needle *A*, the positive wind may be completely cut off (Fig. 2), in which case the negative wind predominates. With a positive wind adjusted to equality with the negative there is no net wind.

An alternating potential applied to the grid causes the air to pulsate and hence to become a source of sound.

With a stacked array of triodes large enough to give a reasonable acoustic area, the device becomes a loud-speaker with certain distinctive features. (*a*) It has no moving parts. (*b*) It requires no electrical power at acoustic frequencies to drive it, since the 'grid' ring takes no current. The power comes from a d.c. source across the needles. (*c*) It has a good bass response, without any bass resonance even down to zero frequency: the steady wind is the zero-frequency response. (*d*) It has a good middle- and high-frequency response smooth to 15 kc./s. (*e*) In its present form it has a severe limitation in its linearity; but a push–pull form is under construction. (*f*) Its power output under an approximately linear adjustment is about 0·1 mW. per sq. cm. of matrix area, a figure comparable with types of electrostatic loud-speaker using diaphragms. The d.c. power input is about 50 mW. per sq. cm. at 12 kV. (*g*) The polar distribution of sound may be varied at will by varying the shape of the matrix. It does not need to be planar.

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July 6.

## Magnetic Moment of an Excited State of the Fluorine-19 Nucleus

There is a well-known technique[1] for the measurement of magnetic moments of short-lived nuclear states. A strong external magnetic field applied to a radioactive source which emits $\gamma$-rays in a cascade process will influence the nuclear spin of the intermediate state, and thus change the $\gamma-\gamma$ angular correlation. The strength of the interaction is a measure of the nuclear moment, and the theory of the process has been worked out[2,3].

The same principle has been applied to a study of the angular distribution of $\gamma$-rays resulting from the nuclear reaction:

$$p + {}^{19}\mathrm{F} \rightarrow p' + {}^{19}\mathrm{F}^{**} \rightarrow p' + \gamma + {}^{19}\mathrm{F} \qquad (1)$$

where the intermediate nucleus (${}^{19}\mathrm{F}^{**}$) is known[4] to have a lifetime of $(1{\cdot}0 \pm 0{\cdot}2) \times 10^{-7}$ sec., spin 5/2 and excitation 197 keV. A uniform vertical magnetic field was applied normal to the beam of the Canberra H.T. set, and protons of 873 keV. were allowed to strike a target of sodium fluoride (0·3 mgm./cm.$^2$) evaporated on copper. Gamma-rays were detected at different angles in a horizontal plane with a photomultiplier (employing a 1-in. diameter × $\frac{1}{2}$-in. sodium iodide (thallium) crystal) mounted on a rotatable table, and the pulse spectrum was recorded on a kicksorter.

Fig. 1 shows the experimental results and a theoretical plot of the function

$$\frac{W(0°) - W(100°)}{W(0°) + W(100°)} = a\,\frac{0{\cdot}97 - 0{\cdot}17x}{1 + x^2} \qquad (2)$$

which approximates (to within ± 2 per cent) to a formula given by Alder[2]. This formula (calculated for $\gamma - \gamma$ correlations) can be shown to apply to the present case since (i) one averages over ($p' + {}^{19}F^{**}$) directions and (ii) the angular distribution function[3] is, in the absence of external fields, of form:

$$W(\theta) = 1 + A\cos^2\theta$$

where $A = \dfrac{2a}{1 - a}$. In equation (2), $x = 2g\mu H\tau/\hbar$, where these quantities have meanings given by Alder. The solid and dotted curves correspond to $g = +\,1{\cdot}35$ and $g = -\,1{\cdot}90$ respectively.

If one assumes, on the basis of the nuclear shell model, that the 197-keV. level approximates to an odd $d_{5/2}$ proton orbit, the Schmidt value[6] for the $g$-factor is $+\,1{\cdot}9171$. Thus, we accept the positive result and, taking account of errors in this experiment and the life-time measurement,

$$g \text{ (197 keV. level)} = +\,(1{\cdot}35 \pm 0{\cdot}35).$$

A decoupling experiment[7] in which a magnetic field of 8,000 oersteds was applied along the beam axis failed to increase the anisotropy factor $A$ above the zero-field value 0·42 ± 0·02, so one may assume that the fluorine-19 nucleus was not magnetically coupled in the sodium fluoride target. Using a manganese fluoride target, however, a value $A = 0{\cdot}10 \pm 0{\cdot}02$ was obtained; but a decoupling experiment again failed to restore any anisotropy. In this case the extranuclear influence at work may be electronic paramagnetic relaxation, though the shortness of relaxation time in manganese fluoride makes this improbable[8]. If, as seems likely, the tetragonal symmetry of manganese fluoride results in anisotropic hyperfine structure, a decoupling field can have little influence. In support of this, the reduction of $A$ from 0·42 to 0·10 is just what would be expected[3] were strong anisotropic hyperfine structure present in random arrangement of microcrystals. A thin possible explanation is that quadrupole interactio are present: this could only be investigated usin single crystals.

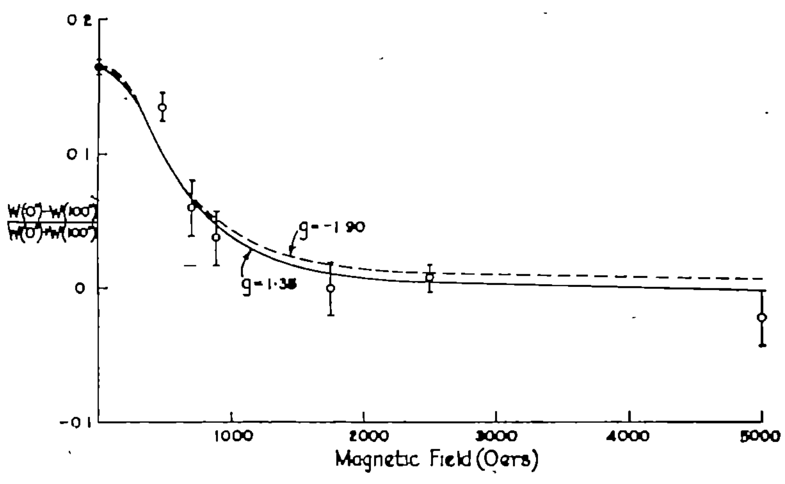

Fig. 1. Anisotropy as a function of the magnetic field-strength

Further experiments are proceeding, and th work will be reported more fully elsewhere.

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# Thermal Expansion of Coal

THE following observations, which form part of a investigation into the pore structure and surface are of coal, are reported here in view of the curren interest[1,2] in the expansion moduli of coal.

Table 1

| Coal | Carbon (per cent, dry, ash-free) | Volatile matter (per cent, air-dry) | Mean linear coefficient ($\bar{a} \times 10^6$) |
|---|---|---|---|
| New Cross Hands | 93·8 | 5·5 | 24 2 |
| Cefn Coed | 93 0 | 6·5 | 25·4 |
| Cwmgwrach | 91·8 | 9·5 | 28·7 |
| Deep Navigation | 91 3 | 14·7 | 31·0 |
| Pochin | 91·1 | 19·5 | 33·2 |
| Wyllie | 89·1 | 25·0 | 35·4 |
| Beynon | 87·4 | 30·2 | 37·0 |
| Cwm Carn | 84·5 | 35·5 | 39 1 |
| Ellington | 79·4 | 38 0 | 37·1 |

The bulk modulus of expansion of a series of coals has been determined by a dilatometric method in which about 40 gm. of bright coal (10–18 mesh B.S. test sieve) was confined under a mercury–thallium amalgam in a steel bomb, and the expansion observed by the change in height of the amalgam in a 70-cm. length of precision-bore tubing of 1·5 mm. internal diameter. Calibration was effected by measurements with the dilatometer empty of coal, and the accuracy of the method confirmed by measurements with 10–18 mesh (B.S. test sieve) borosilicate glass of known modulus.

The temperature-range was 0° to − 47° C., covered by using a series of eight refrigerant baths, in which the steel bomb was immersed up to the junction with the precision-bore glass tubing. With the exception of the Ellington coal, all the coals examined were from the South Wales Nine Foot Seam, which is believed to represent coals of the same origin in widely different states of coalification.

Results for all the samples used are shown in Table 1, the expansions being given as mean linear coefficients to facilitate comparison with the results of other workers.

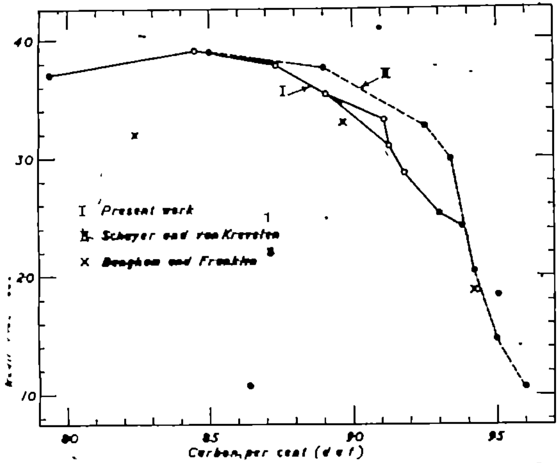

Fig. 1. Relationship between thermal expansion and rank of coal

It should be noted that the expansion coefficient appears to be even better related to the volatile matter than to the carbon content.

The results are shown graphically in Fig. 1. The broken line has been calculated from the results of Schuyer and van Krevelen[1] for expansions perpendicular and parallel to the bedding plane, assuming the expansion to be isotropic in the latter plane. The agreement between the two main sets of independent observations is better than usually expected for measurements on coals of different origin. The values found by Macrae and Ryder[2] refer only to the expansion parallel to the bedding plane and are too large to be included on this graph; but it is interesting to note that the different results obtained by them for two samples of the same coal, measured parallel to the bedding plane, could mean that anthracite is anisotropic in all three major planes. This is not well supported, however, by the agreement, already mentioned, between the mean coefficients obtained by direct observation of the cubical moduli and those calculated from the separately measured parallel and perpendicular moduli.

A full description of the apparatus, and a discussion of the results will appear elsewhere.

This work forms part of the programme of research of the Fuel Research Board of the Department of Scientific and Industrial Research, and is published by permission of the Director of Fuel Research.

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## Separation of Ions at Crystallization of Water

According to Workman and Drost-Hansen[1], a substantial amount of fluorine ions is incorporated into ice if it is crystallized from diluted solutions of cæsium fluoride. We have studied this process further, and found that it is not fluorine ions which are incorporated into ice but rather electrically neutral molecules of hydrogen fluoride.

One half of a diluted solution of cæsium fluoride in water was frozen and the ice separated from the remaining liquid. The water used had been distilled in a vacuum and was free of impurities, especially carbon dioxide. The *p*H of the remaining liquid was found to be higher than that of the thawed ice. An example is given in Table 1.

Table 1

| Sample | mol. F′/l. | *p*H | F′ (mgm./10 cm.³) |
|---|---|---|---|
| Original solution | $5 \cdot 82 \times 10^{-3}$ | 8·0 | 1·105 |
| Non-frozen liquid | $8 \cdot 43 \times 10^{-3}$ | 8·5 | 1·658 |
| Ice | $9 \cdot 7 \times 10^{-4}$ | 7·0 | 0·184 |

The accuracy of these measurements was not very high because the determination of the *p*H-value was carried out by means of an indicator. We are now carrying out more precise measurements.

The above experiments agree with results on the incorporation of hydrogen fluoride into ice. We found that small quantities of hydrogen fluoride can be built into the ice lattice. According to previous investigations[2], ammonium fluoride forms mixed crystals with ice in a range up to about 10 per cent ammonium fluoride. The replacement of water molecules in ice by ammonium fluoride seems to be facilitated by the fact that the ratio H/(N+F) is the same as the ratio H/O in water. Since, if water molecules are replaced by hydrogen fluoride, this ratio is smaller than 2 : 1, a greater disturbance by missing hydrogen bonds is introduced if water is replaced by hydrogen fluoride. This exemplifies the great influence of hydrogen bonds on the stability of the ice lattice.

This investigation was carried out under a contract of the Snow, Ice and Permafrost Research Establishment, Corps of Engineers, U.S. Army.

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## Magnetic Catalysis of the Decarboxylation of Oxaloacetic Acid

Kinetic studies of the decarboxylation of phenylmalonic acid in aqueous solution in the presence of high concentrations of rare-earth ions show that diamagnetic ions have little effect on the rate of reaction, while the paramagnetic dysprosium ion leads to an acceleration in rate of the order of 10 per cent[1,2]. Rare-earth ions do not appear to become co-ordinated appreciably with phenylmalonic acid. Since any magnetic effect must be a very sensitive function of the distance between catalyst and substrate, a study is now being made of the kinetics of decarboxylation of an acid, the anions of which are known to become co-ordinated more strongly with metal ions.

The kinetics of decarboxylation of oxaloacetic acid and its anions have been investigated by Pedersen[3]. We have now measured the rates of decarboxylation of this acid in aqueous solution at 37° in the presence of lanthanum, gadolinium, yttrium, dysprosium and lutecium ions (Clayton, J. P., and Gelles, E., unpublished results). The manometric method[4] employed for following the evolution of carbon dioxide yields first-order rate coefficients accurate to ± 3 per cent. *p*H measurements show that the thermodynamic dissociation constants $(M^{3+})\,(A^{-})/(MA^{+})$, where $M^{3+}$ represents a rare-earth ion and $A^{=}$ the divalent oxaloacetate anion, are around $2 \times 10^{-4}$ at 25° (Gelles, E., and Nancollas, G. H., unpublished results). At the concentrations used in the kinetic experiments, a small fraction of the oxaloacetic acid is in the form of rare-earth complex; but with constant initial conditions of concentration and $p$H, the concentrations of uncomplexed species are effectively constant for different rare earths.

The effect of the rare-earth ions on the rate of decarboxylation might be expected to be a smooth function of the chemical activity of the ions. A linear free-energy relationship between rate and equilibrium data is indeed found for the diamagnetic ions. Fig. 1 shows a plot of the logarithms of the first-order rate coefficients ($\log_{10}$, min.$^{-1}$) in a typical set of experiments against the logarithms of the thermodynamic stability constants of the rare-earth ethylenediaminetetra-acetates[5]. In the set of kinetic experiments, the initial $p$H was constant at 1·02, and the initial concentrations in moles/litre of oxaloacetic acid and rare-earth ion were 0·0300 and 0·100 respectively. The reaction-rate is due almost entirely to the complexed species, the rate coefficients used in Fig. 1 being corrected for the small amount of uncatalysed reaction. Size of circle indicates the probable limits of experimental errors. It is seen that for the diamagnetic ions $La^{3+}$, $Y^{3+}$ and $Lu^{3+}$, an excellent linear free-energy relation is found.

For the paramagnetic ions $Gd^{3+}$ and $Dy^{3+}$, an acceleration in rate of decarboxylation is observed greater than that predicted by interpolation from the linear free-energy relationship. For $Gd^{3+}$ it is about 20 per cent, and for $Dy^{3+}$ about 10 per cent. This additional catalysis by the paramagnetic ions increases with increasing ion concentration, and it can be attributed specifically to the presence of unpaired $4f$ electrons in these ions.

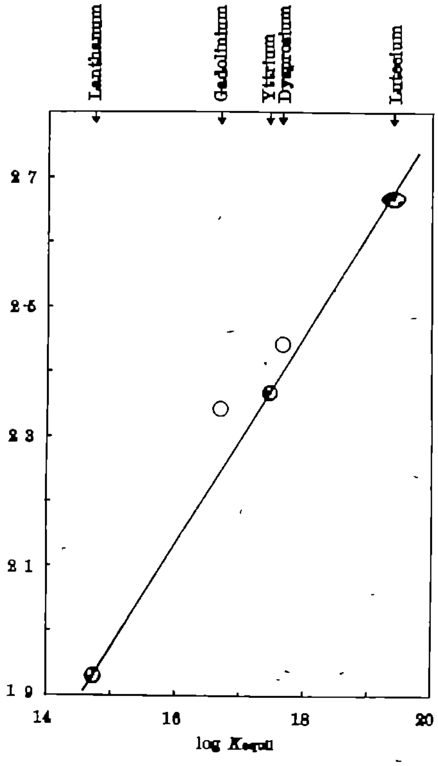

Fig. 1

It is possible that unpaired electron spin–sp interactions between catalyst and substrate result some contribution from a favourable non-adiabat reaction process.

With further kinetic data at lower concentratio (Gelles, E., unpublished results) and the appropria equilibrium constants (Gelles, E., and Nancolla G. H., unpublished results), it will be possible obtain rate-constants for the individual compl species and to make a direct comparison betwe rate and equilibrium properties for one and the sa substrate.

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May 9.

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## Cosmic Sources of Deep-Sea Deposits

Black magnetic spherules found in deposi collected by the *Challenger* Expedition (1872–7 have been recognized as being probably of cosmi origin[1]. These spherules represent but a very sma fraction of the sediments by mass, and have littl effect on their average chemical composition. Th relatively high nickel content of deep-sea deposit in the Pacific Ocean led Pettersson and Rotschi[2] t suggest a cosmic origin for the excess nickel. Th amount of accretion of cosmic matter by the eart required to account for this excess would not con flict with some estimates of the density of matter i the zodiacal-light cloud[3], although other estimate would fall short of the requirements.

The frequency of spherule diameters[4], extracte from samples of deposits obtained by the Swedis Deep-Sea Expedition, showed excellent agreemen with the theoretical frequency for micro-meteors[3] for the following distribution of velocities:

| Velocity (km./sec.) | 11·5 | 13·2 | 16·9 | All |
|---|---|---|---|---|
| Percentage | 33·3 | 16·7 | 50·0 | 100·0 |

The velocity-range is close to what would be ex pected for primordial dust, spiralling into the su under the Poynting–Robertson effect[5], in direc motion and in orbits of small eccentricity. The mai component of the velocity is due to the earth's attraction, which sets 10·8 km./sec. as a lower limit to it. The agreement of the frequency of diameters with theory lends support to the hypothesis that the spherules are of cosmic origin.

However, the cosmic origin of the general nickel excess has been subjected to doubt by Laevastu and Mellis[4], on the basis of the ratio of iron to nickel, and by Smales and Wiseman[6], from the relative abundance of nickel, cobalt and copper. The relative abundances of these elements agree with those of terrestrial sources, and greatly disagree with those of meteorites. Laevastu and Mellis suggest that iron and nickel in the oceanic red clay may be due in part to co-precipitation from sea water.

Nevertheless, the conclusion that the excess nickel is not of cosmic origin would be premature. Meteorites are believed to be fragments of larger bodies—planets—destroyed in collisions; in such a case they are the product of astrochemical differentiation in the interior of the planet, which preceded the ble 1. AVERAGE ABUNDANCE RATIOS OF IRON, NICKEL, COBALT AND COPPER

| | Fe/Ni | Ni/Co | Ni/Cu |
|---|---|---|---|
| Deep-sea red clay (ref. 6) | — | 3·1 | 0·85 |
| Globigerina ooze (ref. 6) | — | 4·1 | 0·77 |
| Pacific deep-sea core (ref. 4) | 100 | — | — |
| Oceanic rocks (ref. 6) | — | 4·3 | 1·2 |
| Solar atmosphere (Russell ; Unsöld) | 16 ; 50 | 2·5 ; 8 | 10 ; 50 |
| Earth's crust (Clarke and Washington) | 250 | 10 | 0·3 |
| Meteorites (Goldschmidt ; Noddack) | 19 ; 14 | 13 ; 16 | 90 ; 100 |

tastrophe and led to the peculiar distribution of e abundances, according to the conditions in the terior and the physico-chemical properties of the lements. On the other hand, the fine primordial ust is most properly described as the product of ondensation from a gaseous medium ; there is no ood reason for assuming that in this case the lection of the elements would be identical with that meteorites ; on the contrary, the composition of e surface layers of the earth and the solar tmosphere could be expected to be more akin than eteorites to that of the primordial dust.

The distinction between meteorites and meteoric ust is not only a theoretical one. An analysis of eteor observations, obtained during the Arizona xpedition[7], indicates that the great majority of aked-eye meteors are fluffy or spongy 'dustballs' hich decompose, not by vaporization or spraying om a solid dense nucleus, but simply by crumbling nder an aerodynamic pressure as low as $10^4$ dyne/ m.[8]. Recent results from Harvard Super-Schmidt hotographs confirm this[9]. The small meteors are robably similar to snowflakes—the results of submation from a gaseous state. Whipple's theory of ometary structure visualizes such substance, interingled with 'ices' ; near the sun the more volatile es have evaporated, and 'dustball' skeletons remain, bserved as naked-eye and fainter meteors when hey enter our atmosphere.

These facts indicate the need for caution in applying he meteoritic analogy to the chemical composition f amorphous cosmic matter, such as would collect n the bottom of the sea.

In Table 1 the meteoritic abundances are comared with terrestrial and other cosmic abundances. he data would vary according to source ; neverheless, the sets chosen are quite characteristic. he increased abundance ratio nickel to iron in the acific core, as compared with the earth's crust, is oticeable. Although the terrestrial abundances gree best with those of the deep-sea deposits, this ould not necessarily mean a terrestrial origin of e latter ; it may be that the earth's outer crust self, being the last addition to our planet from osmic sources, is built of a material the remnants which are still falling on the earth from the odiacal-light cloud.

E. J. ÖPIK

Armagh Observatory,
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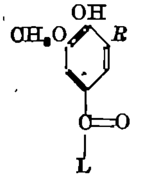
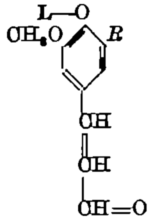
## Contribution of Residues containing Carbonyl to the Ultra-Violet Absorption of Lignins

ABSORPTION spectra and colour reactions indicate the presence in lignins of *p*-hydroxyphenylketone groups (I ; L represents the rest of the lignin molecule)[1] and 4-O-substituted cinnamaldehyde groups (II)[2].

(I)



(II)



*R* = H, or $OCH_3$

Both types of carbonyl-containing residues have an absorption band near 350 mμ, but it has been found possible to distinguish such groups by their different rates of reduction with sodium borohydride in dilute (0·01 *N*) sodium hydroxide.

Table 1. REDUCTIONS WITH SODIUM BOROHYDRIDE

Solutions of the following molarity in 0·01 *N* sodium hydroxide were used. *iso*-Vanillin, 2 × $10^{-4}$ *M* ; acetovanillone, veratric aldehyde, 5 × $10^{-4}$ *M* ; *p*-hydroxybenzaldehyde, vanillin, syringaldehyde, ferulic aldehyde, 3 : 4-dimethoxycinnamaldehyde, 2 × $10^{-5}$ *M*. Each solution (2 c.c.) was mixed with 0·2 *M* sodium borohydride in 0·01 *N* sodium hydroxide (1 c.c.), and the reaction followed spectrophotometrically at suitable wave-lengths in a 1-cm. cell. Temperature 20°

| Substance | Half-reaction time (min.) |
|---|---|
| 3 : 4-Dimethoxycinnamaldehyde | 1 |
| Veratric aldehyde | 2 |
| *iso*-Vanillin | 20 |
| Ferulic aldehyde | 56 |
| Vanillin | 116 |
| *p*-Hydroxybenzaldehyde | 139 |
| Syringaldehyde | 156 |
| Acetovanillone | 1,180 |

Carbonyl compounds which are phenolic and ionized in 0·01 *N* sodium hydroxide are reduced more slowly ; though in *iso*-vanillin, with the carbonyl in the meta position, this effect is least marked.

With four 'native' lignins, the effect of reduction with sodium borohydride is in each case a diminution in extinction in the 350-mμ region. Two stages can be discerned in this : a rapid stage concluded in about thirty minutes, and a slower stage lasting many hours (Fig. 1). Comparison of rates of reduction with those described in Table 1 makes it seem likely that the groups reduced in the rapid stage belong to the non-ionized category. 3 : 4-Dimethoxycinnamaldehyde has an absorption band in the correct position (335 mμ ; giving on reduction 3 : 4-dimethoxycinnamyl alcohol with absorption bands at 260 mμ and 290 mμ), and this is consistent with the presence of rapidly reduced groups of type II in these four lignins.

The analogy between these groups and 3 : 4-dimethoxycinnamaldehyde was strengthened in the case of aspen by a consideration of the effect of *N* sodium hydroxide. In this reagent, 3 : 4-dimethoxycinnamaldehyde is decomposed with a half-reaction time of 55 min. at 20° to veratric aldehyde, which has absorption maxima at 277 mμ and 306 mμ, so that the absorption in the 340–350 mμ region diminishes to zero. The extinction of aspen 'native' lignin in the region of 340–350 mμ diminishes by 40 per cent under the same conditions with a half-reaction time of 60 min. These similarities of behaviour in *N* sodium hydroxide suggest that a like process may be occurring in both cases, and that groups of type II in aspen 'native' lignin may undergo a reversed-aldol reaction in *N* sodium hydroxide with the elimination of acetaldehyde.

Table 2

| | $E$(1%, 1 cm.) at 350 mμ due to: | | | |
|---|---|---|---|---|
| | Extinction of groups rapidly reduced by sod. borohydride (Groups of type II) | Residual extinction (Groups of type I) | Extinction in weakly acid solution (Groups of type II) | Difference in extinction between alkaline and weakly acid solution (Groups of type I) |
| Aspen 'native' lignin | 33·3 | 16·8 | 31·9 | 18·3 |
| Horse chestnut 'native' lignin | 9·7 | 71·2 | 18·3 | 62·2 |

The second stage in the reduction of the four 'native' lignins by sodium borohydride in 0·01 $N$ sodium hydroxide consists of a very slow further diminution in absorption at 350 mμ. In the case of aspen and horse chestnut lignins, the absorption in this region is eventually removed almost completely, and the wave-lengths of absorption and rates of reduction of the slowly reduced groups are both consistent with their having structures of type I. If this is so, then the two lignins in question show great contrast in the relative amounts, measured in terms of extinction at 350 mμ, of groups of types I and II. A check on this is provided by an examination of the absorption spectra of these lignins in acid and in alkaline solutions. Groups of type I absorb at 350 mμ only when ionized, whereas groups of type II absorb at 350 mμ at all $p$H's. The figures obtained by this method are compared with the figures obtained by reduction with sodium borohydride in Table 2.

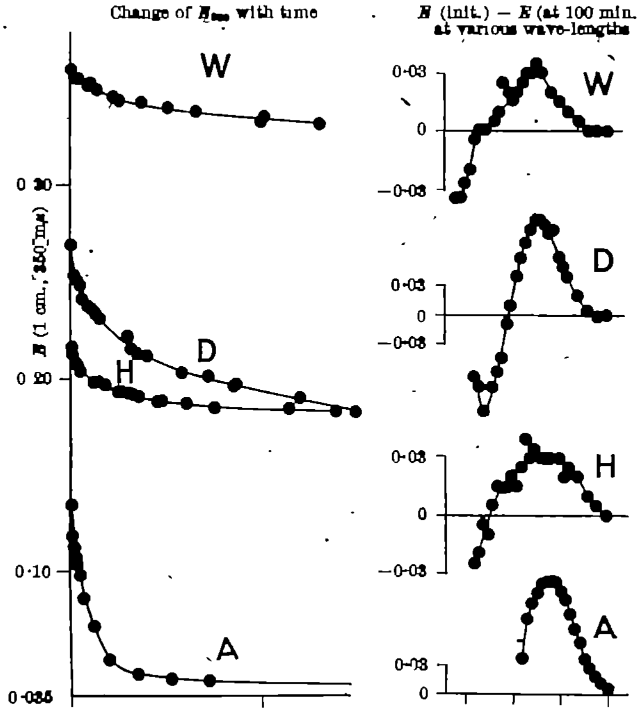


Fig. 1. The rapid stage in the reduction of 'native' lignins with sodium borohydride in 0·01 $N$ sodium hydroxide. Concentration of each lignin, 2·07 × $10^{-3}$ gm./100 c.c.; concentration of sodium borohydride, 2·50 × $10^{-3}$ gm./100 c.c.; temperature, 20°. $W$, wheat straw native lignin; $D$, douglas fir native lignin; $H$, horse chestnut native lignin; $A$, aspen native lignin

It can be seen that there is a reasonable agreeme between the relative amounts of groups I and calculated by each method.

While the conclusions reached must be regarded tentative, depending as they do entirely on specte photometric measurements, yet it seems that duction with sodium borohydride, followed specte photometrically, offers a convenient method measuring cinnamaldehyde groups in 'native' ligni The diminution in absorption at 350 mμ is only index of these groups, since the exact extinction a wave-length of maximum absorption will va depending on whether $R$ = H, or OMe.

This work forms part of the programme of t Food Investigation Organization of the Departme of Scientific and Industrial Research.

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[1] Goldschmid, O., *J. Amer. Chem. Soc.*, **75**, 3780 (1953).

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## Chlorophyll Spectra and Molecular Structure

During experiments on pigment orientation chloroplasts and grana, it was necessary to determi the directions in which linearly polarized light preferably absorbed in a pigment molecule. Th preference corresponds to the directions of maximu transition probability of the electronic transitio which give rise to the different absorption bands i the spectra. By studying dichroism a polarization of fluorescence for chlorophyll $a$, bacteriochlorophyll and the correspondi phæophytins, these directions have been i vestigated.

*Dichroism.* Pigments were oriented in lecith or ammonium oleate by pressing between microscope slide and a cover glass. Absorptic was measured with a barrier-layer photocell photographically. For planar molecules approximate symmetrical shape, such as th porphin derivatives, it is in this way possible t distinguish between absorption in, or perpe dicular to, the plane of the molecule. For th chlorophylls mentioned, it was concluded tha absorption occurs in the plane of the porphi heads in the spectral region from 750 to 400 m

*Polarization of fluorescence.* In Fig. 1 th polarization and absorption spectra of bacteri chlorophyll and bacteriophæophytin and in Fi 2 those of chlorophyll $a$ and phæophytin $a$ a presented. The observations show that th direction of the transition responsible for th band at 590 mμ in bacteriochlorophyll is sit ated perpendicular to the transition directio at 780 mμ. In bacteriophæophytin the band 590 mμ is shifted to 535 mμ.

The chlorophyll $a$ spectrum shows a ban due to a second transition at 580 mμ. A this wave-length the absorption due to th second transition overlaps the tail of the band due to transition I. This is shown in th fluorescence spectrum, which is to a goo approximation a mirror image of the absorptio bands of I. Taking this overlap into account, can be calculated that in chlorophyll $a$ als

Table 1

| ransition | Measured | | | Calculated | | |
|---|---|---|---|---|---|---|
| | Orient. | λ(mμ) | $\epsilon_{rel.}$ | Orient. | λ(mμ) | $\epsilon_{rel}$ |
| I | $\perp$ | 765 | 70 | $\perp$ | 1,150 | 100 |
| II | $\parallel$ | 530 | 30 | $\parallel$ | 620 | 100 |
| III | $\perp$ | (460) | <5 | $\perp$ | 450 | 100 |
| IV | $\parallel$ | 385 | 60 | $\parallel$ | 435 | 100 |
| V | $\perp$ | 365 | 100 | $\perp$ | 330 | 100 |

ansition II is perpendicular to I. In phæophytin *a*, ansition II is shifted to 525 mμ.

The values of *p* in the Soret band of chlorophyll *a* dicate that, contrary to the views of Perrin[1] and upp and Kuhn[2], here also there is overlapping two transitions: one with a maximum at 435 mμ rpendicular to I, and one with a maximum at 15 mμ parallel to I. In bacteriochlorophyll also, the oret band is most probably caused by two transions, one at 390 mμ perpendicular to I and one at 0 mμ parallel to I.

The maximum at 510 mμ in the polarization ectra of bacteriochlorophyll and bacteriophæophytin ay be ascribed to a separate transition with a small ansition probability. In phæophytin *a* and *b* the aximum in this spectral region corresponds to an bsorption band of measurable intensity.

Longuet-Higgins[3] and Platt[4] have calculated spectral ata for the conjugated ring structures of tetrahydroporphin ('long-field' spectrum) and porphin round-field' spectrum) on the basis of the molecular rbital theory. In Table 1 the values of orientation, ave-length (λ) and maximum extinction coefficient ε) measured and calculated are compared for acteriophæophytin and tetrahydroporphin.

The measurements do not give an absolute orientaion of transition I in the porphin plane. For various reasons the authors mentioned assumed transition I to vibrate perpendicular to the elongation of the conjugated system. This suggestion was supported by the fact that transition II, vibrating parallel to this elongation, is shifted but slightly when changing from bacteriophæophytin into phæophytin *a*. Chlorophyll *b* showed a somewhat less pronounced polarization spectrum, being closer to a 'round-field' spectrum than chlorophyll *a*.

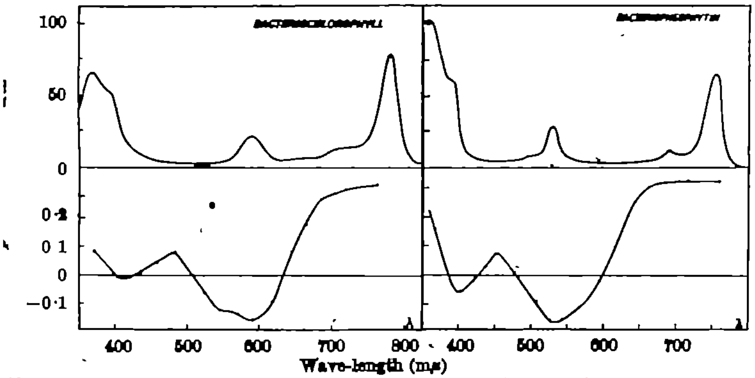

Fig. 1. Absorption spectrum and fluorescence polarization spectrum of bacteriochlorophyll and bacteriophæophytin in cyclohexanol ($\eta$ = 0·66). $\epsilon_{rel.}$ denotes relative extinction coefficient; *p* is degree of polarization

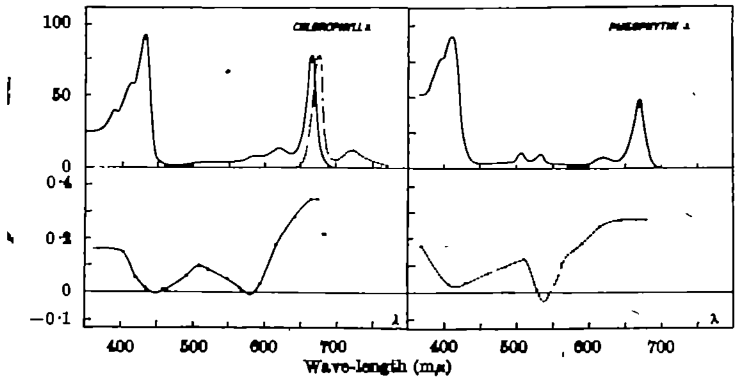

Fig. 2. Absorption and polarization spectrum of chlorophyll *a* and phæophytin *a*

A full account of these and related measurements will be published elsewhere.

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## Use of Acid-Base Indicator for Quantitative Paper Chromatography of Sugars

QUANTITATIVE methods of paper chromatography tend to be unsatisfactory largely because of the very small amounts of substance separated. In the case of sugars, the spots are generally located by guide strips, which are an additional source of inaccuracy. Giri[1] has recently shown that relatively large amounts of sugars can be separated by circular chromatography. The same author and Parihar[2] attempted to recover the sugars by running the solvent off the paper and collecting it in fractions; however, they did not achieve quantitative separation.

In the method described here, the sugars are separated by circular chromatography and are then shown up by an acid-base indicator. The latter does not destroy the sugars, which can then be cut out, eluted from the paper and estimated.

The solution under test is applied to the centre of a Whatman No. 3 paper (17 cm. diameter); 0·2 ml. containing up to 50 mgm. total sugars was found to be suitable. The paper is dried and a wick put through the centre. It is then developed in the normal way, using a desiccator as the cabinet. The desiccator has a clock glass in place of the usual wire gauze, and resting on this is a Petri dish serving as solvent reservoir. More solvent is placed in the bottom of the desiccator to saturate the atmosphere.

After developing, the paper is dried well and sprayed with an indicator solution of the following composition: 40 mgm. bromocresol purple and 100 mgm. boric acid dissolved in 100 ml. methanol to which 7·5 ml. of 1 per cent borax solution is then added. Sugars are shown up yellow against a blue background. The colour difference fades in a few minutes and the position of the sugars is therefore marked immediately with a pencil. This is best done under ultraviolet light.

Table 1. DEXTROSE SOLUTION, 16 HR. IN *n*-PROPANOL (6) : ETHYL ACETATE (1) : WATER (3)

| Amount applied (mgm.) | Amount recovered | Difference |
|---|---|---|
| 9 95 | 10 04 | 0 09 |
| 9 88 | 9 95 | 0·07 |

Table 2. MIXTURE OF LACTOSE AND SUCROSE, 16 HR. IN *n*-PROPANOL (6) : ETHYL ACETATE (1) · WATER (3)

| Solution applied (ml.) | Sugar | Amount applied (mgm.) | Amount recovered (mgm.) | Difference (mgm.) |
|---|---|---|---|---|
| 0 1955 | Sucrose | 19 55 | 19 72 | 0·17 |
| | Lactose | 4·89 | 4 98 | 0 09 |
| 0·1962 | Sucrose | 19 62 | 19 90 | 0·28 |
| | Lactose | 4 91 | 4 98 | 0 07 |

This spray was first proposed by Bradfield and Flood[3] for the detection of polyhydric alcohols (with which it was said to give a strong reaction) in the presence of sugars. Under the conditions described here, it was found to show up sugars satisfactorily. A complex is probably formed between the sugar and the boric acid, giving rise to a stronger acid than boric alone.

The rings containing the sugars are cut out. A short length of filter paper is attached to each ring and this is fastened to dip into a trough filled with water in a normal chromatography cabinet. The sugars are eluted by capillary flow into flasks placed at the bottom of the cabinet. They are then estimated by the complexometric method of Potterat and Eschmann[4,5]. This is particularly suitable for the amounts separated as it gives good results over the range 2–40 mgm. of sugar.

In order to check whether the indicator had any effect on the sugar, pure dextrose solution was chromatographed. The results are given in Table 1.

The completeness of resolution can be seen from results on a solution containing 10 per cent sucrose and 2·5 per cent lactose. This was chosen to simulate the sugars in milk chocolate (Table 2).

Most sugars found in foods can be separated by one overnight run in *n*-propanol (6) : ethyl acetate (1) : water (3). In order to separate dextrose and fructose, four successive runs in formic acid (1) : *n*-butanol (5) : water (4) were found necessary. The first run is carried out overnight. The paper is then dried, run again and, for this and the next runs, is dried as soon as the solvent reaches the edge. Maltose and lactose could not be separated.

Thanks are due to Mr. G. H. Beere for his help and to Dr. A. A. Houghton, who directed this work.

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Research Laboratory, Mars, Ltd.,
Slough, Bucks. July 8.

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# Incorporation of Phosphorus-32 into the Malpighian Tubes during the Metamorphosis of *Culex pipiens*

THE Malpighian tubes are organs with a secretory and a regulatory function with regard to water and salt balance. Studies were made to determine whether, and how, they influence the phosphate-level of larvæ and pupæ of *Culex pipiens* during metamorphosis.

The application of phosphorus-32 was acco plished very simply by placing larvæ in tap wat containing different concentrations of radioacti phosphorus. Pupæ did not take up phosphorus fro the environment. In order to determine whether th incorporation of phosphorus-32 into the Malpighi tubes varies during metamorphosis, the followi experiment was carried out. Early and late 4th inst larvæ were put into a solution of phosphorus-32 f 24 hr. and then removed to tap water. Twenty-fo hours after the administration of the phosphorus, th Malpighian tubes were isolated from the larvæ an from pupæ which had reached the pupal stage duri the time of application of phosphorus-32. Th radioactivity was measured by means of a Geige Müller counter. The age of the animals used w determined by the size of the leg and wing *Anlage*

The changes in the incorporation of phosphorus-3 into the Malpighian tubes of larvæ and pupæ a shown in Fig. 1. A great accumulation of pho phorus-32 occurs in the cells of the Malpighian tub of 4th instar larvæ near pupation and in the pupa The amount then remains more or less constant du ing the rest of metamorphosis. The greatest part c the phosphorus-32 is incorporated in acid-solub substances (10 per cent trichloracetic acid or 2 pe cent perchloric acid) (Fig. 1). The small amount o residual phosphorus-32 occurs as ribonucleic acid lipoids and phosphoproteins, as can be conclude from digestion with ribonuclease and from extractio experiments.

The phosphorus is localized in granules about 1–3 in diameter. These granules are absent from th Malpighian tubes of young 4th instar larvæ They make their appearance for the first time i larvæ nearing pupation, and then persist into th imagos (Fig. 2). They show a strong affinity for basi dyes and are soluble in 5 per cent trichloracetic aci or 2 per cent perchloric acid. Toluidine-blue is boun in the metachromatic form which is, furthermore, no resistant to an alcohol treatment. The real natur of the phosphates is not yet clear. Possibly they ar polyphosphates, which occur in many lower organisms and which could also be demonstrated in som insects[1]. These phosphate-containing granules ar

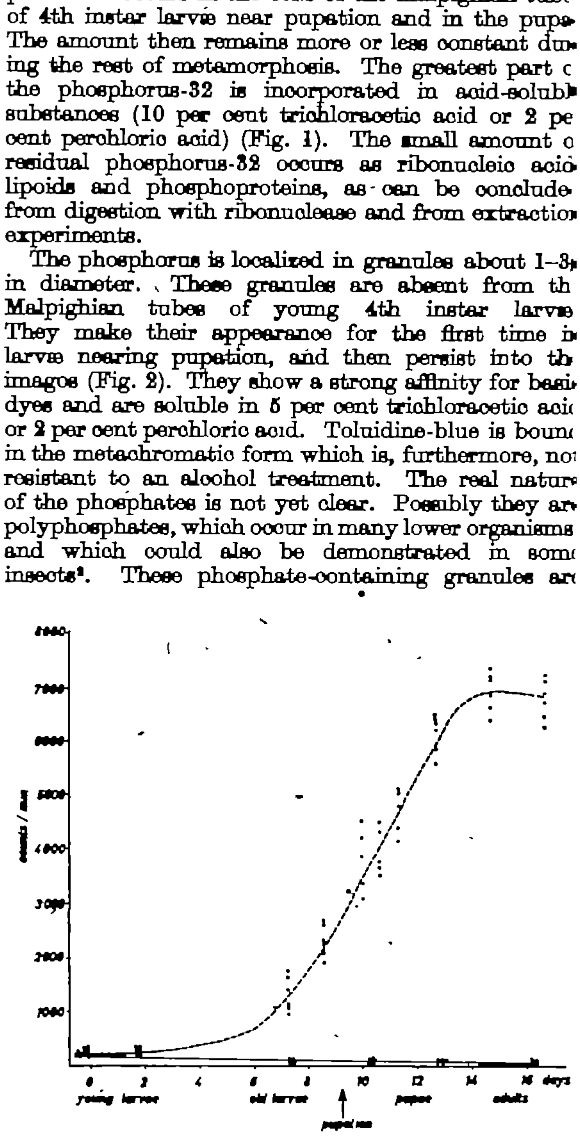

Fig. 1. The incorporation of phosphorus-32 into the Malpighian tubes of *Culex pipiens* during metamorphosis. – – – –, phosphorus-32 accumulated in the cells; ———, after extraction with 10 per cent cold trichloracetic acid

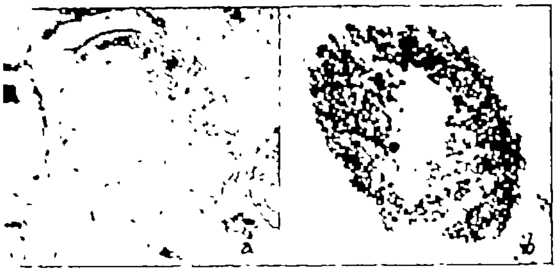

Fig. 2 Section through the Malpighian tubes of *Culex pipiens* treated with phosphorus-32. (*a*) 4th instar larvæ; (*b*) three-day old pupæ. Toluidine-blue stain

omparable with the granules in the Malpighian tubes f blowflies, which were analysed in detail by Waterouse[3].

The phosphorus-32 reaches the Malpighian tubes y way of the blood. This can be concluded from xperiments on animals in which the gut has ceased o show radioactivity. In spite of this absence of adioactivity in the gut, accumulation of phosphorus-2 occurs in the Malpighian cells; hence the phoshorus-32 could not have originated from the gut ontent, but must have been taken up from the lood.

able 1. AMOUNTS OF PHOSPHORUS-32 (AS A PERCENTAGE) WHICH AN BE EXTRACTED FROM ENTIRE ANIMALS (*Culex pipiens*) BY VARIOUS SOLVENTS

he animals lived in a solution containing phosphorus-32 for 24 hr. nd in normal tap water for 24 hr. before the extractions were made

| | Alcohol-ether | Perchloric acid (2%) | Perchloric acid (10%) | Residue |
|---|---|---|---|---|
| Early 4th instar larvæ | 35·4 | 22·4 | 28·8 | 13·4 |
| Late 4th instar larvæ | 29·4 | 41·1 | 24·1 | 5·4 |
| Young pupæ | 25·3 | 46·1 | 22·2 | 6·4 |
| Old pupæ | 24·7 | 45·3 | 21·6 | 8·4 |

The amount of acid-soluble phosphorus-32 in the nimals increases during metamorphosis (Table 1). his is in accordance with the quantitative determinaion of phosphate[4]. We have shown (unpublished xperiments) that it originates from the histolysed rgans (especially the gut) in which the synthesis f phosphorus-containing compounds rapidly declined nd the breakdown of these substances was accelrated. It seems that this increased level of inorganic hosphates in the blood is partially compensated for y the Malpighian tubes, which take up and store he phosphate. The conclusion is justified that the alpighian tubes are active in the regulation of hosphate balance in the animal, and take part in he processes of histolysis and histogenesis.

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* Work done at the Max Planck Institut, Wilhelmshaven, during he tenure of a Fulbright Research Award.

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## Synthesis of (L) α-2,4-Dinitrophenylhistidine

THE reaction of histidine with 1 : 2 : 4-fluorodinitrobenzene (FDNB) could yield a di-substituted histidine and two mono-substituted histidines. Didinitrophenylhistidine has been prepared in pure form[1–4], and although the isolation of a monodinitrophenylhistidine has been claimed[1], neither physical constants nor proof of structure were given. Later workers have not been able to prepare either of the mono-substituted compounds in pure form[4,5]. Efforts to synthesize α-dinitrophenylhistidine were recently reported to have resulted in mixtures containing equal amounts of imidazole dinitrophenylhistidine and α-dinitrophenylhistidine[6].

The present synthesis of α-dinitrophenylhistidine was conceived as a result of chromatographic analysis (Fig. 1) of the products formed in the reaction between histidine and 1 : 2 : 4-fluorodinitrobenzene when the ratio of reagent to amino-acid was varied within wide limits. Examination of the chromatogram suggested that, with 0·5 mole of the fluorodinitrobenzene and 1·0 mole of histidine, only a mono-substituted compound was formed. With larger amounts of reagent this was transformed to the di-substituted compound; the transformation was complete when more than two moles of the reagent were present. The spot obtained with the lower concentration of fluorodinitrobenzene was ninhydrin-negative and reacted strongly positive to the Pauly diazo test. This indicated that the product was α-dinitrophenylhistidine, and suggested reaction conditions for its preparation.

Pure α-dinitrophenylhistidine was prepared as follows: 1·917 gm. (0·01 mole) of L-histidine monohydrochloride and 8·4 gm. of sodium bicarbonate were dissolved in 200 ml. of water, and 0·453 gm. (0·0025 mole) of 1 : 2 : 4-fluorodinitrobenzene in 25 ml. of ethanol was added with stirring. After 1 hr. at room temperature, the volume was reduced *in vacuo* to 50 ml., the *p*H adjusted to 6·5 by

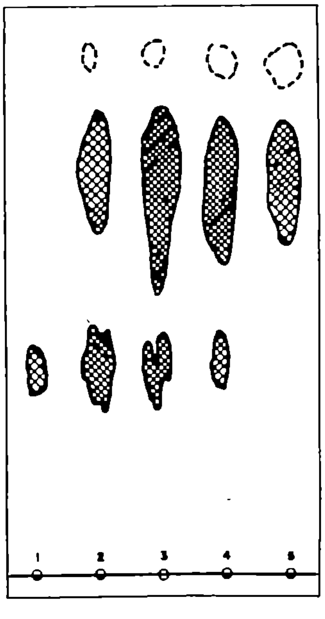

Fig. 1. Chromatogram of the yellow products resulting from the dinitrophenylation of 1 mole histidine for 3 hr. at room temperature with the following amounts of 1 : 2 : 4-fluorodinitrobenzene: (1) 0·5 mole; (2) 1·0 mole; (3) 1·5 mole; (4) 2·0 mole; (5) 2·5 mole

cautious addition of concentrated hydrochloric acid and the solution chilled to 5–10° C. The precipitate was removed by filtration and recrystallized from a minimum volume of dilute alcohol in water. The shiny yellow crystals obtained after 18 hr. in the cold were collected and dried *in vacuo* at 60° C.

Yield: 0 15 gm.
Melting point (uncorr.): 278–280° C. (decomp.).
Specific rotation: $[\alpha]_D^{25}$ − 100·0° (0 154 per cent, 4 *N* hydrochloric acid).
Analysis: found, C, 44 94; H, 3·405; N, 21·50 per cent; calculated for $C_{12}H_{11}O_6N_5$, C, 44 86; H, 3·45; N, 21·79 per cent.

The compound is ninhydrin-negative, indicating substitution of the α-amino group. The Pauly test[6] for the unsubstituted imidazole ring is strongly positive and, mole for mole, is of approximately the same intensity as given by histidine (Fig. 2). The absorption maximum for α-dinitrophenylhistidine in 92 per cent acetic acid is at 342·0 mμ, while that for the disubstituted compound is at 352·0 mμ. The material gives a single spot on paper chromatograms, with $R_F$ = 0·32 (in water-saturated butanol) and 0·43 (in butanol/formic acid/water; 75 : 15 : 10).

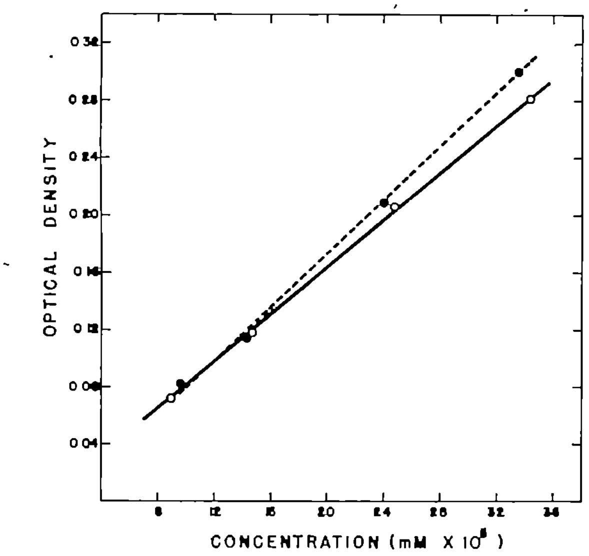

Fig. 2. Intensity of Pauly test for histidine and α-dinitrophenylhistidine. ○—○, Histidine; ●—●—, α-dinitrophenylhistidine

We are indebted to Mr. J. A. Baignee for the carbon and hydrogen determinations.

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# Influence of Cortisone on Connective Tiss —Epithelial Relations in Wound Healin Hair Regeneration and the Pathogenesis Experimental Skin Cancers

Most investigators agree that cortisone retards t development and diminishes the ultimate inciden of experimentally induced skin cancers[1]. Boutw and Rusch[2] reported the induction of papilloma but not of carcinomata to be diminished by cortison Piccagli *et al.*[3] claimed to have increased inductic of tumours with methylcholanthrene by cortison These differences in opinion may perhaps be attribu able to variations in dosage, route and time administration of cortisone relative to the applicatic of carcinogens. This seems likely, since Baker[4], an we too, have shown that cortisone suppresses ha growth, while Andreasen and Engelbreth-Holn demonstrated that tumour incidence depends on th phase of the hair-cycle at the time of application the carcinogen.

We have studied the effects of cortisone on th histogenesis of wound healing in rabbits and on ha regeneration after plucking, and the pathogenes of tumours in mice treated with methylcholanthren special attention being devoted to epithelial – con nective tissue relations. We have found, *inter ali* that cortisone affects wound healing in rabbit primarily by depressing the activity of the connectiv tissue. Whereas, both in rabbits and in mice, cortison produces marked thinning of both dermis an epidermis, wounding in rabbits and plucking o hair and painting with methylcholanthrene in mic induce marked localized epithelial hyperplasia an regeneration even though connective tissue response are still suppressed. However, epithelial 'invasion of the new connective tissue (ultimately forme despite the action of cortisone) and 'pseudo-peg formation, described by us as a constant reactio in healing wounds[6], are suppressed by cortisone.

Local application of cortisone in mice, to an are previously depilated by plucking, completely inhibit hair regeneration in the treated area. This seems t be due to suppression of invasion of dermis by new epidermal *Anlagen* as well as to the apparen inability of cortisone-suppressed connective tissu to form new hair papillæ, despite the presenc of normal epidermal hyperplasia in the pluckec areas.

Cortisone injections fail to suppress epithelia thickening and keratinization localized to the are painted with methylcholanthrene in mice. However, dermal atrophy and loss of subcutaneous fat are marked in mice receiving cortisone injections, and invasion of dermis by healing epidermal spurs is distinctly suppressed. Macroscopically, hair regeneration and the incidence of papillomata and carcinomas are significantly depressed, although on microscopic examination we found that malignant change occurs within the epidermis of cortisone-treated mice. Consequently, numerous carcinomata *in situ*, comparable with Bowen's disease in man, were encountered microscopically in cortisone-treated mice, even when neoplasms were not detectable macroscopically. This accounts for the discrepancy between the macro- and microscopically determined incidence of tumours, and for the apparent delay, but not suppression, of carcinogenesis by cortisone.

Thus, in two separate and slightly differently designed experiments, papillomas occurred in seven-en of eighteen control methylcholanthrene-painted ice, and in only seven of the seventeen in the ethylcholanthrene plus cortisone group; the numbers papillomas averaged 6·5 per mouse in the former, mpared with 1·6 per mouse in the latter. Further- ore, macroscopically detectable carcinomas occurred fifteen of eighteen controls, and in only seven of venteen cortisone-treated mice. In one experiment, ten controls examined microscopically showed alignant tumours (as compared with nine out of n macroscopically), while in the cortisone group, ly three mice showed macroscopically observable alignancies, and eight of nine animals had micro- opically detectable carcinomata *in situ* which were uite unrelated to papillomas.

Thus, cortisone does not eliminate the epidermal sponse evoked by wounding, hair plucking or by eatment with methylcholanthrene. However, the ppression by cortisone of the usual connective-tissue sponses to these stimuli influences the histogenesis f wound healing, hair regeneration and tumour evelopment. Although the incidence of papillomas, nd the subsequent neoplasia in such benign tumours, diminished by cortisone, neoplasia within the pidermis itself is not eliminated. Thus, the patho- enesis and biology of these malignant tumours are istinctly altered.

Our histochemical findings, combined with in- ormation from the literature, indicate that cortisone eems to induce its effects by acting on the ribose ucleic acid and/or mucopolysaccharide metabolism f the dermis, thereby indirectly influencing epidermal esponses to various stimuli.

These findings show, in yet another way, the robable role of the dermis and of disturbed dermal– pidermal relations in the pathogenesis of skin umours, and suggest a new approach to the investiga- ion of the influence of steroid hormones on carcino- enesis.

The expenses incurred during this study were lefrayed primarily by a generous grant from the chlesinger Organization, South Africa. We wish o thank Mr. W. A. Michie of Ciba, Ltd., Mr. F. Vayne of British Drug Houses, Ltd., and especially Ir. A. M. Patt of Scherag, Ltd., for cortisone used n this study.

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## Influence of Osmotic Pressure on the Polyamine Requirement of *Neisseria perflava* and *Pasteurella tularensis* for Growth in Defined Media

THE discovery by Herbst and Snell[1] that putrescine or related di- and poly-amines constitute an essential growth requirement for *Haemophilus parainfluenzae* assigned for the first time a biological function to these substances, known to be of wide occurrence in Nature[2]. Afterwards, putrescine was recognized as an indispensable growth factor for *Neisseria perflava*[3] and a stimulatory agent for *Pasteurella tularensis*[4]. The aim of the present communication is to describe an interrelationship observed between the tonicity of the medium and the polyamine requirement. This observation seems to throw light on the mechanism of the growth-promoting action of these compounds.

Nemes, Pelczar and Doetsch[5] reported that *N. perflava* can be cultivated in a semi-synthetic medium composed of a vitamin-free acid-hydrolysate of casein, salts and biotin. Later, Martin, Pelczar and Hansen[3] found an additional demand of the organism for either putrescine or some other related polyamine, on replacing casein hydrolysate in the above medium by a mixture of eighteen amino-acids.

These results have been fully confirmed by us with two strains of *N. perflava*. The ability of the micro-organism to dispense with putrescine in a medium prepared from a commercial acid-hydrolysate of casein ('Casamino-acids', Difco) suggested the possibility that the hydrolysate might contain, as a natural contaminant, sufficient amounts of an active polyamine not removable by the treatment employed for the preparation of the vitamin-free product. However, this was scarcely compatible with the finding that a tryptic digest of casein did not sustain growth unless supplemented with microgram quantities of either putrescine or spermine. A similar result was obtained with a 'salt-free' casein hydrolysate prepared by digestion with sulphuric acid followed by neutralization with barium hydroxide.

As the commercial hydrolysate was known to contain about 40 per cent sodium chloride, a possible effect of the latter substance was suspected. In fact, an ashed sample of 'Casamino-acids' was found to retain all the activity of the original preparation. Moreover, addition of graded amounts of sodium chloride to the defined medium of Martin *et al.*[3] or to an enzymatic casein digest produced, up to a certain concentration, nearly proportional growth responses. The maximal response was, however, somewhat inferior to that obtained with optimal amounts of putrescine. Sodium chloride could be successfully replaced not only by other salts of the alkaline series (potassium, lithium) but also by certain non-electrolytes (glucose, sucrose) (see Table 1). The optimal range of activity corresponded roughly to salt concentrations isotonic with $0{\cdot}1\,M - 0{\cdot}15\,M$ sodium chloride. With non-electrolytes the onset of growth was usually delayed, but the final yield was nearly as good as with sodium chloride. Maximal growth with glucose or sucrose was achieved at concentrations close to $0{\cdot}1\,M$.

In the light of the above results, it appeared interesting to see whether a similar interdependence between the tonicity of the medium and the polyamine requirement can be demonstrated with strains of *P. tularensis* which, as previously shown, require both sodium and spermine for optimal growth[4]. With strain 176, it was found that sodium chloride and

Table 1. COMPARISON OF THE GROWTH-PROMOTING EFFECT OF SPERMINE AND VARIOUS OSMOTICALLY ACTIVE SUBSTANCES

*N. perflava* was grown in the defined basal medium of Martin *et al.* (ref. 3) supplemented with 0·2 per cent glucose. *P. tularensis* was grown in the synthetic medium *B* as described in ref. 6. The inoculated tubes were slanted and incubated with continuous shaking at 30°. Growth was estimated in the Coleman Junior spectrophotometer and recorded in terms of optical density. × 100

| Additions to basal media | Growth | |
|---|---|---|
| | *N. perflava* (48 hr.) | *P. tularensis* (36 hr.) |
| None | 2 | 9 |
| Spermine, 10 μgm./ml. | 68 | 36 |
| Sodium chloride, 0·1 *M* | 40 | 30 |
| Sodium chloride, 0·15 *M* + spermine, 10 μgm./ml. | 68 | 70 |
| Potassium chloride, 0·19 *M* | 50 | 32 |
| Glucose, 0·1 *M* | 31 | 25 |
| Sucrose, 0·1 *M* | 38 | 28 |
| Mannitol, 0·1 *M* | 2 | 27 |

spermine could be substituted for each other to a large extent, though maximal rate of proliferation was obtained only when both factors acted in combination (Table 1). Here, too, the growth-enhancing effect of sodium chloride could be duplicated by other salts as well as by non-electrolytes.

In the course of this work, it was observed that washing *P. tularensis* cells with distilled water instead of the usual saline resulted in a decrease of their viability as shown by prolongation of the lag phase or even by complete suppression of multiplication. This deterioration could be prevented by adding some micrograms of spermine to the distilled water used for washing. Thus, in this respect again, sodium chloride and spermine proved to be interchangeable.

The results presented so far seem to justify the general conclusion that both the osmotic agents and the polyamines control, each independently and by a different mechanism, some definite cell function essential for growth. It appears likely that this vital function may be related to permeability of the cell membrane; no conclusion as to the exact mechanism involved is yet possible.

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## Systematic Position of the Euphausiacea

ELSEWHERE in this issue of *Nature* (see p. 911) I have mentioned that, although the idea originated with Kemp, Gurney was the first to place the Euphausiacea in the order Decapoda, which he divided into two suborders, Euphausiacea and Eudecapoda. Gurney never intended to include the Euphausiacea in his Ray Society monograph, "Larvae of Decapod Crustacea" (1942)—Euphausid literature is omitted from the earlier companion volume, "Bibliography of the Larvae of Decapod Crustacea" (1939)—but a chance remark of mine prompted him to do so when his manuscript was almost, or quite, finished. This resulted in some inconsistency of treatment of the Euphausiacea, partly because he sometimes omitted to alter 'Decapoda' to 'Eudec poda' where necessary, partly because he had alrea mentioned the Euphausiacea (as an independe order) here and there, in the same way as he mentio the Stomatopoda, for example. He did not expla why he altered the classification; Kemp's idea w quite new to him and he doubtless misundersto what I said. That he had not considered the matt carefully is proved by the letter which he sent me 1949 after we had again discussed the systemat position of the Euphausiacea (see p. 911 for h suggested solution, which has much in its favou Incidentally, Nakazawa's claim, referred to l Gurney[1], that an economically important Japane species of *Sergestes* has a free nauplius larva is soun Recently I had the relevant passage translated Nakazawa collected sixty eggs on August 6, from th fishing grounds, and from these he obtained the thr naupliar stages which he figured; eighteen of th third-stage nauplii metamorphosed to the first-sta protozoea, which is an undoubted Sergestid larva.

All carcinologists would, I think, agree that th general classification of the Decapoda is in urge need of revision. According to Gurney (ref. 1, p. 11 "the four main difficulties in framing a satisfactor system for the Decapoda are: (i) relation of th Euphausiacea to the Decapoda; (ii) relation of th Penaeidea to the Caridea; (iii) position of th Stenopidea and of the Thalassinidea; (iv) relation the Dromiacea to the Brachyura"; and there a others. On embryological grounds, Gurney altered th position not only of Euphausiacea but also of Sten opidea, Thalassinidea and Dromiacea. Moreover, h maintains that the Thalassinidea is not homogeneou but comprises a homarine and an anomuran grou It would be interesting to follow this up with referenc to adult morphology, to see whether or not Gurney' views can be substantiated. In a forthcoming pape I hope to discuss more fully the systematic positio of the Euphausiacea; as I also intend to conside the relationships of the Dromiacea and of the Gymno pleura, and perhaps of other groups as well, it ma be some time before the work is finished. Meantim I would welcome any suggestions or comments tha may occur to other specialists.

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[1] *Discovery Reports*, 20, 4 (1940); Ray Society Monograph, 1942, 3 footnote.

## *Chainia*, a New Genus of the Actinomycetale

AN actinomycete isolated from soil in Poon showed on examination characters representing a undescribed genus. The species was saprophytic aerobic and mesophilic, growing readily on the variou nutrient agar media employed. The colonies o glucose–peptone agar are faint cream-yellow in earl stages, with well-developed fine non-septate mycelium 0·4–0·8μ in diameter and branching in a monopodia type. The hyphae developing in a radiating manne grow into the substrate, giving a lichenoid appear ance. There is no true aerial mycelium formed though growth at later period appears compact an raised. The unseptate mycelium never fragments int bacillary or coccoid forms and is Gram-positive an non-acid fast.

The chief distinguishing character of the genus i the formation of spherical sclerotic granules in larg

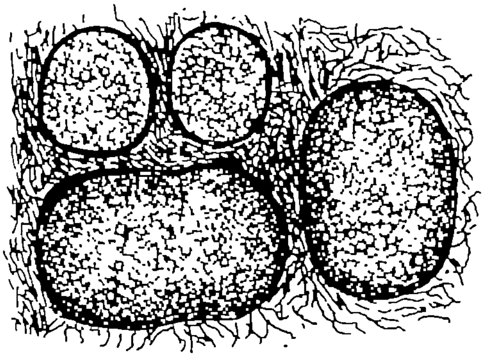

Fig. 1. Sclerotic granules in *C. antibiotica*. × 500

gregate masses from the mycelium (Fig. 1). In eir formation, closely septate hyphæ thickened up 1·5μ, incurl and become compacted to form hard lerotic granules ranging from 16 to 75μ in ameter. There is an enveloping layer of mycelium, in some cases several small granules become closed in a common mycelial sheath. In old colonies, e granules become readily separated from the getative mycelium and on transferring to fresh edia germinate and develop into new colonies.

Comparative studies indicated that the occurrence f a branching non-septate mycelium without true erial mycelial formation shows affinity with *Micro-onospora* Orskov, but lacks the characteristic single ores produced in the latter genus. The type of lerotic granules resemble in a general way those resent in *Actinomyces bovis* Harz. and *A. israeli* Kruse) Lachner-Sandoval, which incite actinomycoses higher animals[2]. The granules in the *Actinomyces* pecies mentioned above are structurally different, ith radiating 'clubs'. Further, the genus *Actinomyces* arz (*sensu* Waksman and Henrici[1]) has a vegetative mycelium fragmenting into bacillary or coccoid orms, and is mainly anaerobic to microaerophilic. n contrast, the species under study has a true ycelium as in Streptomycetaceae and is aerobic nd mesophilic. These characters indicate that the pecies under study represents an undescribed genus, or which the name *Chainia* is proposed, in honour f Prof. E. B. Chain, of the Istituto Superiore Sanità, ome.

*Chainia* Thirumalachar *gen. nov.*: mycelium well eveloped, fine, non-septate, growing into substrate, ot forming true aerial mycelium, non-fragmenting, ram-positive, non-acid fast, deeloping sclerotic granules comosed-of incurled hyphal cells, single r in aggregates, enveloped in yphal sheath at first and later ecoming free. Conidial form unnown. Type species: *Chainia ntibiotica* Thirum., isolated from oil, Poona, India.

Studies on antibiotic activity ave indicated that *C. antibiotica* roduces a very powerful antifungal ubstance both on agar plates and n agitated submerged cultures in hake flasks. While the nature of he substance is under test, the eneral antibiotic spectra indicated n agar streak tests is given in able 1. A fragment of mycelium f *C. antibiotica* 2 mm. in diameter was inoculated on glucose peptone agar for five days in Petri dishes (10 cm. diam. with 20 c.c. of medium), incubated at 24° C. and tested for antifungal or antibacterial activity.

Table 1

| Name of organism tested | Diam of zone of inhibition |
|---|---|
| *Cryptococcus neoformans* | 70 mm. |
| *Sporotrichum schenkii* | 50 mm |
| *Microsporum audouini* | 50 mm. |
| *Saccharomyces* sp. | 60 mm. |
| *Curvularia lunata* | 60 mm. |
| *Penicillium chrysogenum* | 50 mm. |
| *Botryodiplodia phaseoli* | 45 mm. |
| *Bacillus subtilis* | 40 mm. |
| *Micrococcus pyogenes* var. *aureus* | 45 mm. |
| *Escherichia coli* | Nil |

Detailed accounts of the description of the species and genus, biochemical and antibiotic activities will be published separately.

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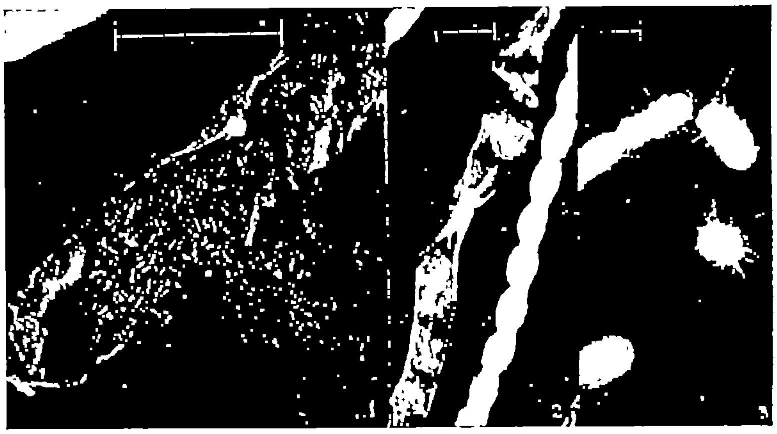
## Spore Formation in the Genus *Streptomyces*

In the course of a study of the Streptomycetes present in New Zealand soils, the electron microscope revealed certain details of spore formation which may be of interest.

Micrographs of a number of named cultures as well as of freshly isolated material give support to the views expressed so far back as 1898 by Lachner-Sandoval[1].

Spore formation takes place within the hyphal wall. The contents divide into fragments which are separated by less dense partitions, having the appearance of septa. The fragments are somewhat irregular in size and divisions appear to occur simultaneously along the hypha.

The spores remain in chains, held together by the sheath-like hyphal wall. As the spores mature, the nature of the sheath appears to undergo change. In some strains it persists, the spores being liberated by means of a longitudinal split, and the old wall is seen as a ribbon-like sheath. The sheath may have cross markings that show clearly the positions of the spores it formerly enveloped (Fig. 2). In other strains



Scale length 1 μ

the sheath disintegrates readily and small fragments only remain to indicate its presence.

Micrographs of the sheath show a definite structure. Narrow pointed plates lie side by side in groups at various angles, the whole presenting a more or less regular pattern as if crystalline (Fig. 1). The persistence of the sheath seems to be associated with the degree of marking. The most strongly patterned sheaths observed were those which broke up readily, apparently fragmenting parallel to the long axes of the narrow plates.

Using the technique of Erikson[2], the sheath did not stain with sudan IV.

Attached to the sheath and sometimes enfolded by it, small dense spherical bodies were frequently observed. These inclusions varied in size from 0·1μ to 0·2μ. The nature and function of these bodies are not known (Fig. 1). Electron micrographs of *Nocardia ruber*[3] show granules which may be similar.

The presence of spiny processes on the spores of certain strains was reported by Flaig *et al.*[4], and several isolates from New Zealand soils have been noted to produce spores with spiny outgrowths. Micrographs show that spores with spines are produced within the hyphal wall in the normal manner, and are liberated by a longitudinal splitting of the sheath. The sheath shows clearly markings and indentations caused by the spines. In some cases the spines were observed to penetrate the hyphal wall and occasionally were broken off when the spores were released.

As no previous record has been seen, it is of interest to note that a culture of *S. flaveolus* NRRL. B.1334 showed spiny spores. The spines on the spores of *S. flaveolus* are long and thin (1μ × 0·04μ) tapering only slightly towards the tip. They are very fragile and easily broken off (Fig. 3).

I am indebted to Mr. K. I. Williamson and Mr. W. Bertaud of the Dominion Physical Laboratory for the electron micrographs.

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## Isolation of *Microsporum gypseum* and of *Keratinomyces ajelloi* from Australian Soil

SIXTY-SIX samples of soil collected from various parts of New South Wales were examined for the presence of keratinophilic fungi. Following the technique of Vanbreuseghem[1], Petri dishes half-filled with moistened soil were baited with autoclaved human hair. At varying intervals, ranging from three to seven weeks, some hairs were found to be overgrown by fungi; these were examined microscopically and transferred to Sabouraud's agar containing 'Actidione' (cycloheximide), penicillin and streptomycin[2].

*Microsporum gypseum* was isolated in pure culture from five samples of soil and *Keratinomyces ajelloi* from eight samples. So far as we know, this is the first occasion on which these fungi have been isolated from Australian soil. Other fungi are being encountered in the course of this work, which is supported by a grant from the National Health a Medical Research Council of Australia and wh will be reported in full later.

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## Selection of Aphid Species by Different Kinds of Insect Traps

MOERICKE yellow trays are a simple and che method of trapping aphids, and are being wide used for the study of aphid flight and behavio These traps, however, have never been standardiz with respect to their differential catch of vario species. Three yellow trays and a suction trap we operated close to each other, over a small plot pyrethrum not infested with aphids, for more th two years at the East African Agriculture a Forestry Research Organization, near Kikuy Kenya. There are reasons for thinking that t suction trap takes a fairly accurate sample of aph density. The ratio of yellow-tray to suction-tr catch for the commoner species is shown in Table The total number of specimens, from both traps, placed in parentheses. All the specimens listed we alate viviparous females except for the male *Rhopal siphum maidis*.

Table 1. RATIO OF CATCHES IN YELLOW TRAYS TO THOSE BY SUCTIO TRAP

| | | | |
|---|---|---|---|
| 1 | *Toxoptera citricidus* | 30·7 | (95) |
| 2 | *Myzus ornatus* | 25·0 | (52) |
| 3 | *Macrosiphum euphorbiae* | 14·7 | (771) |
| 4 | *Hyadaphis coriandri* | 12·7 | (41) |
| 5 | *Brevicoryne brassicae* | 11·1 | (799) |
| 6 | *Brachycaudus helichrysi* | 9·5 | (21) |
| 7 | *Trifidaphis phaseoli* | 9·5 | (21) |
| 8 | *Myzus persicae* | 6·4 | (844) |
| 9 | *Aphis* spp. | 3·3 | (2,048) |
| 10 | *Hyperomyzus lactucae* | 2·9 | (37) |
| 11 | *Lipaphis erysimi* | 2·7 | (720) |
| 12 | *Longiunguis sacchari* | 2·7 | (76) |
| 13 | *Dactynotus compositae* | 2·2 | (305) |
| 14 | *Aulacorthum vincae* | 2·1 | (49) |
| 15 | *Geoica lucifuga* | 2·1 | (25) |
| 16 | *Rhopalosiphum maidis* ♂♂ | 2·0 | (51) |
| 17 | *Tetraneura hirsuta* | 1·6 | (102) |
| 18 | *Aploneura lentisci* | 1·5 | (168) |
| 19 | *Rhopalosiphum splendens* | 1·3 | (734) |
| 20 | *Micromyzus agavi* | 1·2 | (35) |
| 21 | *Macrosiphum* (*Sitobion*) spp. | 0·8 | (261) |
| 22 | *Rhopalosiphum maidis* ♀♀ | 0·8 | (972) |
| 23 | *Schizaphis cyperi* | 0·6 | (344) |
| 24 | *Acyrthosiphon pisum* | 0·5 | (414) |

From these figures it is evident that some specie may be selected as much as thirty times as strongl as others by yellow trays than by suction trap The host plants of species 1–11, 13 and 14 and 2 are dicotyledons, and of 12 and 15–23 are grass or sedges. These grass- and sedge-feeding specie belong to several different taxonomic groups, an the yellow trays select against them in favour of mos of the common species feeding on dicotyledons.

Statistical analysis of these trap catches from hou to hour shows that the presence of sunshine increase the yellow-tray catch relative to the suction trap these findings are to be published in greater deta elsewhere.

V. F. EASTOP

East African Agriculture and
Forestry Research Organization,
P.O. Box 21,
Kikuyu. July 11.

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, November 14

nstitute of Metal Finishing (in the Thames Room, Charing ss Hotel, London, W.C.2), at 11 a.m.—Annual General Meeting. 3 p.m.—Mr. R. A. F. Hammond: "Research and Industrial plication in Metal Finishing" (Presidential Address).

Royal Geographical Society (at 1 Kensington Gore, London, V.7), at 5 p.m.—Mr. R. A. Hamilton and others: "Scientific search by the North Greenland Expedition".

British Society for the History of Science, Philosophy of ence Group (in the Joint Staff Common Room, University College, wer Street, London, W.C.1), at 5.30 p.m.—Dr. H. Ezriel: "The e of Psychoanalytic Sessions as Experimental Situations".

Institution of Electrical Engineers (at Savoy Place, London, .C.2), at 5.30 p.m.—Discussion on "Is the Engineer Broad Enough his Outlook?". Opening Speaker: Dr. P. Dunsheath.

University of London (in the Physiology Theatre, University llege, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. W. S. ldberg, F.R.S.: "Recent Experiments on the Pharmacology of e Periventricular Grey Matter of the Brain".*

Royal Institute of Chemistry, London Section (joint meeting th the Woolwich Polytechnic Scientific Society, at the Woolwich lytechnic, London, S.E.18), at 7.30 p.m.—Dr. T. V. Arden: "Ion change Resins".

## Tuesday, November 15

Institution of Chemical Engineers (at the Geological Society, rlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. F. H. lams and Mr. A. G. Baker: "An Assessment of Dry-Blending quipment".

Institution of Electrical Engineers, Measurement Section oint meeting with the Radio Section, at Savoy Place, London, .C.2), at 5.30 p.m.—Dr. D. L. Holloway: "An Electrolytic-Tank quipment for the Determination of Electron Trajectories, Potential d Gradient" and "A Method of Tracing Electron Trajectories in osed Electric and Magnetic Fields" (Papers to be read by Dr. J. H. estcott).

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, eppel Street, London, W.C.1), at 5.30 p.m.—Prof. R. H. Tunbridge: Observations on the Structure of Connective Tissue Fibres". (Sixth fifteen Lectures on "The Scientific Basis of Medicine".)*

Royal Aeronautical Society (at 4 Hamilton Place, London, .1), at 7 p.m.—Sir Ronald A. Fisher, F.R.S.: "The Planning of xperiments".

## Wednesday, November 16

Royal Microscopical Society, Industrial Section (at the ritish Pharmaceutical Society, 17 Bloomsbury Square, London, .C.1), at 2 p.m.—Exhibition and Symposium on "Fibre Microopy".

University of London (at the Postgraduate Medical School of ondon, Ducane Road, London, W.12), at 2 p.m.—Dr. G. Popjak: Fat Metabolism".*

Royal Meteorological Society (at 49 Cromwell Road, London, .W.7), at 5 p.m.—Mr. Joanne Malkus: "The Effects of a Large land Upon the Trade-Wind Stream"; Mr. R. P. Pearce: "The alculation of a Sea Breeze Circulation in Terms of the Differential eating Across the Coast-line"; Mr. R. C. Smith: "Theory of Airow Over a Heated Land Mass".*

Royal Statistical Society (at the London School of Hygiene nd Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—r. D. J. Finney: "The Statistician and the Planning of Field xperiments".

Eugenics Society (in the Rooms of the Royal Society, Burlington ouse, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. C. Maurice illiams: "Problem Families in Southampton".*

Research Defence Society (in the Physiology Lecture Theatre, niversity College, Gower Street, London, W.C.1), at 5.30 p.m.—ir Henry Dale, F.R.S.: "Humanity's Rising Debt to Medical esearch" (Twenty-fourth Stephen Paget Memorial Lecture).

Aslib (at the Royal Society of Arts, 8 John Adam Street, Adelphi, ondon, W.C.2), at 6 p.m.—Dr. E. J. Crane: "The Chemical Abstracts ervice and its Plans".

Iron and Steel Institute (at the Seymour Hall, Seymour Place, ondon, W.1), at 6 p.m.—Sir Robert Shone and Mr. W. F. Cartwright: 'The Russian Iron and Steel Industry".

Royal Institute of Chemistry, London Section (at the Institute f Metals, Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Annual eneral Meeting. Dr. D. W. Kent-Jones: "A Progressive Institute".

Polarographic Society (at the Royal Institution, Albemarle treet, London, W.1), at 7.30 p.m.—Prof. J. Heyrovsky (Czechoslovakia): Presidential Address.*

## Thursday, November 17

Royal Aeronautical Society (at the Institution of Civil ngineers, Great George Street, London, S.W.1), at 10 a.m.—Meeting n "Aircraft Design Philosophy"; Dr. P. B. Walker: "Structural esting"; Mr. H. Giddings: "Fatigue"; Mr. C. F. Joy: "Flight oads"; Mr. J. K. Williams: "Safety Factors".

University College London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. Kenneth Garside: "The Arrangement of Books: a New System of Classification in the College Library".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. R. A. Smith: "Physics at the Radar Research Establishment, Malvern".

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. Kingdon-Ward: "Travels in the Great Forest Belt of North Burma".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting. Prof. J. H. C. Whitehead: "Duality in Topology" (Presidential Address).

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Dr R. J. P. Williams: "Metal Complexes as Models for Metallo-Enzymes". (Further Lectures on November 24, December 1 and 8.)*

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall of the Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, S.W.1), at 6 p.m.—Mr. K. H. Clare and Mr. P. T. Sherwood: "Organic Matter in Soil in Relation to Soil–Cement Stabilization".

Oil and Colour Chemists' Association (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. H. M. Evans: "Recent Developments in Polyester Resins".

Chemical Society (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.30 p.m.—Prof. D. H. Everett: "Some Developments in the Study of Physical Adsorption" (Tilden Lecture).

Royal Society of Tropical Medicine and Hygiene (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7.30 p.m.—Laboratory Meeting.

## Friday, November 18

Society of Chemical Industry, Corrosion Group (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 10 a.m.—Symposium on "The Protection of Cable Sheathing".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. F. A. Pantin, F.R.S.: "The Primitive Nervous System".

## Friday, November 18—Saturday, November 19

Institute of Physics, X-Ray Analysis Group (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1)—Autumn Conference—"Semi- and Non-Crystalline Materials".

## Saturday, November 19

Biochemical Society (at the Middlesex Hospital Medical School, Mortimer Street, London, W.1), at 11 a.m.—Scientific Papers.

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. F. N. Ghadially: "Fish, Reptiles and Amphibians".*

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Training Officer (with an honours degree in chemistry and physics or corporate member of a senior Engineering Institution, or equivalent qualifications, with some years' experience in industry and knowledge of industrial training methods) at the Industrial Group Headquarters, United Kingdom Atomic Energy Authority, Risley, to take part in the preparation and administration of training courses, and to assist the Chief Training Officer (Operations)—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting 1160 (November 18).

Assistant Experimental Officers (2) (with at least G.C.E. to advanced level in biology, or equivalent qualification, preferably with a degree in biology), at the Merlewood Research Station, Grange-over-Sands, for laboratory work, including microscopical examination and fine manipulation, on microarthropods or nematodes, and some field work—Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (November 19).

Head, Grade II (with high academic or professional qualifications and considerable full-time teaching experience, preferably with industrial, research or administrative experience), of the Department of Chemistry and Biology—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (November 19).

Lecturer in Electrical Engineering—The Registrar, Queen Mary College, Mile End Road, London, E.1 (November 19).

Lecturer in Social Philosophy—The Secretary, The Queen's University, Belfast (November 19).

Research Assistant (with a good honours degree in chemistry) in the Department of Chemistry, to work under direction on a project involving radiochemical techniques—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (November 19).

**Senior Lecturer** (with qualifications and experience necessary to plan and supervise the teaching of physical chemistry up to honours degree standard) in Physical Chemistry—The Principal, Royal Technical College, Salford 5 (November 19).

**Statisticians** (with a first- or second-class honours degree, or equivalent, in statistics, mathematics, economics or other appropriate subject, or with examinations of approved statistical society) at the Central African Statistical Office, Ministry of Finance, Federation of Rhodesia and Nyasaland—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (November 19).

**Professor of Mechanical Engineering** at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (November 24).

**Scientific Officer** (with first- or second-class honours degree in chemistry) at the Northern Outfall Works, Beckton, London, for scientific control and development duties—The Medical Officer of Health (PH/D1), County Hall, London, S.E.1 (November 25).

**Lecturer** (with an honours degree and research experience) in Physics, at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (November 28).

**Deputy Conservation Officer** (graduate in biological science, agriculture or forestry, with some administrative experience, or equivalent qualifications), with the Nature Conservancy in Wales, for duties including the investigation of wild life conservation problems, contacts with Natural History Societies, landowners, local authorities and government departments; co-operation with research scientists and others on management of Nature Reserves—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (November 30).

**Lecturer** (with an honours degree in zoology, and preferably a special knowledge of agricultural entomology, with research and teaching experience of this subject) in Agricultural Entomology—The Secretary, School of Agriculture, Downing Street, Cambridge (November 30).

**Lecturer** (graduate, with special interest in surveying) in Civil Engineering—The Registrar, King's College, Strand, London, W.C.2 (November 30).

**Physiologist in the Department of Physiology and Plant Culture**, to work on plant response to environment—The Secretary, John Innes Horticultural Institution, Bayfordbury, Herts (November 30).

**Professor of Parasitology** and **Professor of Bacteriology** at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (November 30).

**Demonstrator** (honours graduate in chemistry) in Chemistry—The Registrar, College of Technology, Manchester 1 (December 1).

**Assistant Experimental Officers** or **Experimental Officers** (preferably with a degree in natural sciences or engineering, with statistics) for the Scientific Adviser's Branch, Air Ministry, London, for duties including control of field studies and analysis of data relating to operation of military aircraft, including technical supply problems, logistics and flying safety—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.392/5A (December 3).

**Lecturer in Animal Production**, and **Lecturers (2) in Crop Production**, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (December 6).

**Senior Lecturer** (with a research degree in organic chemistry and experience of teaching this subject) in Organic Chemistry at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W C.1 (December 9).

**Research Fellow** (with experience in low energy nuclear physics or photo disintegration problems) in the Department of Nuclear Physics, Research School of Physical Sciences, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 30).

**Lecturer** (with an honours degree and practical experience in public works engineering) in Civil Engineering—The Registrar, The University, Leeds 2 (January 2).

**Agricultural Engineer** (with a university degree in agriculture or engineering and postgraduate training in agricultural engineering) in British Guiana, to be responsible for the general improvement of local practices relating to agricultural engineering, to test and develop new techniques and mechanical devices for field and factory, and to train persons in the care and maintenance of farm machinery—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/30/05.

**Chemists** and **Biochemists** (with a good honours degree and preferably some research experience) for research on microbiological methods of analyses and the chemistry of cereal lipids—The Director, Research Association of British Flour-Millers, Cereals Research Station, Old London Road, St. Albans.

**Demonstrator** (graduate in economics, agriculture or geography) in Agricultural Economics, for research and teaching duties—The Secretary, Institute for Research in Agricultural Economics, Parks Road, Oxford.

**Mathematician**, Principal or Senior Scientific Officer grade (with a first- or second-class honours degree, or equivalent qualification, in applied mathematics and considerable experience in formulation and solution of advanced mathematical problems), at the Ministry of Supply, Armament Research and Development Establishment, near Sevenoaks, Kent, to lead a mathematical team in advanced basic research in either mechanics of fluids, steady and unsteady compressible flow, or of solids, elasticity, plasticity and fracture—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.391/5A (November 26).

**Physical Metallurgist** (with a university degree, or equivalent qualification, and preferably with some postgraduate research experience) for the British Iron and Steel Research Association, Sheffield, to work in a research group concerned with measurements of fundamental properties of iron and steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W quoting M.G.1.

**Scientific Officer** (with a good honours degree and an inter in biological problems, preferably with research experience) in t Department of Chemistry, to take part in researches on the che istry of milk proteins and enzymes—The Secretary, National Instit for Research in Dairying, Shinfield, Reading, Berks, quoting 55/19

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# REPORTS and other PUBLICATION

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

The British University System 1914–1954. By Sir Hector Hetheri ton. (The P. J. Anderson Memorial Lecture, 1954.) (Aberdeen Univ sity Studies No. 33.) Pp. 18. (Edinburgh and London: Oliver a Boyd, Ltd., 1955. Published for the University of Aberdeen.) 1s. [1

Annals of the Cape Observatory. Vol. 18: Cape Photograp Catalogue for 1950.0. Zone −35° to −40°. Prepared under t directions of Dr. J. Jackson and R. H. Stoy. Pp. xii+260. (Londo H.M. Stationery Office, 1955.) 30s. net. [1

Report of the Conference on Industry and Technical Educatio (Organized by the Regional Advisory Council for the Organization Further Education in the East Midlands and the F.B.I. North Mi land Regional Council, and held at the College of Technology, Loug borough, 21 April 1955.) Pp. iii+41. (London: Federation of Brit Industries, 1955.) 4s. [1

Report of a Sub-committee on University Entrance Requiremen Pp. 20. (London: Committee of Vice-Chancellors and Principals the Universities of the United Kingdom, 1955.) [2

Science Museum. Classified Lists of Historical Events. Mechani and Electrical Engineering, including Energy Conversion, Tra mission and Storage; Atomic Energy; Pumping; Blowing a Compressing Machinery; Explosives and Ordnance. Compiled G. F. Westcott. Pp. iv+40. (London: H.M. Stationery Office, 1955 2s. net. [22

Peaceful Uses of Atomic Energy. Pp. 16. (London: Association Scientific Workers, and the Labour Research Department, 1955 6d. [22

Empire Cotton Growing Corporation. Progress Reports from Expe ment Stations, Season 1953–54. Queensland. By R. W. Peter Pp. 16. 9d. Survey of Reports. By J. B. Hutchinson. Pp. 14. 9 (London: Empire Cotton Growing Corporation, 1955.) [22

Technical Survey of the Copper Development Association. No. July, 1955. Pp. 36. (Radlett: Copper Development Associatio 1955.) [22

Air Ministry: Meteorological Office. British Rainfall 1953: Repo on the Distribution of Rain in space and time over Great Britain a Northern Ireland during the year 1953 as recorded by about 5,0 observers. (The Ninety-third Annual Volume of the British Rainf Organization.) Pp. iv+219. (M.O. 588.) (London: H.M. Stationer Office, 1955.) 25s. net. [22

## Other Countries

World Health Organization. Technical Report Series. No. 92 Joint ILO/WHO Committee on the Hygiene of Seafarers. Secon Report. Pp. 20. 1 Swiss franc; 1s. 9d.; 0.30 dollars. No. 93: Expe Committee on Midwifery Training. First Report. Pp. 21. 1 Swi franc; 1s. 9d.; 0.30 dollars. No. 96: Expert Committee on Biologic Standardization. Eighth Report. Pp. 19. 1 Swiss franc; 1s. 9d. 0.30 dollars. No. 98: Legislation Affecting Psychiatric Treatment Fourth Report of the Expert Committee on Mental Health. Pp. 25 1 Swiss franc; 1s. 9d.; 0.30 dollars. Monograph Series. No. 27 Chemotherapy of Malaria. By Sir Gordon Covell, Dr. Robert Coatney Dr. John W. Field and Dr. Jaswant Singh. Pp. 123. 10 Swiss francs 17s. 6d.; 3.25 dollars. (Geneva: World Health Organization; London H.M. Stationery Office, 1955.) [22

United States Department of Agriculture. Leaflet No. 386: Mos quitoes: How to Control Them on Your Property. Pp. 8. 5 cents Leaflet No. 388: Horn Flies on Cattle: How to Control Them. Pp. 6 5 cents. Circular No. 957: Investigations of the Pink Bollworm and Hemipterous Cotton Insects. By L. W. Noble. Pp. 16. 10 cents Farmers' Bulletin No. 2084: The European Corn Borer and Its Con trol. Pp. 20. 15 cents. Home and Garden Bulletin No. 46. Insects and Diseases of Vegetables in the Home Garden. By L. B. Reed and S. P. Doolittle. Pp. 64. 25 cents. Picture Sheet No. 21: Pink Boll worm. Pp. 2. 5 cents. (Washington, D.C.: Government Printin Office, 1955.) [22

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 36 No. 6 (June 1955): Cancer in Adults Before Midlife. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [22

Durban Museum Novitates. Vol. 4, Part 12 (30th June, 1955): Mordellidae and Scraptiidae in the Collections of the Durban Museum. 29: Contribution to the Knowledge of Mordellidae and Scraptiidae By Dr. Mario E. Franciscolo. Pp. 161–186. Vol. 4, Part 13 (31st July, 1955): Results of the Durban Museum Ornithological Expedition to Pondoland in August, 1954. By P. A. Clancey. Pp. 187–214. (Durban: Durban Museum and Art Gallery, 1955.) [228

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 113, No. 4: A Study of LeConte's Species of the Chrysomelid Genus *Graphops* with Descriptions of Some New Species. By Doris H. Blake. Pp. 263–301+6 plates. Vol. 113, No. 5: The Permian Reptile Araeoscelis Restudied. By Peter Paul Vaughan. Pp. 303–469+2 plates. Vol. 113, No. 6: A Revision of the Australian Ant Genus *Notoncus* Emery, with Notes on the other Genera of Melophorini. By William L. Brown, Jr. Pp. 471–494. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1955.) [228

University of California Publications in Botany. Vol. 28, No. 1. A Study of Half-Chromatid Fragments in Meiosis of the Hybrid Bromus Trinii × B. Maritimus. By Marta Sherman Walters. Pp. 18+2 plates. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1955.) 35 cents. [228

# SCIENTIFIC BOOKS AND PAPERS

HE paper entitled "The Tower of Babel: the Language Barrier in Science" which Mr. B. C. kery presented before the Library Association at annual conference at Southport on September 22 ls with some aspects of the communication of owledge and ideas with which the scientist is ticularly concerned. Mr. Vickery discussed more ticularly the difficulties which language differences ate in communication between scientists; and his servations on the question of translations, made m the point of view of one who is librarian in the ers Research Laboratories of Imperial Chemical lustries, Ltd., deserve the attention of the research rker and technologist quite as much as that of the rarian. Moreover, some comments on the multicity of scientific and technical periodicals have turbing implications for the scientist and techlogist as well as for the librarian.

Mr. Vickery approaches the whole subject with the m purpose of attempting to remedy the inadeacies of modern methods of communication by the nted word, and not the least merit of an admirable rvey is that he sets his problem in the context of lucid historical survey, which incidentally disposes any claim for French as the major medium of mmunication at any time in the scientific world. e starts, however, by referring to a protest made Dr. Ancel Keys some five years ago in *Science* on e appearance of a periodical, the *Acta Physiologica lonica*, written entirely in Polish. This represented break with the pre-war practice of the Central ropean countries of providing summaries in rman, French or English when the text of the pers appeared in a minor language. The protest inted out that in modern times the overwhelming ajority of scientific work is published in English, rench and German, with an increasing proportion Russian, and to a lesser extent in Italian and anish. This protest brought a reply that to require inority linguistic groups to publish in languages her than their own would be to handicap whole ations of scientists, and it was argued that the real fficulty was that all countries are publishing in so any varied languages. Dr. J. E. Holmstrom has timated that about fifty per cent of the world's ientific papers are written in English, about fifteen r cent each in French and in German, perhaps ten r cent in Russian, while the remaining ten per cent are ublished in other languages, including two to three r cent in Spanish. That estimate alone sufficiently lustrates the unrealistic character of the reply to r. Keys's protest, nor is that comment substantially fected if Mr. Vickery is correct in his assumption at the situation is likely to get worse. The proortion of scientific periodicals published in Russian as probably doubled in the past twenty years, and may well be true that the importance of Russian d Japanese and possibly Spanish will continue to crease and that of French and German to decrease. does not, however, seem reasonable to anticipate, on the most chauvinistic forecast, that the contributions of each linguistic group will in the foreseeable future be proportionate to its size. Chinese may come to assume major importance; but there is little evidence as yet of any vernacular language emerging in India or Pakistan capable of overcoming the practical difficulties involved in replacing English as a *lingua franca* of scientific communication.

Such a forecast, indeed, implies a political climate most unfavourable to continued scientific advance, and happily in sharp contrast with that manifested at the recent international conference at Geneva on the peaceful uses of nuclear energy. There was little support for such pessimism in the atmosphere of that conference, and such forecasts entirely overlook two important restraining factors, one primarily psychological and the other financial. If nationalism prevails to the extent implied in Mr. Vickery's prediction, we are more likely to re-enter the dark ages than to approach one of free communication of ideas and unrestricted scientific and technical advance.

The psychological factor is indicated in the valid comment, made in replying to Dr. Keys's protest, that it is much more difficult to write a paper accurately in a foreign language than it is to translate a paper from a foreign language. That is true; but it equally follows that a paper is likely to be more accurate if the writing into a foreign language is done by the author himself or in association with the translator, than when done by some translator not in direct touch with the author. If our primary concern is for accuracy, we can scarcely escape association of the author with the task of translation.

The real factor, however, as is well realized, for example in the Scandinavian countries, is that a nation using what may be termed from a world point of view a minority language cannot escape bilingualism if it desires to attain high standards of culture and scholarship. It cannot afford to cut itself off from direct access to the world's literature or from discussion with professional men in other countries of new advances in science, in technology, in art and sociology, which limiting itself to its own language would involve. The choice of which major language to use may be difficult, and Mr. Vickery may be quite right in predicting that the Asian peoples may adopt Chinese and possibly some other indigenous language as a *lingua franca* throughout that area. But that the scientist in Java, in India, in Japan, in Nigeria or elsewhere can keep himself abreast of scientific advance in the world by relying solely on a knowledge of his own vernacular, and that he will not acquire a working knowledge of at least one major scientific language, is inconceivable. It ignores, in fact, the scientist's own desire to publish his work where it will be known and read by his scientific colleagues whatever their race.

The financial factor is likely to restrain excessive nationalism still more effectively. Even in Great Britain, major scientific societies such as the Chemical

Society with a membership of several thousand find great difficulty in meeting the mounting costs of publication. Nationalism could indeed induce Governments to bear a large proportion of the costs of publication if national prestige is involved. But in countries where the demands on Government are likely to be greatest if publication of new scientific and technical periodicals in a minority language is to be possible, economic resources are already stretched and limited, and there are likely to be strict limits to the support which the Governments can give to ventures that promise no solid return and only pander to national vanity.

Nor can the prospective publisher of such new scientific and technical periodicals count on a wide overseas demand. Few scientific and technical libraries are even now able to subscribe to all the scientific and technical periodicals they wish, or to buy the number of copies of individual periodicals that efficient service would suggest. The figures for expenditure on periodicals by the university libraries of Great Britain, which are given in the annual returns from universities and colleges issued by the University Grants Committee, show not only how limited are the funds expended for that purpose, but also how far over the past decade or more such expenditure has failed to keep pace with the mounting costs of scientific and technical periodicals. Figures given for a few of the larger technical college libraries by Mr. C. H. Wright in a paper in *The Engineer* last May show that even such major institutions as the Manchester College of Technology, the Royal Technical College, Glasgow, the Northern Polytechnic and the College of Technology and Art, Leicester, have to be severely selective in their range of periodicals.

It is unrealistic to assume that to-day a new scientific or technical periodical can count on more than a limited volume of support, unless in most exceptional circumstances. From the purely scientific or technical point of view, everything points to the desirability of counteracting the unavoidable tendency to specialization by concentrating publication in a relatively few major periodicals in languages which are widely understood and read. From that point of view it could, of course, be urged that use of some one universal language would have an overriding advantage without tending to encourage chauvinism. Apart, however, from the practical difficulties in selecting such a language, Mr. Vickery's historical survey suggests that for the present, in any event, such a proposal is unrealistic and premature, even if we discount somewhat the development of vernacular literature in Eastern Europe, Asia and Africa.

Mr. Vickery concludes from his survey that science has been faced twice before with a great language problem, and that each time the barrier to scientific communication fell to an organized attack on it by men of great zeal and scholarship, patronized and financed by the highest authorities in the land. It is not necessary to adopt that conclusion without reserve in agreeing with him that the pressing and more complex problems of scientific and technical publication in Britain can only be solved by a similarly grand plan of attack. Mr. Vickery does outline such a plan, but he makes several sound gestions as to what is needed, and these suggest call for study and support by professional bodies learned societies as much as by librarians.

The first need, Mr. Vickery suggests, is for effec bibliography—a list of all books and papers lished. Although, as he rightly remarks, this prim need is at present only imperfectly met and ther much overlapping, it should be noted that the scie centres of Unesco are attempting to deal with problem and have done something to meet the ne of the Middle East, Asia and the South Ameri countries. The second need, he suggests, is translations, or at least précis, of the more import papers. This need Mr. Vickery discusses in m detail, without, however, indicating the extent which use is made of English in this respect. rightly emphasizes, however, that attention sho be concentrated on the major scientific periodic and to do so would probably encourage the inher tendency of the scientist to publish in the m widely read and used periodicals.

On the third need, for more facilities for gett translations of any particularly useful paper, Vickery brings out the inherent difficulties as gards speed, accuracy and cost, emphasizing need for more good technical multi-lingual dicti aries and for scientists with a good knowledge of t or more languages. He indicates something of possibilities of mechanical translation but emphasi the need for further organization and co-operation this field, including the formation of scientific tra lation bureaux. He does not claim that his su gestions are novel but merely that they contin current trends.

What is needed, Mr. Vickery argues, is the co certed planned attack on the whole problem scientific communication already mentioned. T prelude to such collaboration of scientists, translato and teachers as he suggests would seem to be preliminary study of the various aspects of t problem by professional bodies and learned societi of the scientific world, as well as by librarians a information officers. A weakness of Mr. Vickery survey is, in fact, the omission of any reference what has already been done in this field by t Abstracting Board of the International Council Scientific Unions. Co-operative efforts in physi have now extended to chemistry and promise cover biology and mechanics also, while the feasibili of a comprehensive Russian to English translati service has been explored and an initial effort start by the American Institute of Physics. A lead clearly required by the scientist, however, a that lead should not only emphasize the vit importance of free communication of knowled and ideas, but also the incompatibility of scienti advance with the nationalism which in the pa forty years has done more than anything else hinder communication and obstruct scientific a vance. On that issue neither the self-respect of t scientist nor the prudent use of resources permi compromise.

# THE UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION

## e Story of FAO

y Gove Hambidge. Pp. xii+303+30 plates. (New
ork : D. Van Nostrand Company, Inc. ; London :
acmillan and Co., Ltd., 1955.) 48s. net.

OF all the activities of the United Nations, none seems likely to have more lasting effects than e Food and Agriculture Organization, often known FAO for short, and not to be confused with FOA, e Foreign Operations Administration of the United ates, which sometimes operates alongside though ways in harmony and with no overlapping. The od and Agriculture Organization was founded in uebec in October 1945 with the purpose of carrying the "War against Want" which was one of the clared purposes of the historic Atlantic Charter, d the tenth anniversary was but recently celeated on October 15 last in the Organization's birthace. The British people can justly feel proud of e leading part played in its foundation by Stanley L. Bruce, now Viscount Bruce of Melbourne ; F. L. cDougall, also of Australia ; and John Boyd Orr, ow Lord Boyd Orr. Bruce's famous speech at the eague of Nations meeting in 1935 directed attention the anomalous situation that had then arisen : griculture in the advanced countries was seriously epressed because farmers could not sell the food hey were producing, and they were advised to roduce less, while in the less-advanced countries illions of people went hungry and suffered accordgly in health and efficiency. He urged the imperative ecessity of effecting a "marriage of health and agriulture". The idea gradually developed. A few years ter (1942) McDougall proposed the establishment f a Food and Agriculture Organization of the United ations to study problems of nutrition and food upplies in the different countries and to foster reater output wherever necessary ; by 1945 the rganization was established with John Boyd Orr s head. An account of its achievements is now given y the well-known American agricultural writer, ove Hambidge, in the present book.

No fewer than seventy-one countries contribute to he Organization ; but the largest part of the cost—0 per cent—is borne by the United States, and the econd largest—10·5 per cent—by Great Britain, this eing the relative numbers of the population, though relation to the national income per head the ritish contribution is double that of the United tates. The budget for the ordinary programme of ork is 6 million dollars annually.

Its best-known work is the *Survey of the World ood Supplies*, produced periodically, which shows ow much food each country is producing and xpresses the results as calories supplied per head er day ; these are compared with the numbers onsidered desirable. These statistics are the best vailable ; unfortunately, the U.S.S.R. and its atellites do not participate, so that they have to be xcluded from the tables, and we have little trustorthy information about their food resources.

More important than the statistical records is the echnical aid offered to the countries where the food upplies are obviously inadequate. This began in a mall way at the Geneva Conference in 1947 and was reatly extended after the 1950 Technical Assistance Conference of the United Nations when fifty governments subscribed some 20 million dollars for technical aid. The United States contributed 60 per cent of this sum, 29 per cent being for the Food and Agriculture Organization and the rest going to the World Health Organization, Unesco and other bodies. The story of the resulting achievements occupies a large part of the book.

The first important operation was in China, where a campaign was started against rinderpest, estimated at that time to be killing a million animals a year there. Fortunately, a vaccine had been discovered during the Second World War, the search having been stimulated by the fear that the Germans or the Japanese might liberate the virus in North America and so wipe out the cattle population. Suitable methods of use in China were worked out. Chinese technicians were trained, and the programme included the vaccination of some fifteen million cattle. Other important agricultural improvements were also undertaken and large sums of money had already been spent when for political reasons the teams had to leave China late in 1948. Similarly, much good work was started in Poland and Czechoslovakia ; but these countries also withdrew from membership, leaving the work uncompleted.

Elsewhere, however, very valuable results have accrued : animal diseases have been better controlled, and higher output of food crops achieved. Tests have been made in a number of countries of hybrid maize, one of the United States' great gifts to the world : it is proving very valuable in the Central and Eastern Mediterranean countries, giving up to 50 per cent higher yield than the older sorts, and it now forms some 30 per cent of the Italian crop. In Siam, fish culture in ponds is being extended to make good some of the shortage of protein in the people's diet ; in the Arabian peninsula joint action against locusts has been organized ; much work is being done on rice ; and R. O. Whyte and his team have promoted surveys of the grasslands of India and other countries.

No less than fifty-three countries are being helped by the Food and Agriculture Organization, and some three hundred experts are engaged in the field. Steps are taken to train local people to continue the work after the Organization's teams leave. It is a great enterprise never before attempted in the history of the world, and the sincerest wishes for its success must go out to the director-general, P. V. Cardon ; the director of the very important Agricultural Division, F. T. Wahlen ; and all the staff.

E. John Russell

# SURVEY OF CANCER

## One in Six

An Outline of the Cancer Problem. By Dr. I. Hieger. Pp. 80+15 plates. (London : Allan Wingate (Publishers), Ltd., 1955.) 12s. 6d. net.

IT is almost as difficult to review a popular book on cancer as to write one, and for similar reasons. The subject ranges over such a vast canvas that one is always acutely aware of numerous important omissions and of the minor distortions which inevitably appear. No one can assimilate all the facts, and a selection tends to be confusing without the aid of an accepted unifying concept of the nature of cancer. In writing a short popular account, one is compelled to stress those aspects most dominant in one's own experience, and Dr. I. Hieger naturally stresses the important role of the chemical carcinogens in etiology. He was in the team which first isolated from coal tar a pure chemical carcinogen, and he gives us the most interesting story of this pioneer discovery. Moreover, we have seen lately the firm linkage of exposure to tobacco and industrial smoke to the tremendously rising incidence of lung cancer. Up to now, the types of human cancer with a definitely proved relation to exposure to chemical carcinogens, though important, were a small part of the human total. If it is shown that lung cancer is in fact due to exposure to chemical carcinogens in smoke, their practical significance in human cancer will become of greatly enhanced importance.

It is possible that these statistical findings have stimulated the author to write this book and to devote one out of the five chapters to lung cancer. Even here, however, while the firm evidence for its relationship to cigarette-smoking is clearly presented, the assumption that this is due to the carcinogens undoubtedly present in the smoke, even if in very small concentration, cannot yet be justified. Of course, even if this assumption is not true, it will not affect in the slightest the practical danger of heavy cigarette-smoking. But knowledge of the real mechanism could very well affect profoundly our mode of approach to the millions of cigarette smokers, a substantial proportion of whom may, on the basis of a simple carcinogen hypothesis, be doomed to die of cancer of the lung. This illustrates one of the difficulties inherent in the popular approach to an enormously complicated subject which also has profound applications to the welfare of man—so profound indeed that the average man manages to forget about it completely and, short of man-handling, cannot be induced to listen to a popular lecture on the subject.

It is difficult to know how far any popular book on cancer can give anything but a confused idea of the present trends in research. It can, of course, state what some of them are and indicate some of the major advances of the past. Long experience of teaching medical students reveals that the great majority of them retain only the haziest notion of even the most elementary facts about cancer research, despite having received systematic instruction. This suggests only a faint possibility that the ordinary layman will derive any clear picture from popular accounts at the present time. On the other hand, the scientist would find much of the present book too elementary in his own field, and would get an incomplete idea of the scientific basis of the problem in other fields. This is not a criticism of this book in particular, which is a fairly good specimen of its kind. It is quickly read and gives quite a lot of interesting statistical information about cancer mortality-rates. Here, incidentally, the author brings out the point that the overall cancer death-rate, adjusted for age grouping, has not significantly altered during the past forty-five years. He does not comment on the disturbing fact that while diagnostic methods have continually improved and treatment facilities widely expanded, the mortality from cancer remains practically the same. The cancer problem is full of such paradoxical facts; and since all are subjects of debate and argument, it would be unfair to expect any writer to enter into these controversial issues in a popular account. The reader who would like to know something about a few of the many thousands of facts which cancer research has elucidated should turn to Dr. Hieger's book, for it is some ti since we had a popular book from an establisl scientist in the field. The book, therefore, has merit of being reasonably up to date.

H. N. Green

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# THE TEACHING OF MODERN PHYSICS

**Introduction to Experimental Physics**

By Prof. William B. Fretter. (Prentice-Hall Phys Series.) Pp. viii+349. (London and Glasgo Blackie and Son, Ltd., 1955.) 35s. net.

THIS book consists of notes, taken at the ti and written up by Dr. W. B. Fretter, of lectu given by fifty-two lecturers in the University California, Berkeley. The chapters deal with a wi variety of subjects, from low-temperature work a spectroscopy to pile techniques and cosmic rays, within 344 pages. It is not surprising, therefore, th the information provided is exceedingly scrapp There is no consistent thread running through t book, and sometimes scarcely one going through single chapter.

Unfortunately also, the separate scraps are ther selves often incoherent. For example, ten pages a allotted to the subject of cyclotrons, including account of the principles of the ordinary cyclotr and the synchro-cyclotron. There is no picture what a cyclotron looks like, and no intelligib description of the ion source or of the radio-frequen system. Also, although phase stability is briefly d cussed, there is no general description of partic oscillations. Instead, the chapter looks like a set notes by a student who, already knowing a good de of the subject, jots down the points that intere him. These include very brief remarks of vario engineering items, mostly associated with the Berkel 184-in. cyclotron. This kind of treatment is qui typical, and in fact some other topics are even mo sketchily dealt with.

Although a student already well versed in t various subjects will certainly find many co siderations and ideas which he may not ha thought about, for a raw student the book would useless.

This is not the way to teach physics. A book or set of lectures should have as its main aim coheren This can be done at any level, elementary or advance If the book is to be advanced, since it should inclu a complete account of the subject, it will need to of appropriate length. It is not possible to tre thirty-two separate, mostly independent, topics at rather advanced level with on the average only eleve pages for each. If one takes at random any of th topics dealt with, say magnet design, this shou either be dealt with from an elementary point view in a book about electromagnetism, or, if on wants to go into detailed practical applications, special book would be required. A few pages miscellaneous information serve no purpose.

In any event, I think it is a mistake to try t teach elementary techniques in isolation. It is muc better to give a treatment dealing with all the aspec of the subject. For example, cyclotrons are be treated in connexion with the subject of nucle disintegrations. This is the usual method, and I a sure it is right.

H. W. B. Skinner

# NEW MONOGRAPH ON DDT

T

s Insektizid Dichlordiphenyltrichloräthan und
ne Bedeutung. Herausgegeben von Paul Müller.
d. 1. (Lehrbücher und Monographien aus dem
biete der Exakten Wissenschaften. Chemische
ihe—Band 9.) Pp. 300. (Basel und Stuttgart:
khäuser Verlag, 1955.) 37.50 Swiss francs;
.50 D. marks.

HE insecticide DDT has been well known for a dozen years, though latterly a number of new nthetic compounds have emerged to challenge its periority in various fields. However, there are t so many new types of insecticide as may appear m the lists of names; most of the newcomers long either to the chlorinated terpene group (to ich γ-benzene hexachloride is toxicologically ied) or to the phosphoric acid series. The dis-very of a new class of insecticides is, in fact, rare. DT marked such an advance that it is generally nsidered to have opened a new era of pest control, d it continues to be widely and satisfactorily used r many purposes.

A few years ago Dr. P. Müller, of Geigy, who was rgely concerned with its discovery, decided that e time was ripe for a new monograph on DDT. he first volume has now appeared, in the form of symposium of five sections, by Swiss, British, ustrian and Swedish authors. Four of the contri-utions are in German and one in English, with ummaries in the alternative language. One or two ooks on DDT have already been published, though one recently. About the best was that by T. F. est and G. A. Campbell (1950); but these authors dmitted delays in publication, and their text contains o reference later than 1946. (To remedy the efect, they added a supplement of more than eight undred references for 1947 and 1948, which gives me idea of the enormous output of papers on the ubject.)

The present monograph takes the account up to 953; but the more recent work has added very ttle to the data on physical and chemical matters hat comprise Section 1, by Dr. Müller himself. ection 2, by Prof. V. B. Wigglesworth, summarizes ur knowledge on the mode of action of DDT, this ontribution being by far the most generally inter-sting. It begins by considering factors involved in he contamination of insects by DDT and continues o the final minutes of intoxication—so far as they re known. This lucid survey integrates the findings f 137 papers, 80 per cent of them published between 946 and 1951. After reading it, we still do not now how DDT kills; but the possibilities are greatly arrowed.

The remaining contributions are of a more practical ature and deal with the use of DDT against parti-ular types of pests. Section 3, by Dr. E. Bernfus, f Vienna, deals with the control of stored product ests, especially those of breweries. In view of the erious importance of toxic residues, methods are escribed for determination of DDT traces in food. ection 4, by Dr. O. Walchli, of St. Gallen, ustria, discusses the use of DDT for protecting oollen textiles against clothes moths and carpet eetles. The final section, on control of forest insect ests, is by Dr. V. Butovitsch, of Stockholm. It ives full details of spraying and dusting by aircraft nd from the ground against the woodland pests. No information on control of agricultural and horticultural pests is given in this volume, nor are insect disease vectors or parasites mentioned; no doubt they will receive attention in the next volume.

J. R. BUSVINE

# GEOPHYSICAL RESEARCH IN NORTH AMERICA

Advances in Geophysics
Edited by H. E. Landsberg. Vol. 2. Pp. x+286. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 7.50 dollars.

THIS volume is the second in a series. It contains five essay reviews, each approximately fifty pages in length, dealing with recent advances in various branches of geophysics. Each is by a separate author or authors; but the whole volume is edited by H. E. Landsberg, of the United States Weather Bureau, assisted by a small advisory committee. As might be expected of a composite work of this kind, the style and quality of the different contributions vary considerably; but, on the whole, a high standard is maintained. Each essay contains a good bibliography, and author and subject indexes are provided.

In the first essay, on advances in radar weather, J. S. Marshall, W. Hitschfeld and K. L. S. Gunn (McGill University) describe typical precipitation patterns and give an outline of the ways in which quantitative data can be derived from radar signals. In "Methods of Objective Weather Forecasting", by I. I. Gringorten (Air Force Cambridge Research Center, Cambridge, Mass.), various objective methods of weather forecasting are classified, and the success and future objective of such systems discussed. W. J. Pierson, jun. (Department of Meteorology and Oceanography, New York University), discusses wind-generated gravity waves, and gives an outline of mathematical methods of describing such waves. This can be applied to analyse the form and motion of actual waves at sea. Some practical methods of observing and forecasting are also considered. In the essay on geological chronometry by radioactive methods, J. L. Kulp (Lamont Geological Observatory, Columbia University, New York) gives brief accounts of the lead, carbon-14, strontium, potassium, helium and ionium methods of radioactive dating and also reviews some other potential methods. The final essay is on earthquake seismographs and associated instruments, by H. Benioff (Department of Seismology, California Institute of Technology). The progress in design during the past twenty-five years is illustrated by short descriptions of some thirty different types of seismograph; advances in methods of recording and time-keeping are also summarized.

The whole volume is written and produced in North America. It is not surprising, therefore, to find that most of the work described has been carried out either in the United States or Canada. Within this field, the reviews are fairly complete; but they could be improved if research carried out in other countries were more fully treated. As a series of reviews of recent geophysical work in North America, this book can be strongly recommended, and future volumes in the series will be awaited with interest.

B. C. BROWNE

## SOME RECENT EXPERIMENTS IN FRICTION*

### Friction of Solids at High Speeds

MOST of our earlier experiments on friction have been conducted at low or moderate speeds of sliding which come within the range that an engineer might normally use. These speeds rarely exceed 30 m./sec. (70 m.p.h.). It has been shown[1] that, even at low speeds, a localized heating can occur and cause a softening or melting at the summits of the surface irregularities. On prolonged sliding this causes surface flow and polishing, but the heating is concentrated mainly in the very small regions of intimate contact. At low speeds the friction of metals is due primarily to adhesion and shearing of the contact regions, and the surface damage is characteristic of this. More recently, we have been studying the behaviour of surfaces sliding at very high speeds—up to 1,000 m./sec. (2,200 m.p.h.). An engineer would certainly regard such speeds as excessive ; but they are reached, for example, by the copper driving-band of a shell when it is leaving the muzzle of a gun.

In the laboratory these speeds can be achieved by using a technique which has been developed by Beams[2] for his ultracentrifuge. A steel sphere is suspended by an electromagnet, its top is illuminated and the shadow falls on a photoelectric cell. If the ball sinks, the current in the magnet will increase ; if it rises, it will decrease so that the ball is held in a stable vertical position. It can be caused to spin by a rotating magnetic field. If the ball is surrounded by an evacuated glass chamber, the forces opposing its rotation will be very small and it will soon reach a very high speed (more than a million revolutions a minute for a steel ball of ¼ in. diameter). The speed is limited only by the rupture strength of the ball. As the top of the ball is illuminated, an etch mark can be detected by means of a photomultiplier cell and transmitted to a cathode-ray oscillograph or an electronic frequency meter and recorder. The sliding speed can thus be measured accurately.

In our friction experiments the fast-spinning ball rubs against three symmetrically arranged vertical surfaces as shown schematically in Fig. 1. All three are initially in such a position that they cannot interfere with the ball during its acceleration. Two of them are mounted rigidly, and when the desired speed is reached, a spring is released which pushes the third surface against the ball and thus moves it a very short distance sideways until it also touches the other two stationary surfaces. A measurement of the deceleration under the known load gives the coefficient of friction.

If the spring-operated surface is withdrawn, the ball returns quickly to its free-spinning position and can be slowed down in such a way that the high-speed wear marks are not further damaged. In th way it is possible to measure the friction and t study the physical processes occurring over a gree range of speeds, up to 1,000 m./sec. The result plotted in Fig. 2 were obtained with a steel bal bearing of ¼ in. diameter rubbing against surfaces ( copper (curve *A*) and of bismuth (curve *B*). Th load was 20 gm. The friction was measured immedi ately after the sphere had touched the surface Both metals show a very great decrease in th coefficient of friction as the speed is increased. Th low values measured at high speeds are striking, sinc the surfaces are clean and in a moderate vacuum

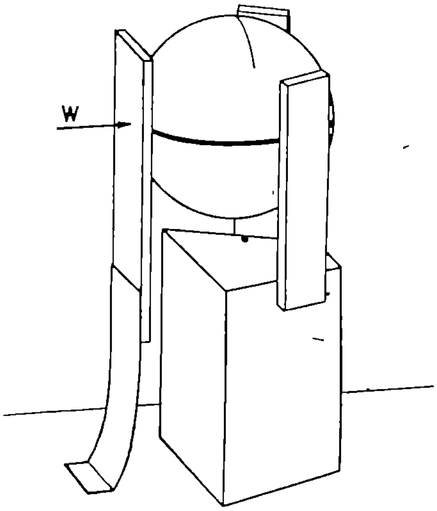

Fig. 1. Arrangement for measuring friction at high speeds (load *W*)

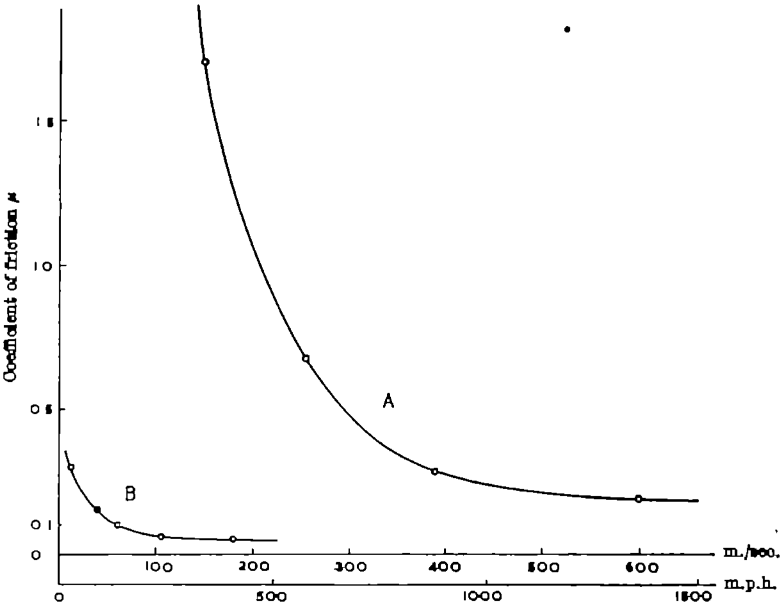

Fig. 2. Friction of metals at high speeds : (*A*), steel on copper (m p. 1,083° C.) ; (*B*), steel on bismuth (m.p. 271° C.). Load 20 gm.

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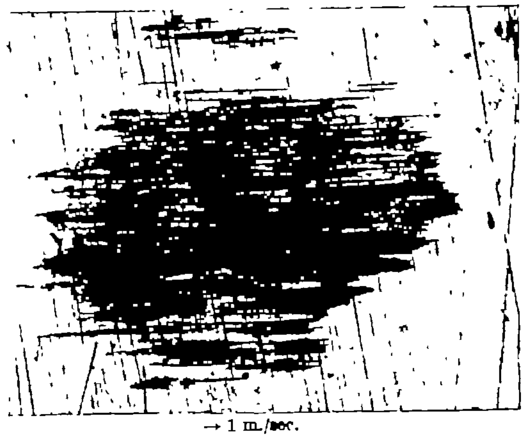
* From a Friday Evening Discourse given at the Royal Institution, London, on May 6.



ig. 3(a). Slow-speed sliding wear on copper, showing normal abrasion (× 160)

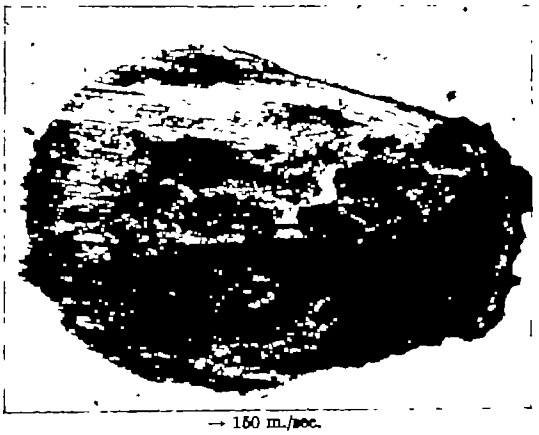


Fig. 3(b). Medium-speed sliding wear on copper, showing flow of metal (× 160)

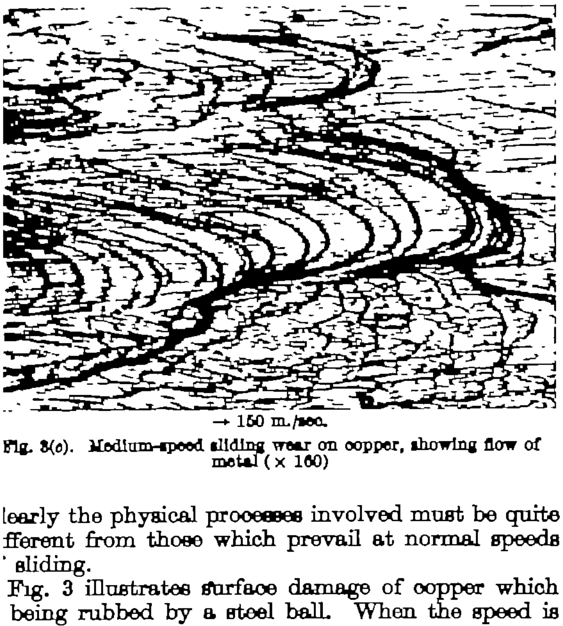


Fig. 3(c). Medium-speed sliding wear on copper, showing flow of metal (× 160)

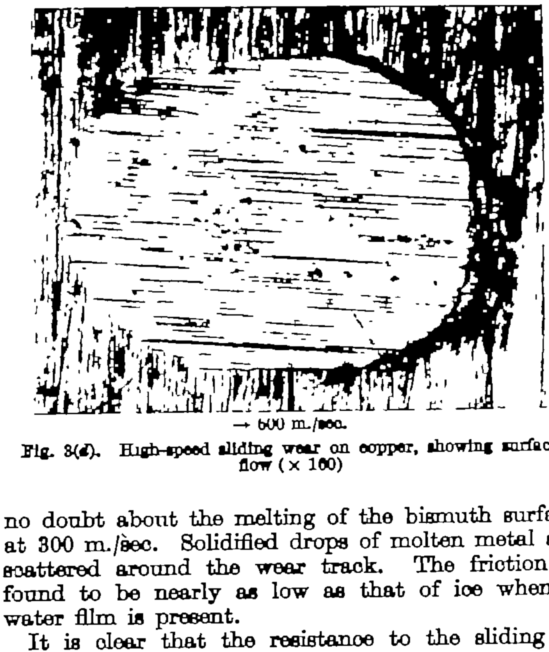


Fig. 3(d). High-speed sliding wear on copper, showing surface flow (× 160)

learly the physical processes involved must be quite fferent from those which prevail at normal speeds sliding.

Fig. 3 illustrates surface damage of copper which being rubbed by a steel ball. When the speed is ıly a few metres per second (Fig. 3a) the copper ırface shows the characteristic marks of abrasion. ne would expect a high friction, and in a vacuum, ıce the oxide films are removed, seizure occurs. At 50 m./sec. (Fig. 3b) the surface damage is clearly of new type. The copper is flowing, and a considerable nount of it (up to 0·5 mgm.) is picked up by the eel ball. The coefficient of friction is reduced to out 1·5, but a deceleration from this speed would pidly lead to seizure. The flow of copper after ore prolonged rubbing under the same conditions 50 m./sec.) is illustrated in Fig. 3c. If the sliding faster (Fig. 3d), the surface layers of copper pproach the molten state and may act as a lubricant the same way as water on ice (see below). The iscosity of molten copper is of the same order of agnitude as that of water. The coefficient of friction 600 m./sec. falls to the very low value of 0·2. As on as the rubbing surfaces are separated, the copper lidifies to form a relatively smooth shiny surface. he wear per unit distance slid is very much less an that observed at normal speeds.

With bismuth, which is a bad thermal conductor nd has a low melting point, the surface melting and w friction should occur more readily. Fig. 4 leaves no doubt about the melting of the bismuth surface at 300 m./sec. Solidified drops of molten metal are scattered around the wear track. The friction is found to be nearly as low as that of ice when a water film is present.

It is clear that the resistance to the sliding of metallic surfaces is not constant but can fall to very low values at high speeds. At these speeds the wear

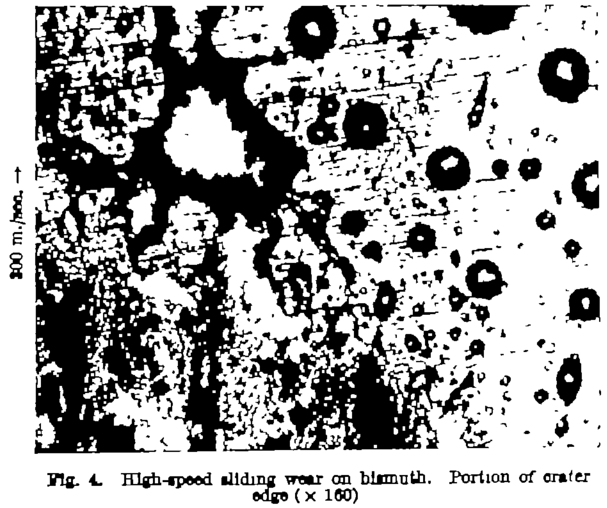


Fig. 4. High-speed sliding wear on bismuth. Portion of crater edge (× 160)

per unit distance of sliding is also very much less than that observed at normal speeds. There is evidence, both from the frictional behaviour and from the examination of the surface, that this behaviour is due to the formation of a thin layer of molten metal which acts as an effective lubricant film.

F. P. Bowden
E. H. Freitag

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## Friction on Snow and Ice and the Development of some Fast-Running Skis

We may draw an analogy between the mechanism of the friction of metals at very high speeds and that of skiing. Ice is an interesting solid from the frictional point of view because its friction can be lower by an order of magnitude than that of other crystalline solids. Osborne Reynolds[3] suggested that the low friction in skating was due to a water film formed by pressure melting. Some years ago an experimental study[4] of the friction of snow and ice was made at the Jungfraujoch Research Station. The friction of cold snow or ice is very high; it is only near 0° C. that the friction is low. The experiments supported the view that the low friction is due to surface melting. They showed, however, that pressure melting is a factor only at temperatures very close to 0° C. and with slow-moving surfaces. If the sliding speed is appreciable and the temperatures are below 0° C., the local surface melting is produced, not by pressure melting but by the frictional heating of the sliding surfaces. Under the conditions which exist in skiing and sledging, it is this frictional heating and melting which is the major factor responsible for the low friction. Experiments with sliders of different thermal conductance were in harmony with this view. These early experiments were carried out with miniature sliders.

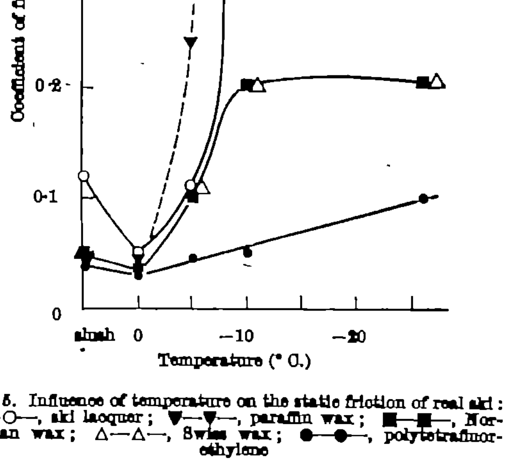

Fig. 5. Influence of temperature on the static friction of real ski: ○—○—, ski lacquer; ▼—▼—, paraffin wax; ■—■—, Norwegian wax; △—△—, Swiss wax; ●—●—, polytetrafluorethylene

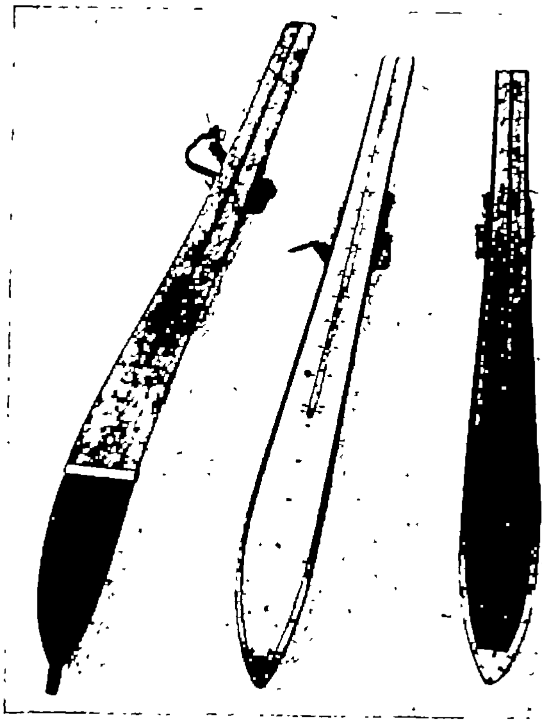

Fig. 6

Recently[5], the experiments have been extended real skis, and a study has been made of the behavio of some new plastic materials sliding on ice and sno The experiments support the earlier conclusions tha the low friction on snow and ice is due to a surfa melting produced by the friction-heating of the slidin skis. The rubbing of the ski at the localized point of contact of the snow crystals causes a surfa melting. Very cold snow or ice behaves like an other crystalline solid. At low temperatures th static friction (or the slow-speed friction) of ice high, and it is not until the ski begins to slide at a appreciable speed that the friction falls to a sma value. This is illustrated by Table 1.

Table 1. Influence of Speed on Friction. on Ice at − 10°

| Ski surface | Coefficient of friction: Static | At 3 cm./sec. | At 5 m./sec. |
|---|---|---|---|
| Waxed wood | 0·20 | 0·18 | c. 0·02 |
| Lacquered wood | 0·40 | 0·36 | c. 0·03 |
| 'Perspex' | 0·35 | 0·32 | c. 0·03 |
| Aluminium | 0·38 | 0·34 | c. 0·04 |

The influence of temperature on the static frictio of skis on snow is illustrated in Fig. 5: most of thes surfaces (except polytetrafluorethylene) are standar ones used in skiing. Two important points whic may be noticed from this figure are, first, that th friction for all these surfaces falls as the snow warm up and is at a minimum at 0° centigrade; and second, the very low friction given by the plasti material polytetrafluorethylene under all conditions An account of the general frictional behaviour o this material has been given elsewhere[6]. Method used for attaching the plastic to the skis are show in Fig. 6. The behaviour of polytetrafluorethylen on snow is due partly to its inherently good frictional properties and partly to the fact that it is not wetted by water. There is evidence that the frictional behaviour of different solids sliding on snow i ble 2. Timed Descents: Comparison of Waxed Ski with New Ski of Polytetrafluorethylene

Crystalline spring snow; air temperature 5° C.; snow temperature 0° C.; gentle slope of length 700 ft. (tracked)

| Weight on ski (lb.) | Time of descent (sec.): Conventional ski with Norwegian wax and paraffin | New ski of polytetrafluorethylene |
|---|---|---|
| 168 | 61 | 42 |
| 140 | 83 | 54 |

New snow fallen a few hours previously; air temperature 10° C.; snow temperature 0° C.; unloaded ski (tracked)

| Details of slope | Time of descent (sec.): Conventional ski, with ski lacquer | New ski of polytetrafluorethylene |
|---|---|---|
| Gentle, 20 m. long | 10 | 6 |
| Steeper, 30 m. long | 6 | 3 |

fluenced by the contact angle which the water film akes with the surface. With polytetrafluorethylene is contact angle is very high (126°), and it remains igh even after prolonged sliding on snow. This is ppreciably higher than the contact angle observed on axed surfaces which have been rubbed on snow. The xperiments suggested that polytetrafluorethylene might have interesting possibilities as a skiing surface, and several pairs of skis have been coated with it and tried out in the Alps under a variety of snow conditions during the past three years. Some timed straight-run descents under controlled conditions have also been made. The results are quite striking, some typical experiments being illustrated in Table 2.

It is clear that skis of polytetrafluorethylene are considerably faster under these conditions. They are easy to ski on, because they give a low uniform friction even when running on patchy snow. They should have useful applications not only to skiing but also to sledging and to aircraft landing, particularly on very cold, very wet or difficult snow and ice.

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# SOLAR ECLIPSES AND THE IONOSPHERE

ONOSPHERIC measurements at the time of solar eclipses may be expected to yield useful informa- ion on problems such as the nature of the ionizing adiation and its distribution on and outside the isible solar disk, on theories of the formation of the nosphere and of recombination processes within the arious layers. It has long been established that the rimary ionizing source of the *E* and *F*1 layers of the onosphere is solar ultra-violet light. This conclusion s amply confirmed by both long-term measurements nd by results obtained during solar eclipses. How- ver, in the case of region *F*2 the source is less clearly lefined; eclipse effects in this region are often com- lex and the interpretation of the observations mbiguous. Certain aspects of eclipse phenomena in ll the ionospheric regions were discussed at a ymposium on "Solar Eclipses and the Ionosphere" eld in the rooms of the Royal Society, London, luring August 22–24. The symposium was organized y the Mixed Commission on the Ionosphere and ponsored by the International Council of Scientific Jnions. Some twenty-five British and fifty-five verseas delegates participated.

Opening the symposium, Mr. J. A. Ratcliffe presented a general survey of ionospheric eclipse phenmena and discussed the eclipse effects to be expected n a simple Chapman-type layer. Eclipse results for egion *E* have been reconciled with the predictions f simple theory by supposing that the process of lectron loss is recombination-like with an effective oefficient $\alpha' \simeq 10^{-8}$ cm.$^3$ sec.$^{-1}$. In most cases it has lso been necessary to suppose that the intensity of he ionizing radiation is not uniform over the solar isk, and furthermore that a measurable fraction riginates outside the visible disk. In the case of egion *F*1, eclipse estimates of $\alpha'$ lie between 5 and × $10^{-9}$ cm.$^3$ sec.$^{-1}$, and for this region there is again vidence for enhanced radiation from the same areas hich contribute to the *E*-layer ionization. In the *F*2 layer complex eclipse effects are often observed, and here it is clear that consideration must be given to the influence of movements in the layer during the eclipse. An interesting phenomenon which has received attention during recent eclipses is the temporary appearance of a new critical frequency between the *F*1 and *F*2 critical frequencies. It has been suggested that this might correspond to a separate layer, the so-called *F*1½ layer, due to some special process of electron production. However, it can be shown that if the electron loss coefficient decreases upwards, then the appearance, during an eclipse, of a point of inflexion on the *h'f* curve between the *F*1 and *F*2 layer critical frequencies is to be expected.

Mr. C. M. Minnis discussed eclipse results for region *F*2 obtained at Khartoum, Singapore, Slough and Inverness during eclipses of 1952, 1954 and 1955 and stressed the desirability of always computing the electron density/true height profile, since deductions based only on critical frequency variations can be misleading.

Prof. S. Chapman outlined the development of ideas concerning a possible corpuscular eclipse effect in the ionosphere. The observed delay of about one day between certain solar disturbances and terrestrial magnetic storms indicates that the solar particles have an average speed of about 1,000 miles/sec., and for this speed the corpuscular eclipse might be expected to occur about two hours before the optical eclipse. This difference in time would, of course, result in a considerable difference in position on the earth between the optical and corpuscular eclipses. As far back as 1919 Chapman and Milne pointed out that a speed of 1,000 miles/sec. seemed quite inadequate for particles to reach the 100-km. level, and it is now believed that if there are any corpuscular eclipse effects these may be expected to be weak and to affect only a high layer in the ionosphere. Prof. Chapman also outlined the theory of the effect of an eclipse on the Earth's magnetic field. The reduction in the electron and ion content of the ionosphere during a solar eclipse reduces the conductivity; this modifies the electric current intensity and hence affects the transient variations in the earth's field. In general, the magnetic effect of an eclipse may be expected to be quite small—the precise magnitude and nature will depend on the location of the observing site with respect to the electric current systems in the ionosphere. At stations near the foci of these systems the eclipse effect may be expected in the vertical force, whereas in equatorial latitudes it should appear in the north horizontal force.

Recent successful measurements of geomagnetic effects during a solar eclipse were described by Mr. J. Egedal. Records of magnetic declination from fourteen observatories in Europe showed small but quite definite effects during the eclipse of June 30, 1954. The magnitude was of the order to be expected if the ionospheric currents concerned flowed near the level of region *E*. Dr. T. Nagata presented similar results for observations in Japan during the eclipse of May 9, 1948. In this case it was found that the magnitude of the changes in the east component were consistent with calculations based on the observed eclipse decrease in electron density in the *E*-layer.

One session was devoted to a discussion of present solar knowledge with particular reference to ionospheric studies. Prof. C. W. Allen showed that long-period ionospheric data for regions *E* and *F* require a quiet component from the whole Sun together with a component associated with centres of activity. Dr. M. A. Ellison discussed some ionospheric effects of solar flares, and Prof. D. R. Bates presented a short summary of present views concerning the theory of layer formation. The *D* layer is now believed to be due to photoionization of nitric oxide by Lyα, the *E* layer to X-rays centred mainly near 40 A., and the *F*1 and *F*2 layers partly to longer X-rays and partly to ultra-violet ionization of atomic oxygen. Mr. M. Ryle and Dr. J. P. Hagen respectively presented summaries of knowledge concerning the solar corona and chromosphere as deduced from solar radio noise studies.

A session on recombination in the ionosphere was introduced by Prof. D. R. Bates, who emphasized that recombination takes place through a complex variety of processes. For the higher layers the basic mechanism is probably dissociative recombination. In the case of the *D*-layer the position is still open. To explain the very large recombination coefficients for the *D*-layer, the mechanism might be negative ion recombination, it might be ordinary dissociative recombination or the process might involve complex ions. Prof. J. Sayers briefly outlined laboratory experiments on recombination processes now in progress in the University of Birmingham.

Measurements of effective recombination coefficients deduced from solar eclipse ionospheric observations were presented by Mr. C. M. Minnis, Dr. O. Burkard and Dr. K. Rawer. Mr. Minnis showed how the effective recombination coefficients deduced from eclipse measurements depend critically on assumptions concerning the amount of residual radiation at totality. He also showed that although it is often difficult to give accurate estimates of $\alpha'_E$ and $\alpha'_{F1}$, it is possible, both from measurements of the normal diurnal variations in $fE$ and $fF1$ and from eclipse observations, to obtain reliable estimates of the ratio $\alpha'_E/\alpha'_{F1}$. Dr. Rawer stressed the errors likely to be involved in evaluating effective recombination o efficients by applying an over-simplified theory eclipse observations. The usual assumptions monochromatic ionizing radiation, of an isotherm atmosphere and of simple recombination process are not satisfied, and in presenting future ionospher results he suggested that data should be given f parameters which are independent of any speci theories. Dr. Burkard considered ionospheric da for the eclipse of February 25, 1952, and showed th if the results are interpreted not in terms of the usu simple theoretical equilibrium equation but in term of a modified equation in which layer conditions a not assumed to be isothermal, then there is r necessity to assume a non-uniform distribution of t sources on the solar disk as had been done by oth workers.

Mr. W. R. Piggott discussed eclipse observatio of vertical-incidence ionospheric absorption at Ibada in 1952 and showed that eclipse changes in th absorbing region and in regions *E* and *F*1 a appeared to indicate similar (irregular) distributio of the emission of the ionizing radiation from th Sun. Interesting eclipse observations on the lowe ionosphere were described in papers by Dr. B Weekes and by Dr. E. A. Lauter.

In the final session of the meeting, Dr. S. I Gossner directed attention to some unusual ge metrical conditions pertaining to the solar eclipse c October 23, 1957. These conditions result from th fact that the axis of umbra will pass near the surface c the Earth without actually touching it and the centr lines will intersect the ionosphere twice. For vertica soundings this second intersection will take place i the general area of the Falkland Islands Dependencie

The principal points which would appear to hav arisen from discussions at this symposium are th following. In the case of region-*E*, some 10–15 pe cent of the ionizing radiation comes from beyon the visible solar disk. The uncertainty concernin the actual magnitude of this residual radiation mean that there is corresponding uncertainty about th effective recombination coefficients deduced fro eclipse observations. In interpreting eclipse result it is also very important to consider what is th appropriate value for the index *m* in the expressio $fE \propto (\cos\chi)^m$ ($\chi$ = solar zenith angle). In general experimental results do not fit the value predicted b simple theory, namely $m = 0{\cdot}25$, and during th discussions a number of possible causes for th observed variations in *m* were brought to light. I the case of region *F*1, the above difficulties are agai all present. It is clear that, in eclipse observation on this region, changes in the electron density/tru height profile and not merely changes in the critica frequency $fF1$ must be considered. In the case o region *F*2, similar profiles must also be calculated and the discussions also clearly brought out th importance of movements in this region. Severa speakers referred to the appearance of the $F1\frac{1}{2}$ trac during eclipse observations, and although som results suggested that this phenomenon is confine to places of low magnetic dip and to eclipses of larg magnitude, it was not clear that this is always th case.

During the symposium, limitations of time onl permitted the presentation of summaries of a few o the fifty papers submitted. These papers, togethe with the discussions, will shortly be published in a single volume by the International Union for Scientifi Radio.

W. J. G. BEYNON

# GEORGIUS AGRICOLA (1494–1555)

By JOAN M. EYLES

IF one were to ask a well-informed student of the history of science to name the three most important scientific books published in the first half of the sixteenth century, his first choice would certainly be the "De Revolutionibus Orbium Coelestium" by Copernicus, published in 1543. Next he would probably select the "De Humanis Corporibus Fabrica" by Vesalius, which also appeared in 1543. He would probably hesitate before making a third choice, and might possibly decide in favour of one of the great herbals, perhaps that of Leonard Fuchs, published in 1542. If reminded of Agricola, he might answer that this author's famous "De Re Metallica" was not published until 1556, and was, in any event, like the "Pirotechnia" of Biringuccio (1540), essentially a work on technology rather than science. It is unlikely that he would be acquainted with the contents of Agricola's earlier book, "De Ortu et Causis Subterraneorum", published in 1546, which consists of several treatises, the first of which gives the book its name. Yet it can be justly claimed that this book, which contains almost all that Agricola wrote on mineralogy and geology, laid the foundations on which these sciences were built, and entitles Agricola to be ranked equally with Copernicus and Vesalius as one of the really great sixteenth-century scientists.

In many well-known histories of science, the name of Agricola either does not appear at all, or is mentioned only in connexion with his great work on mining and metallurgy, "De Re Metallica". Wolf's "History of Science, Technology and Philosophy" is an exception, for its author does record some of the geological opinions of Agricola contained in the "De Ortu". These have been extracted from the excellent notes given by H. C. and L. H. Hoover in their well-known translation of the "De Re Metallica"[1]. However, Wolf, while realizing the importance of the views which he quotes, makes no attempt to appraise Agricola's standing among the scientists of the early sixteenth century.

Lack of appreciation of Agricola's "De Ortu" is not surprising, for in most general histories of science the evolution of geology, the one subject that forms a bridge between the biological and physico-chemical sciences, is allotted a very minor role. It must be admitted that this is largely the fault of geologists themselves, who by neglecting a rewarding field of research, have failed to arouse general interest in the subject.

The neglect of Agricola by modern geologists, particularly those of the English-speaking world (for his own countrymen have always been more appreciative of his merits), was recognized by the Hoovers when they wrote in 1912: "The wider interest of the members of the medical profession in the development of their science than that of geologists in theirs has led to the aggrandizement of Paracelsus, a contemporary of Agricola, as the first in deductive science. Yet no comparative study of the unparalleled egotistical ravings of this half-genius, half-alchemist, with the modest sober logic and real research and observation of Agricola, can leave a moment's doubt as to the incomparably greater position which should be attributed to the latter as the pioneer in building the foundation of science by deduction from observed phenomena. Science is the base upon which is reared the civilization of to-day, and while we give daily credit to all who toil in the superstructure, let none forget those men who laid its first foundation stones. One of the greatest of these was Georgius Agricola".

Agricola's life has been related in some detail by Hofmann[2], and more recently by Hartmann[3]. His surname was, in the vernacular, Bauer, but he had adopted the Latin version by the time his first book, a small Latin grammar, was published in 1520, and he retained this form thereafter. He was born in Glauchau, in the Saxon Erzgebirge, at a time when the leaven of the Italian Renaissance was already working in the universities of northern Germany. Therefore, when he went to the University of Leipzig in 1514, he was able to study Greek as well as Latin, first under the instruction of an Englishman, Richard Croke, who later became lecturer in Greek at Cambridge, and then under Petrus Mosellanus, father of humanism in Saxony. Agricola spent four years at Leipzig and after graduating was appointed vice-principal of the town school at Zwickau, a place of some importance near his home. The town council of Zwickau clearly appreciated the brilliance of the young teacher, for in 1519 they opened a new tri-lingual school, in which Greek, Latin and Hebrew were taught, with Agricola as rector. Three years later, however, he returned to Leipzig as lecturer, assisting Mosellanus; and about this time he began to interest himself in the study of medicine and philosophy. A desire to hear the most famous doctors and to read the texts of Galen in the original Greek took him next to Italy. Here he spent two years, mostly in Venice, where he was closely associated with the Aldine Press, and assisted in editing the great collected edition of Galen's works in Greek, which it issued in 1525.

On returning to Zwickau in 1526 he was, so he wrote later, burning with a desire to know more of the mines and minerals so abundant in the Erzgebirge. This region had for the previous fifty or sixty years been the scene of intense mining activity. Agricola had graduated in Italy as a doctor of medicine, and in 1527 he accepted the post of *Stadtarzt* (town physician) in Joachimsthal, a new mining town in Bohemia, on the south side of the Erzgebirge. There he was in a most favourable position for following up his new interests. The mines at Joachimsthal, at that time producing much silver, supplied, some 450 years later, the pitchblende used by the Curies in their researches on radioactivity. They were first opened up in 1516, and by the time Agricola arrived the population of the district was already some 10,000, nearly all miners and officials.

The first fruit of Agricola's interest in the mines was a small volume entitled "Bermannus sive de re metallica", published at Basle in 1530 by the Froben Press, which also published most of his later works. There is a foreword, praising the book, by the great humanist, Erasmus of Rotterdam. The text takes the form of a conversation between three learned men, one skilled in mining matters; and it contains descriptions of many minerals and ores. Its publication added to the reputation of Agricola, already renowned as a classical scholar, and his friends eagerly awaited further works on the subject from his pen.

In 1530 he gave up his post at Joachimsthal, and a few years later returned to Saxony, settling at Chemnitz, another mining centre, where he remained until his death in 1555. He was appointed *Stadtarzt* and in later years was several times *Bürgermeister*. Apart from a minor, though still valuable, work on weights and measures, he published nothing further until 1546, when the results of his many years of research in geology and mineralogy appeared in "De Ortu et Causis Subterraneorum".

Each treatise is preceded by a dedicatory letter to some friend or patron, and these letters often contain interesting information about Agricola himself. In one he lists the works he has yet to publish. Of these, some appeared in 1550, but the "De Re Metallica", the great work on mining and metallurgy so long awaited by his friends, was not issued until 1556, four months after his death. In the interim he had been called on to serve his patron, Duke Maurice, who became Elector of Saxony in 1547, in a diplomatic capacity. Maurice was a Protestant, and Agricola had remained a staunch Catholic during the stormy years of the Reformation. However, his writings reveal a tolerant outlook, and no doubt his wide knowledge and experience were valuable to the Elector, who sent him on various missions to the Emperor Charles V, Ferdinand, King of Hungary, and other princes. The rich mines of Saxony and Bohemia played an important part in the economy of Europe at that time, and probably Agricola's specialized knowledge made him a valuable intermediary. The Elector died in 1553, and was succeeded by his brother Augustus, who continued the patronage Agricola had previously enjoyed from Maurice. The text of the "De Re Metallica", dedicated to Maurice and Augustus, appears to have been completed by the end of 1550, but was long delayed, probably by the preparation of the several hundred woodcuts. In 1553 the completed book was sent to the Froben Press; but it was March 1556 before it appeared in print. Meanwhile, Agricola had died on November 21, 1555, from a sudden fever that lasted only four days. His position as a Catholic *Bürgermeister* in a fiercely Protestant town must have been anomalous, yet it is sad to learn his family were not allowed to bury him in the cathedral of Chemnitz, the town in which he had been so distinguished a citizen. Four days after his death, his body was conveyed to Zeitz, some forty miles away, and interred there, in the Catholic cathedral.

New editions and translations of his books, particularly the "De Re Metallica", continued to appear at intervals in the succeeding centuries, and a reprint of the Hoover translation was issued only a few years ago. No English translation of the "De Ortu" has yet appeared. For this reason it has been eclipsed in fame by the better known and beautifully illustrated "De Re Metallica". Nevertheless, it has every right to be regarded as a major scientific classic. Agricola brought to a study of the Earth and its constituents the touchstone of his own experience, and assayed the theories of earlier authors in the crucible of his profound knowledge of their writings, often finding the 'ore' to be of poor quality.

The "De Ortu" contains four new works and reprint of the earlier "Bermannus". Though eac treatise is self-contained, and the titles may appe unrelated, yet in fact their arrangement follows methodical plan. The first book, "De Ortu et Caus Subterraneorum", discusses the physical phenomen affecting the earth, in particular the part played b water; and Adams[4] comments that Agricola description of the earlier stages of erosion might we have been written in the twentieth century. Anothe of the topics in this treatise is the origin of or deposits, and here Agricola's reasoned view, tha ores were deposited from solutions in channels o fissures that had originated after the containing rock constitutes a remarkable advance on all previou speculations. The next two treatises deal with th constituents of the Earth. The first ("De Natur eorum quae effluunt ex Terra") discusses those which are vapours or liquids, and the second ("De Natur Fossilium") discusses solid bodies, for which he use for the first time, the word 'fossil'. The use of thi term to describe all substances dug out of the eart continued for well over two centuries, and it is onl since the beginning of the nineteenth century that i has been restricted to fossil organisms. The "D Natura Fossilium" is the first attempt at a systemati mineralogy, and in it Agricola describes man minerals for the first time. His classification of thes 'fossil' bodies has been described by Adams, but fact of considerable historical importance, which doe not appear to have been commented on by chemists is his recognition of the difference between chemica compounds ('mista') and mixtures ('composita'). The former, he states, are composed of two or more simple fossil bodies, so intimately mixed that "even in the smallest part there is not wanting any substance contained in the whole", and inseparable except by fire; whereas the components of the 'composita' can be separated not only by fire but also by water and sometimes by hand ("De Natura Fossilium", 1546, p. 185). This clear statement was made more than a century before that of Boyle in the "Sceptical Chymist". Boyle, incidentally, was familiar with the works of Agricola, whom he described as "the most classick author we have about mines".

Agricola's fourth treatise, on old and new mines and minerals ("De Veteribus et Novis Metallis"), contains a wealth of information concerning the situation of mines and the metals obtained from them. It is worth mentioning here that he gives a list of places in Cornwall where tin was worked, and refers to the meeting of miners from Cornwall and Devon every seven or eight years on "Hengenstendonus mons" (Hingston Down, twelve miles northwest of Plymouth) to discuss their affairs. This is later mentioned by Camden.

The "De Ortu" was translated into Italian in 1550, and other Latin editions appeared in 1558, 1612 and 1657; but the most useful edition for the student is the German translation, with many notes, which appeared during 1806–10. Unfortunately, this is as scarce as the earlier editions. An English translation would be most valuable and attract to the book the attention it undoubtedly merits. Meantime, one can say there is no question of placing Agricola among the great—he already stands there—but, unfortunately, almost unrecognized.

[1] London, 1912, reprinted 1950.

[2] Hofmann, R., "Dr. Georg Agricola" (Gotha, 1905).

[3] Hartmann, H., "Georg Agricola" (Stuttgart, 1953).

[4] Adams, F. D., "The Birth and Development of the Geological Sciences" (Baltimore, 1938).

# ENERGY EXPENDITURE BY MAN

IT is notorious that there are fashions in science. The discovery of a new approach in any branch of work tends to direct attention to a restricted spect: not until the cream has been skimmed by means of the new technique is a balance restored. The study of nutrition is peculiarly liable to such endencies: the discovery of vitamins ushered in a ruitful and major preoccupation with the fundamental biochemical processes of cellular metabolism, nd so did the appreciation of the importance of race elements. Indeed, the earlier interest in proximate principles' was well-nigh ousted, and the dictum, "look after the calories in food and the other onstituents will look after themselves", fell into a robably well-deserved disrepute.

In nutrition, however, there is a very special sense n which a balance of interest must be preserved. As individuals and as communities we must balance the intake and expenditure of energy: the energy we give to the world in the work of our muscles and n the heat of our bodies we must recapture from ood. If expenditure exceeds income, the body of the individual wastes away, and on a national scale amine is abroad in the land; if intake is greater han expenditure, the individual will suffer from the ethal nuisance of obesity, and in the community here will be a glut and, in default of adequate methods of storage, a waste of food. Thus it is not ufficient to concern ourselves solely with the intake of food, to make available what we believe to be a afe margin in excess of requirements. If it comes o the point that we have to adjust our expenditure o income, we shall have to know how best to use he energy available to us. To combat obesity, the usual practice is to recommend a restriction in intake of food. But a human being is not a mere machine. He has genetical roots stretching far into the past when his body was adjusted to a life of hard physical toil. To restrict the intake of food is to throw his physiological processes out of gear, and it is better, f the food is available, to adjust the balance by ncreasing exercise. That demands some knowledge of the time-course of energy expenditure in different activities.

At the beginning of this century there was considerable interest in human calorimetry, both direct and indirect, this interest being well illustrated in the successive editions of Graham Lusk's classical book "The Elements of the Science of Nutrition" (1906–31). For the reasons already mentioned, nterest in calorimetry lapsed but now shows signs of a revival, in part due to the introduction of new apparatus and in part due to a realization that, after all, calories do matter. It was not inappropriate, therefore, that the Nutrition Society should arrange this year a symposium on the "Energy Expenditure by Man", which was held in the National Institute for Medical Research, Mill Hill, on October 15.

The first paper at the symposium, on the development of experimental methods for determining the expenditure of energy by man, was given by O. G. Douglas. He explained briefly the theoretical bases of calorimetry and followed the changes in technique, primarily in indirect calorimetry, from the early days of Regnault and Reiset[1] in 1849 to the present time. There have been no changes in fundamental principles and surprisingly few variants in the technical approach to the problem. The determination of the expenditure of energy depends on measurement of the gaseous exchange between a living organism and the atmosphere which surrounds it. The earlier techniques tended to be elaborate and cumbrous. The animal or human being was enclosed in a chamber through which air was circulated by a pump. The oxygen used by the animal was replaced from outside the system, and carbon dioxide absorbed within the system. Such techniques restricted gravely the living activities which could be studied, although brave attempts were made to study muscular activity in man by placing ergometers within large chambers. Indirect calorimetry was first successfully freed from the shackles of cumbrous laboratory equipment by Dr. Douglas's use of a large gas-tight bag to collect the expired air. Such a bag could be worn on the back, giving the subject very considerable freedom to carry out normal activities. The idea came to Dr. Douglas when watching an old-fashioned 'magic lantern': the gases for the lime-light were stored in large bags. No advance on this Douglas-bag technique appeared until 1940, when German workers introduced the Kofranyi–Michaelis respirometer (Max-Planck respirometer), which is a reversion to an old principle[2]. The expired air is passed through a light, dry flowmeter worn on the back like a haversack. As the expired air passes through the meter, small samples are withdrawn and collected for subsequent analysis.

Accurate methods of indirect calorimetry demand accurate gas analysis. Attempts have recently been made to replace the Haldane and similar types of apparatus by rapid physical methods; but these have not yet proved satisfactory.

H. S. Wolff described his light-weight integrating motor pneumotachograph[3], the principle of which is the same as that of the Max-Planck respirometer, except that the flowmeter employs a method new to calorimetry. The pressure of the expired air lifts a diaphragm from off the exit tube of the meter, and the lift of this diaphragm is proportional to the flow. The excursion of the diaphragm, by means of an electro-mechanical integrating device, allows the volume of expired air to be read on a veeder counter. In the latest models the volume of air expired can be recorded at a distance by transmitting impulses from the meter. A small pump draws a sample of expired air into a polythene bag, and the air in this bag is afterwards analysed. The pneumotachograph, with its associated equipment, is light, offers little back pressure to breathing and records faithfully rates of flow far in excess of those found during maximum expiration in strenuous exercise: with a face mask it can be worn for hours without distress, and thirst can be slaked with the mask in position. Observations have been made on men in the Army performing hard physical exercises. The way is thus open for a very complete survey of the expenditure of energy over long periods and in all walks of life.

In the afternoon session O. G. Edholm dealt with the value of measuring expenditure of energy in nutritional studies. These in the past have depended almost wholly on dietary surveys. Such surveys give reasonably accurate information on the income of energy, but give no indication of how the energy is spent. A review of the few surveys in which both intake and expenditure were measured shows good agreement on the average over a period of days. In a recent careful study[4], however, no correlation was found between individual daily intake and expenditure of calories: there was no correlation even between the mean expenditure of the group on any one day and the intake on that day. There was a correlation between the mean expenditure on one day and the intake two days later. Here is revealed an aspect of metabolism that is but imperfectly understood. The human body is able apparently to adjust its intake of food to an expenditure of energy which took place days before. Indeed, there is evidence that such belated adjustment may extend over a much longer period.

R. Passmore discussed the time-course of the daily expenditure of energy by human beings. With increasing mechanization in industry, with '*Homo sapiens*' becoming '*Homo sedentarius*', we tend, in our estimation of the severity of work, to place undue emphasis on the nature of the employment. Lying, sitting and standing occupy a large part of the twenty-four hours even for an active man. Roughly 500 Calories are spent asleep in bed, and 1,500 Calories in recreation and off-duty activities; and this seems to hold whether the occupation involves light or heavy work. Should there be a diminution in expenditure of energy in the period of recreation, as there may well be with advancing years, and if the appetite is not correspondingly curbed, obesity will rear its ugly head.

J. V. G. A. Durnin had the rather thankless task of talking about the influence of age on expenditure of energy. The report on calorie requirements by a committee of the United Nations Food and Agriculture Organization[5] suggests that the intake of calories at twenty-five years of age should be decreased by 7·5 per cent for every ten years beyond that age. There is very considerable criticism of this proposal; but the original suggestion, and all criticisms thereof, suffer alike from a practically complete lack of known facts. Information is badly needed in all communities where shortened working-hours for the young make an increasing demand for labour from the elderly. How do advancing years affect muscular efficiency, and what load can we place with safety on the age group 55–70 years? We do not know. A short pilot experiment showed that elderly men used more energy in walking than did younger men. The elderly, however, spent no more energy when the exercises were confined to the muscles of the arms. There is no reason why the metabolic processes in the muscles of the elderly should not be as efficient as those in younger people; perhaps neuromuscular control is not so efficient.

H. R. Noltie dealt with the expenditure of energy by athletes, a subject on which information is scanty: with the older techniques it was scarcely feasible to find with any degree of accuracy the expenditure of energy during the more strenuous and competitive forms of exercise. Golf is known to make comparatively modest demands on expenditure of energy, about 5 Cal./min.; fast walking, due to swinging of the arms, can be expensive in energy and even more expensive than slow running: sustained running at speed may demand 25 Cal./min. Swimming makes very great demands, and so does skiing. But the ski, from the point of view of energy expenditure, is, in all circumstances, more economical than the snowshoe. It is possible, too, to estimate the influence of style and of length of stride in running. Th 'fast start' is costly in terms of energy expenditur Thus, it is not beyond the bounds of possibility th athletes, trainers, and spectators with a financi interest in the outcome will all have ultimately t discuss athletic contests in relatively pure physio ogical terms.

General discussion after the final paper tended t focus on obesity, on its causation and on the ver real problem of the control of body-weight: restric the food intake and we are unhappy, increase exerci and we become all the hungrier. What is the cau of fatigue? What causes muscle soreness aft unwonted severe exercise? We have no answer These may come by future closer integration tha in the past between the physiological and biochemic approaches to the problems of nutrition.

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# OBITUARIES

## Dr. W. K. Spencer, F.R.S.

Dr. William Kingdon Spencer, whose deat occurred at Ipswich on October 1 at the age o seventy-six, was a prominent figure in the world o education who, notwithstanding exacting officia duties, found time to carry out important researche on fossil starfishes and other Echinodermata. Th son of J. F. Spencer, formerly of Parkstone, Dorset he was born at Barrow-on-Soar, and spent his boyhood at Upper Hopton, Yorkshire, where his fathe had been appointed headmaster of the village school From Batley Grammar School (where he was a contemporary of Sir Owen Richardson) he gained demyship in natural science at Magdalen College Oxford, where he proceeded in 1898 after studyin for a short time at the University of Marburg Graduating in 1902 with first-class honours in zoology he was awarded the Burdett-Coutts Scholarship an began his researches on fossil invertebrates.

For a year (1903–4) Spencer held the post o lecturer and demonstrator in the University Department of Geology at Oxford, under W. J. Sollas. Hi career as a teacher of palaeontology soon terminated however, for in 1904 he was appointed to a post under the Board of Education, and before lon became the Board's chief examiner in science. In 1914 he was appointed inspector of schools for East Suffolk, where he guided the educational programme until his retirement in 1938 and was largely responsible for the very effective reorganization and the extension of the schools of that area which followed the Hadow Report of 1926. On retirement he lived for a time in Southern France and continued with his research work in the University of Montpelier. When France was overrun by the German army he escaped to Portugal and proceeded to South Africa, where he resumed educational work. After the War he again retired to France, first re-visiting Great Britain in 1953.

Spencer's first echinoderm paper, published by the Royal Society in 1904, dealt with the Palaeozoic genera *Palaeodiscus* and *Agelacrinus*, to the investigation of which he applied Sollas's technique of serial sections.

then turned to the Cretaceous Asteroidea, com-eting (1905–7) for the Palæontographical Society e monograph on that group which had been begun W. Percy Sladen in 1891–93. The evolution of ese forms was the subject of a subsequent paper in e *Phil. Trans. Roy. Soc.* (1913). His major work as his monograph of the British Palæozoic Asterozoa, n parts of which were published by the Palæonto-aphical Society between 1914 and 1940, when the ar made further progress impossible. Spencer's st work, in which he described and discussed the arliest known starfishes, which occur in the Lower rdovician of southern France and Bohemia, was ublished in 1951 by the Royal Society.

Spencer's work was concerned largely with ancient nd often indifferently preserved fossils; but he was n adept at getting the most out of his material and lways regarded the subjects of his researches rimarily as animals which had once lived in har-ony with their environment, and the functional gnificance of every structure of which demanded terpretation. The skilful reconstructions of these nimals and their organs, well depicted under his uidance by his artist, F. T. Jones (an Ipswich art aster), are a notable feature of his papers. He eceived his Oxford doctorate and the Lyell Award f the Geological Society of London in 1918, and in 931 was elected to the fellowship of the Royal ociety.

L. R. Cox

### Mr. R. B. Pilcher, O.B.E.

The name of Richard Bertram Pilcher, who died t his home in Northwood on October 1 in his eighty-econd year, will remain indelibly impressed on the ecords of two distinct professional organizations—he Royal Institute of Chemistry and the Chartered nstitute of Secretaries. A native of Patrixbourne, ear Canterbury, he was appointed clerk to the nstitute of Chemistry in 1892 and became suc-essively assistant secretary (1894), secretary (1895) nd registrar and secretary (1900–45). Pilcher had nown all the presidents from 1877 onwards, and rom his youth completely identified himself with the rofession and with its interests and aspirations. is tall, lean and dignified figure, with a hint of the scetic, due more to the delicate state of his health in early manhood than to any avoidance of the pleasures of life, was well known in scientific and official circles for many decades.

During the First World War the Institute became the chief agency whereby the various ministries and Government departments obtained chemists, and Pilcher, then secretary to the Glass Research Committee, was in constant demand. After the War he interested himself in the re-settlement of officers and other careers matters, serving on committees of the Ministry of Labour. He was appointed O.B.E. in 1920. He served as honorary secretary of the Chemical Council from its inception in 1935 until 1943. He became a member of the Parliamentary and Scientific Committee in 1935, and a vice-president in 1943. In 1952 the Institute paid tribute to his long service and abiding interest in the profession by admitting him as one of its first honorary Fellows.

An avid reader, fond of honest labour, and prone to contemplation, his pen never rested long. Several of his compilations became standard reference works, passing through a number of editions. Among these were "Official Chemical Appointments" (1906); the joint work "What Industry Owes to Chemical Science" (1918); and "The Profession of Chemistry" (1919). Having a keen interest in the history of chemistry, and particularly in chemical biography and iconography, he acquired a mass of manuscript material and a well-known collection of prints.

A Fellow of the (then) Institute of Secretaries in 1897, Pilcher served it as a member of council from 1908, as vice-president (1924–26) and as president (1926–27). He introduced the system of registered studentship, and was ever pleased to think that many thousands of young people had thereby increased their knowledge and worth to the community. He was also a past chairman of council of the Association of Men of Kent and Kentish Men.

Pilcher was intensely human and loved all growing things. This, perhaps, provides a clue to the main interests of his life—children and flowers; students and the history of science; the nurturing and service of two rapidly expanding professional organizations: in these matters his years did not weary him nor diminish his ardour. He is survived by his widow, Violet Frances, two sons and a daughter.

F. W. Gibbs

## NEWS and VIEWS

### oyal Society: Award of Royal Medals

H.M. The Queen has been graciously pleased to pprove recommendations made by the Council of he Royal Society for the award of the two Royal edals for the current year as follows: Sir Alexander odd, professor of chemistry, University of Cam-ridge, for his distinguished work in organic chem-stry; Prof. V. B. Wigglesworth, Quick professor of iology, University of Cambridge, for his distinguished xperimental contributions of outstanding value to any aspects of insect physiology.

### lectronic Engineering at Liverpool: Prof. J. D. Craggs

The Robert Rankin chair of electronic engineering n the University of Liverpool has been filled by the ppointment of Dr. J. D. Craggs, formerly reader in lectronic engineering. Dr. Craggs graduated in 1937 in the University of London and, after a year's research in the Mechanical Engineering Department at King's College, London, he was awarded a Department of Scientific and Industrial Research grant to enable him to work under the direction of Sir Charles Ellis on the development of a high-voltage accelerator for nuclear research. This work was carried out in the Research Department of the Metropolitan-Vickers Electrical Co. at Trafford Park, Manchester. In 1940 Dr. Craggs joined the research staff of this Company and continued to work on the accelerator until 1941, when he became concerned with the development of high-power spark modulators for radar. During 1944–45 he spent six months in the University of California, Berkeley, on studies of collision process connected with the uranium fission programme. In 1945 he returned to the Metropolitan-Vickers Research Department and was responsible for the construction of a 20-MeV. betatron. He also carried out work on the characteristics of electric sparks. In 1948 he joined the University of Liverpool as senior lecturer in electrical engineering and in 1949 he was promoted reader. Prof. Craggs's recent researches have been concerned mainly with electrical discharges. He has been an active member of the Institute of Physics and has been largely responsible for the formation of the Liverpool and North Wales Branch of the Institute. He is a member of a Ministry of Supply committee dealing with the application of electronic techniques to ballistic problems.

## Geology at St. Andrews :

### Dr. Charles F. Davidson, O.B.E.

Dr. C. F. Davidson has been appointed to the chair of geology in the University of St. Andrews, consequent upon the retirement in 1954 of Prof. D. E. Innes. Dr. Davidson is a graduate of that University (University College, Dundee), where he took his degree with first-class honours in geology and mineralogy; afterwards he was awarded the D.Sc. degree for a thesis on the geology of a part of South Harris, Outer Hebrides. Dr. Davidson has had a distinguished career with the Geological Survey of Great Britain and the Museum of Practical Geology, which he joined in 1934, and from which he has resigned his appointment as district geologist in charge of the Atomic Energy Division. He was first concerned with preparing exhibits for the new Museum in South Kensington which was opened in 1935, and his duties under Dr. W. F. P. McLintock widened his experience, especially in mineral determination. During the Second World War his attention was turned to preparing reports on overseas geology for the intelligence departments of the Services, particularly for the Naval Intelligence Division; in 1941 he compiled a report on uranium resources. It was this latter work which led to the setting up in the Geological Survey, with Dr. Davidson in charge, of a special department for investigations upon radioactive ores. Towards the end of 1945, the responsibility for research and development on atomic energy passed from the Department of Scientific and Industrial Research to the Ministry of Supply, and in 1954 to the United Kingdom Atomic Energy Authority. The work of the Survey's Atomic Energy Division, undertaken in conjunction with these various bodies, was directed towards the discovery and evaluation of radioactive mineral deposits capable of furnishing uranium and thorium ores to the British market. Dr. Davidson's success was marked both in field-work and in the development of appropriate laboratory techniques. In the course of his very extensive travels, he has visited areas in remote parts of the world to assess the economic potentialities of these important ores, and in several cases he has contributed to the scientific understanding of their genesis.

## Visit of Russian Scientists to Britain

The Royal Society, in association with the Soviet Relations Committee of the British Council, has arranged for a party of leading Russian scientists to visit Britain. The delegation is led by Academician A. N. Nesmeyanov, president of the Academy of Sciences, Moscow; other members of the delegation include Academician I. G. Petrovsky, mathematician and rector of the University of Moscow; Academician A. L. Kursanov, plant physiologist; Academician V. A. Kargin, physical chemist; and corresponding member of the Academy P. Ya. Kotchina, hydraulics engineer. Academician Nesmeyanov is a distinguish chemist and was director of the Institute of Orga Chemistry of the Academy of Sciences. He beca president of the Academy of Sciences in 1951, a has been a member of the Supreme Soviet of t U.S.S.R. since 1950. In addition to a number functions at the Royal Society, the delegation is visit Cambridge (November 18–20), where they w be the guests of Lord Adrian at Trinity Colleg Edinburgh (November 21–22), where their programm is being arranged by Sir Edward Appleton, princip and vice-chancellor of the University; and Oxfo (November 25–26), where Sir Cyril Hinshelwoo foreign secretary of the Royal Society, is arrangi a programme of visits. The Parliamentary a Scientific Committee will receive the delegation in th Houses of Parliament, and visits have been arrang to the National Physical Laboratory and Rothamst Experimental Station. The delegation will be th guests of the Royal Society at its anniversary dinn on St. Andrew's Day, November 30.

## Visit of British Atomic Scientists to the U.S.S.

A delegation from the United Kingdom Atom Energy Authority is on a six-day visit to the Sovi Union. Owing to heavy commitments in Gre Britain, Sir John Cockcroft, director of the Atom Energy Research Establishment, Harwell, has n been able to take part in the visit; the delegation therefore being led by Dr. B. F. J. Schonland, deput director at Harwell. The other members of th delegation are: Dr. Willis Jackson, representing th Royal Society and the British Nuclear Energy Co ference; Mr. B. D. Goodlet, head of the Engineerin Research and Development Division, Harwell; D J. V. Dunworth, head of the Reactor Physics Division Harwell; Dr. D. W. Fry, head of the General Physic Division, Harwell; Mr. A. A. Smales, head of th Analytical Chemistry Group, Harwell; Dr. L Rotherham, head of research and developmen Industrial Group, Atomic Energy Authority; an Mr. J. C. C. Stewart, director of the Technical Polic Industrial Group, Atomic Energy Authority. Th visit is the result of an invitation for a Britis delegation to visit the Soviet Union addressed to Si John Cockcroft at Geneva in August by the Sovie delegation to the United Nations Conference on th Peaceful Uses of Atomic Energy. Fifteen Sovie scientists were among the delegates to that Con ference which visited Harwell last August. Th programme of the visit to the U.S.S.R. includes a atomic power station, a powerful phasotron (a accelerating machine), the Lebedev Institute and th Institute of Geochemistry and Analytical Chemistry of the Academy of Sciences of the U.S.S.R.

## Astronomical Clock in York Minster

A memorial to airmen who fell while operating from bases in Northumberland, Durham and Yorkshire during the Second World War was unveiled in York Minster by H.R.H. the Duke of Edinburgh on November 1. The memorial contains an astronomical clock, designed by Dr. R. d'E. Atkinson and made under his direction in the workshops of the Royal Observatory. There are two main dials. On the west is a "Zodiacal" dial which shows the apparent motions of the sun. A large convex disk represents the horizon, as seen from York facing south, and a sun rises from behind this, passes across the sky and sets behind the disk again. The times of rising and setting are accurate to within one minute. The rays surrounding model sun are of such a length that when they appear behind the disk, twilight is approximately ding. In addition to its daily motion, the sun is own to move along a circle representing the iptic and it thus rises to the appropriate elevation any time of year. Solar time may be read from is dial and Greenwich Mean Time is shown on a l below. The equation of time may thus be tained as the difference between the dials. The er side of the memorial carries an "Astral" dial. is shows the daily apparent motion of the northern cumpolar stars. Sidereal time may be read from this l and it is also shown on dials on the "Zodiacal" e converted into degrees. The clock depicts events propriate to the latitude and longitude of York, d is intended to give a picture of the heavens as n by a navigator in an aircraft over the city. It housed with a Book of Honour in a walnut frame signed by Prof. A. E. Richardson and ornamented Mr. Maurice Lambert and Mr. H. J. Stammers.

## mospheric Pollution in Great Britain

In moving the second reading of the Clean Air ll in the House of Commons on November 3, the rliamentary secretary to the Ministry of Housing d Local Government, Mr. W. F. Deedes, said that e Government believes that the necessary replace-ent in the black areas scheme of about 19 million ns of house coal by smokeless fuels can be gradu-ly achieved over fifteen years. The Government s accepted the Beaver Committee's recommenda-ns that the most efficient practicable method of moving sulphur should be used in power stations or near populated areas, and research into this oblem is being pressed forward. He emphasized at the rate of progress may be limited by the fficulty of finding the technical staff required by cal authorities for the discharge of their additional sponsibilities. Mr. Deedes announced the Govern-ent's acceptance of the Beaver Committee's commendation for the establishment of a Clean ir Council, and in replying on the debate the inister of Housing and Local Government said that is the Government's intention to make the Bill as fective, tight and strong as possible consistent with hat is practicable. He is prepared to consider the clusion of a general introductory clause stating at clean air is a national policy, though he does t think it would add anything to the Bill, and also make the appointed day, for the purpose of the ven-year period allowed for the modification of uipment, the day after the passing of the Bill. In gard to research, he emphasized the work already ing carried out by the Department of Scientific d Industrial Research and referred to the con-ruction by the Central Electricity Authority of a ll-scale pilot plant for extensive trials at a power ation. Mr. Sandys promised to consider sym-athetically at a later stage any amendments likely make the Bill a more effective instrument to adicate a great social and economic evil, a enace to public health and a source of waste and estruction.

## entific Library Centre in London

In a written answer to questions from three embers of the House of Commons on November 1, r. J. R. Bevins, parliamentary secretary to the inistry of Works, as representing the Lord President the Council, stated that the proposals for improved ientific libraries referred to in the eighth annual report of the Advisory Council on Scientific Policy are at present being considered by the Departments concerned. As these projects involve considerable capital expenditure, and the reference library scheme is bound up with wider questions affecting the Patent Office, Mr. Bevins regretted that he was not yet able to make a statement. In a further reply on November 8, Mr. Bevins said that the capital cost of a new building to house both the Patent Office and its library, extended to provide a National Reference Library, was estimated at rather more than £2,000,000.

## Economics of the Press in Great Britain

The broadsheet on the "Balance Sheet of the Press", issued earlier this year by Political and Economic Planning (*Planning*, **21**, No. 384; 1955. Pp. 14; 2*s*. 6*d*.), is of particular interest in view of the recent announcement by the Board of Trade that control of newsprint in Great Britain is to end next year. The broadsheet directed attention to great changes which are impending in the organization of the British Press. It is the first of a series which sets out to examine these problems, and it throws some light on the critical reception of the Government's decision by the Newsprint Supply Company, which is desirous that some form of voluntary rationing should continue to safeguard the weaker papers, as the ending of control does not mean that supplies will then be adequate to meet demands. On this point the broadsheet suggests that the high price of newsprint is likely to prevent daily newspapers from reaching their pre-war size, although twelve-page papers are probable. A considerable rise in world demand is anticipated during the next decade, and substantially increased production is planned in spite of the fact that world supplies are severely limited in the immediate future; the provision of more newsprint during the next few years depends on renewed contracts with Canada, although, later, increased supplies may be available from non-dollar sources.

Between 1937 and 1947 the circulation of London and provincial dailies rose by more than ten million and that of Sunday newspapers by fourteen million, compared with an increase in population in the period of 2·6 million. Magazines and periodicals had a circulation of about twenty-six million in 1938 and probably more than forty million in 1952. Press advertising in 1954 was estimated at about £160 million out of a total advertising expenditure of £280 million, and, of this, 38 per cent was in provincial newspapers, 24 per cent in national newspapers, 21 per cent in magazines and periodicals and 16 per cent in trade and technical journals. The provincial newspapers, posters and the smaller-circulation magazines are expected to lose most to television advertising. As regards the future, costs in all departments of newspaper production are expected to continue to rise, and the total circulation of the national papers is probably near its limit. Total sales revenue is unlikely to be increased by raising the price of the daily paper; unaccompanied by a larger paper, it could cause a substantial fall in sales. In view of competition from television advertising, substantial increases in advertising-rates are unlikely, nor, while papers remain at their present size, can the 33 per cent of their space devoted to advertising be increased. Much could be done, however, to eliminate waste of man-power and materials, and the broadsheet suggests that both management and labour should pay greater attention to the increase of efficiency in this way.

## Cortisone and Corticotrophin

The November issue of *The Practitioner* is devoted to a consideration by a number of authorities of the value and dangers of the hormones cortisone and corticotrophin (ACTH). Until recently, supplies of both these drugs in Great Britain were not adequate; but now there are good reasons for believing that supplies of them will soon be enough to satisfy all needs. They are, in most instances, used empirically, because we do not yet know enough about how they act; but their value in carefully selected cases is very apparent from Dr. C. L. Cope's article on their pharmacology and from the other articles by experts who discuss their uses for treating chronic rheumatic diseases, gout, rheumatic fever, certain diseases of the skin, the eye, the endocrine glands and blood, and for asthma, or as an aid to surgery. To summarize these articles in a brief review is impossible, and would be dangerous; indeed, it would not be wise to epitomize, or take out of the context, the scope and content of Prof. E. J. Wayne's contribution on the dangers and complications of the use of these drugs. Nevertheless, an indication of the general position can be gathered from the opinion expressed on the first page of the issue that "the practitioner will not go far wrong if he continuously bears in mind the advice given by Prof. Wayne that, in cases of doubt, it is better to be cautious in deciding to give these drugs". Prof. Wayne, however, also says that fifteen years ago the text-books "devoted pages to the side effects of sulphonamides, but they are still used in considerable quantities and with good effect".

## The South African Museum, Cape Town (1855–1955)

The centenary of any organization is an appropriate time to publish details of its origin and progress. The South African Museum at Cape Town has thus just published an admirable booklet to celebrate that event (pp. 23+4 plates; 1955). As with so many museums of the early and middle nineteenth century, it was founded on the pattern of the British Museum in London. It is indeed fortunate in that as early as 1855 the trustees realized that the Museum should be a place of education combined with recreation and also a centre of research on the natural products of South Africa. It was not until 1897 that the Museum acquired a second and more adequate building, and now it is rightly suggested that the centenary should be marked by additional galleries. This would enable the greatly increased collections to be more properly preserved and the display to be modernized. The booklet gives a brief description of the principal acquisitions since 1855, and an important section deals with the field-work that the Museum has been able to organize.

## British Nuclear Energy Conference: Meeting in London

The British Nuclear Energy Conference, which has been formed by the Institutions of Civil, Mechanical, Electrical, and Chemical Engineers and the Institute of Physics (see *Nature*, June 11, p. 1023), will hold its first meeting in the form of a lecture symposium, to be held at the Institution of Civil Engineers (Great George Street, London, S.W.1) on November 30 (2.15–8.15 p.m.) under the chairmanship of Sir Christopher Hinton. Lectures will be delivered as follows: the United Kingdom Atomic Energy Project (Sir John Cockcroft); the place of nuclear energy in United Kingdom power development (V. A. Pe and J. C. Duckworth); the use of research reacto in nuclear power development (H. J. Grout); a health and safety in a nuclear power industry (A. Maclean and Dr. W. H. Marley). The papers will published in the new *B.N.E.C. Journal* of the Co ference (see *Trans. Inst. Chem. Eng.*, 33, No. Oct. 1955). Attendance at the symposium will confined to members of the five member bodies co cerned, and those who wish to attend should write soon as possible to the secretary of their particul professional body.

## Atomic Energy Exhibit at British Industries Fair

The "Atoms for Britain" exhibition, shown Geneva during the Conference on the Peaceful Us of Atomic Energy, will be seen for the first time Britain at next year's British Industries Fair. It to be presented by the U.K. Atomic Energy Authori and will be a major feature in the electrical a electronics sections of the Fair at Olympia, Londo during April 23–May 4. The exhibition, which cove 7,000 sq. ft., will show Britain's progress in ha nessing nuclear power and in using atomic energy industry, agriculture and medicine. The resear carried out at Harwell will be illustrated by larg scale models, photographs and diagrams. One of th models will be of DIDO, the 'heavy-water' researc reactor which will be completed by next summer. model of Britain's first atomic power station no being built at Calder Hall, Cumberland, will also on show. This station, which is scheduled to sta feeding electricity into the national grid at the e of next year, is the first of twelve to be built Britain during the next ten years. Another mod on display will be of a more advanced and expe mental type of power unit now under constructi at Dounreay, Caithness. The uses of radioacti isotopes will also be shown.

## First International Congress on Documentation Applied Chemistry

The first International Congress on Documentati of Applied Chemistry will be held in London duri November 22–25, at the Institut Français, Queen berry Place, South Kensington. The Congress under the patronage of the International Union Pure and Applied Chemistry, and the president honour is Lord Cherwell, Dr. Lee's professor experimental philosophy in the University of Oxfor who will open the first session. The Congress confined to one particular field, namely, applie chemistry, and although not the first of its kin it is the first conference at an international lev at which a serious attempt has been made t bring together librarians and information officer on one hand, and the applied chemists, who u the information they supply, on the other. O November 23 two sessions will be held on the inte national and national scenes, respectively, with D L. H. Lampitt and Sir Alfred Egerton as chai men. On November 24 two sessions will be devote to particular problems, with Prof. E. Velande (Sweden) and Prof. A. Nasini (Italy) as chairme On the last morning, the Congress, with Prof. W Albert Noyes (United States) as chairman, will loo to the future. At the final session in the afternoo there will be an open discussion on the problem raised during the various sessions and a paper givin a summary of the proceedings; a valedictory addre will be given by Sir William Ogg, director of th

Rothamsted Experimental Station and chairman of the Congress Council. A registration fee of 2 guineas will be charged, payable to the Honorary Secretary of the Congress at 56 Victoria Street, London, S.W.1, from whom further information can be obtained.

## Aluminium in Shipbuilding

A symposium on "The Use and Welding of Aluminium in Shipbuilding", organized by a joint committee representing the Institute of Welding, the British Welding Research Association, the Institution of Naval Architects, the British Shipbuilding Research Association and the Aluminium Development Association, will be held in the Weir Lecture Hall of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1, during December 7–8. The symposium will consist of four sessions on, respectively, welding processes and techniques; materials and design; applications; and applications and economic factors. Admission to the symposium for he discussion of the papers to be presented is free. The papers will be published before the symposium, and a complete set can be obtained on payment of a registration fee of 4 guineas. The full proceedings will be published later and offered for sale by the Institute of Welding. Further information can be obtained from the Secretary, Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1.

## International Wool Textile Research Conference

The proceedings of the International Wool Textile Research Conference held in Australia in August and September (see *Nature*, October 15, p. 712) are to be published in five volumes. The Commonwealth Scientific and Industrial Research Organization is making a special pre-publication offer at a price of £A10 per set of five volumes, or £A2 per volume for Volumes *A–D* and £A4 for Volume *E*. The titles of the volumes are: Volume *A*, "Histology of Wool and Hair and of the Wool Follicle"; Volume *B*, "Chemical Physics and Physical Chemistry of Wool and Proteins"; Volume *C*, "Chemistry and Biochemistry of Wool Proteins, Peptides and Amino Acids"; Volume *D*, "Physics of Wool and other Viscoelastic Fibres"; Volume *E*, "Wool Technology". The ordinary price will be £A25 for the five volumes, and the reduced price is possible only for orders which are received before printing commences. Order forms are available from: Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2.

## University of Glasgow

The following have been appointed lecturers in the University of Glasgow: G. W. Crosbie (biochemistry); N. G. Waton (experimental pharmacology); N. Grassie (macromolecular chemistry); J. Aitchison (mathematics); H. A. de Borde, B. H. Bransden, D. Dixon and W. S. C. Williams (natural philosophy); I. A. Boyd and Ann B. MacNaught (physiology), and L. M. Kellas (veterinary histology and embryology). Dr. A. Bhati has been appointed to an Imperial Chemical Industries, Ltd., fellowship in chemistry. A course in nuclear engineering, consisting of forty lectures and about twenty-five hours of practical work, is now available in the University for final-year students in engineering; it is being run by the Department of Natural Philosophy. A new petrochemical laboratory has been added to the Geology Department, and some of the space vacated by the Chemistry Department in the main University building is being taken over as an extension by the Geography Department. For the present session, 343 new students (273 men and 70 women) have been admitted to the science departments, compared with 287 in 1954. In the University as a whole, the total number of matriculated students has increased by about a hundred to 5,679.

## University of London

The title of professor of biology in the University of London has been conferred on G. E. H. Foxon in respect of his post at Guy's Hospital Medical School, and that of professor of geography in the University of London on A. E. Smailes in respect of his post at Queen Mary College. The following have been appointed to University of London readerships tenable at the institutions indicated: Dr. P. M. Butler, zoology at the Royal Holloway College; Dr. S. W. Hinds, public health at the London School of Hygiene and Tropical Medicine; N. P. W. Moore, mechanical engineering at the Imperial College of Science and Technology; and Dr. R. K. S. Wood, plant pathology at the Imperial College of Science and Technology.

## Announcements

Dr. J. F. Lockwood, master of Birkbeck College, has been elected vice-chancellor of the University of London for the remainder of the university year 1955–56, in succession to Prof. H. R. Robinson, who has resigned on medical grounds.

The Ellen Browning Scripps Fellowship for 1955–56 has been awarded to Dr. Gordon W. Ballmer. The Fellowship is awarded by the San Diego Zoological Society, California, and is for research in any field of biology, a stipend of 3,500 dollars for a ten-month period being provided, together with full facilities for work at the San Diego Zoological Gardens. Dr. Ballmer, who is a graduate in zoology of the University of Michigan, Ann Arbor, will study carbohydrate metabolism in the Testudinata.

Mr. S. L. Huthnance, at present county agricultural officer for Berkshire, has been appointed deputy provincial director for the West Midland Province of Britain, in succession to Dr. D. H. Robinson, who was recently appointed provincial director.

The ninth meeting of the European Association of Exploration Geophysicists will be held in London, at Church House, Westminster, during December 7–9. Further information can be obtained from the British representative, J. E. R. Wood, British Petroleum Co., Ltd., Kirklington Hall, nr. Newark, Notts, or from the Association itself at 30 Carel van Bylandtlaan, The Hague, Holland.

The Scientific and Technical Group of the Royal Photographic Society is arranging a conference on "Photographic Science and Technique", to be held on December 3, in the Arthur Worthington Hall of the University of Manchester (Dover Street, Chorlton-on-Medlock, Manchester 13). Seven papers will be read. It is hoped to make a visit in the evening to the Shirley Institute. The conference will be open to the public. Further information can be obtained from R. E. Withrington, 49 Kensington Avenue, Manor Park, London, E.12.

In his review of Dr. Pollitzer's book on plague, which appeared in *Nature* of October 1, p. 615, Dr. E. Ashworth Underwood wrote on line 7: "Dr. Pollitzer, the only surviving author". Dr. Wu Lien-teh is in fact alive and still very active in other capacities.

# PHYSICAL CHEMISTRY OF ENZYMES

## FARADAY SOCIETY DISCUSSION

THE Faraday Society held a discussion on "The Physical Chemistry of Enzymes" during August 10–12 in the Department of Physiology, University of Oxford. At the suggestion of the chairman of the organizing committee, Prof. F. J. W. Roughton, the time of the meeting was arranged so that it followed the International Congress in Biochemistry. As a result, a large number of biochemists from the Congress were able to be present at the Faraday Society discussion, and the total attendance was 244. Twenty-nine papers concerning a wide field of enzyme topics were discussed, and a great many valuable contacts were made between enzyme biochemists and physical chemists interested in the enzyme field. The chair at the opening session was taken by the president of the Society, Prof. R. G. W. Norrish, and the introductory paper was given by Dr. M. Dixon, whose lucid exposition of the present position of the field set the pattern for the subsequent discussion.

Dr. Dixon pointed out that of approximately four hundred and fifty known enzymes, all of them protein molecules, about a hundred have been obtained in crystalline form. He noted that enzyme studies include both protein properties and catalytic properties, and that most of the papers before the meeting were concerned with the latter aspect. A great many enzyme reactions fall into the general class of group transfer reactions, and the requirements of specificity suggest in many cases a close fit between enzyme and substrate over a patch 15–20 A. in diameter. Such an active patch might be associated with a particular folding of polypeptide chains in the surface of the protein, giving rise to a characteristic arrangement of side-chains. Passing to problems of kinetics, Dr. Dixon discussed the various developments of the basic Michaelis–Menten equation, which supposes enzyme ($E$) and substrate ($S$) to combine to form a complex ($ES$) which decomposes to the product ($P$), with the rate-constants given:

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_3} P$$

He referred to the various ways of identifying the rate-determining step for the overall enzyme reaction, later treated in detail by several contributors to the discussion. He showed how the effect of $p$H on enzyme velocity may lead to a knowledge of the $pK$ of ionizing groups in the active site, and also described the use of isotopes in investigating the sequence of bonds broken in enzyme reactions.

### Characterization and Physical Properties

The papers in the section on "Characterization and Physical Properties" were concerned entirely with soluble enzymes. It is well known that a crystalline protein is not necessarily homogeneous. In cases where two or three species are present, they may frequently be separated by electrophoresis or sedimentation, the first technique depending on differences in charge (therefore ionizing groups) and the second on molecular weight. A single homogeneous protein diffusing across a boundary according to Fick's law sets up a concentration gradient/distance relationship of Gaussian type, but a mixture of proteins leads to departures from this curve. A paper by R. L. Baldwin, L. J. Gosting, J. W. Williams and R. A. Alberty (Wisconsin) described first how th diffusion method has been increased in sensitivit until 0·1 per cent impurity is detectable in crystallin albumins, using an interference-fringe method. study of the reversible spreading of electrophoreti boundaries can detect differences of one electroni charge between protein molecules.

V. Massey, W. F. Harrington and B. S. Hartle (Cambridge) have 'labelled' enzymes with an organi dye molecule, and compared the inhibiting effect o the dye with measurements of fluorescent depolarization and sedimentation constant. The evidence is tha the first dye molecules taken up combine with a active group of the enzyme, and that the same grou is involved in chymotrypsinogen, chymotrypsin and di*iso*propylphosphofluoridate-chymotrypsin. The grou concerned is therefore probably the enzyme-substrate-binding group, and it is of great interest that th group is free in the precursor molecule. Since the di-*iso*propylphosphofluoridate site is also essential for catalytic activity, this is associated with activation of the enzyme-substrate complex:

$$E + S \rightleftharpoons ES \rightarrow ES^* \rightarrow P$$

According to H. Neurath and W. J. Dreyer (Seattle), the conversion of the precursor chymotrypsinogen into the active enzyme chymotrypsin involves the hydrolysis of a peptide bond between arginine and an *iso*leucine residue, a similar process, but involving lysine, occurring in the trypsinogen-to-trypsin change.

In the living cell the enzymes are in contact with lipoidal membranes which may modify their activity, and this aspect was considered by M. J. Fraser, J. G. Kaplan and J. H. Schulman (Cambridge), who found negatively charged oil–water emulsions to adsorb positively charged catalase very strongly, the first eight monolayers of catalase being completely inactivated. A positively charged oil droplet, however, only adsorbed one monolayer of enzyme, which still retained some activity. Liberation of catalase from living cells has been found to give an eighteen-fold increase in activity in agreement with the emulsion findings. A paper by L. Robert and J. Polonovski (Paris) dealt with the liberation of xanthine oxidase from the fat droplets in milk by various methods. If enzyme activity can be modified by adsorption on membranes, then a new dimension is added to enzyme biochemistry within the cell.

### Kinetics and Mechanism

The second half of the meeting was devoted to a consideration of "Kinetics and Mechanism". A paper by J. G. Kirkwood (Yale) advanced the view that, in addition to the usual dispersion and ion–dipole forces, the fluctuation of proton configuration on the protein part of an enzyme will lead to an attractive electrostatic force on a substrate molecule at its surface. If now in the process of forming the activated complex ($ES \rightarrow ES^*$) there is an increase in dipole, then there will be a lowering of $\Delta G^*$, the free energy change of activation, that is, a catalytic action on the substrate. The discussion turned on how far this mechanism will predict the details of the activity/$p$H curves observed in practice—it accounts for the maximum observed in terms of only one arbitrary constant. A paper by K. J. Laidler (Washington, D.C.) gave criteria for deciding the relative magniudes of $k_1$, $k_2$ and $k_3$, and then tabulated $\Delta S^*$ entropy of activation) in the various cases. Laidler stressed an interpretation of entropy changes in terms of water-release effects following polarity changes in the activation process.

E. L. Smith, B. J. Finkle and A. Stockell (Utah) discussed the hydrolytic action of purified papain. They found the Michaelis constant $K_M$ ($K_M = k_2 + k_3/k_1$) and $k_2$ to vary with $p$H in a rather complex manner, $p$H optima depending upon temperature. The explanation given was that $k_2$ involves a sequence of steps,

$$E + S \rightleftharpoons (ES)_1 \rightarrow (ES)_2 \dashrightarrow (ES)_n \rightarrow P$$

and that the rate-determining step changes with temperature. The papain molecule contains an SH-group in the active site which may function by forming a thiol ester with the carbonyl group of the benzoyl arginine amide substrate. R. Lumry and E. L. Smith (Utah) prefer to consider the Michaelis equation simply as the general equation for the conservation of enzyme molecules, replacing $K_M$ by $\beta/\alpha$ and $k_2$ by $\beta$, and then seeking correlations between $\alpha$ and $\beta$ for the carboxypeptidase system for a range of variables, $p$H, solvent, etc. These authors stressed the need for a proper statistical treatment of the experimental results.

Four papers were presented on esterases. J. A. Cohen (Netherlands) has worked with acetyl cholinesterase and chymotrypsin and confirmed the studies of Shaffer and Summerson, using di-*iso*propylphosphofluoridate labelled with phosphorus-32. Reaction of the enzyme with this substance and subsequent hydrolysis yields phosphoserine; but it seems unlikely that serine is the initial site of attack, as $pK$ evidence points to histidine as the active site. It may be that the di-*iso*propylphospho-groups migrate from an initial histidine site to serine, and B. J. Jandorf *et al.* (Maryland) presented evidence that ageing chymotrypsin–di-*iso*propylphosphofluoridate makes it more and more resistant to reactivation by nucleophilic agents. I. B. Wilson (Columbia), in his paper, pictured the active site of acetyl cholinesterase as an anionic site next to an esteratic site. While nucleophilic agents are normally used for removing the di-*iso*propylphospho-group from the esteratic site, he found that incorporation of a cationic group in the agent much increased its speed of action. Presumably the cationic group is adsorbed on the anionic (enzyme) site and helps the nucleophilic attack. Bergmann compared monoquaternary and diquaternary inhibitors with acetylcholinesterase and butyrylcholinesterase, and on this basis concluded that the former contains two anionic sites, the latter one, and ordinary liver esterase none.

Two papers were contributed on bacterial hydrogenase, a particulate enzyme. That by A. Couper, D. D. Eley and A. Hayward (Bristol and Nottingham) found the $p$H$_2$ conversion to be about five times faster than either $D_2 - H_2O$ or hydrogenation reactions. The true activation energy for the conversion was considered to be 10 k.cal., and a dehydrated film of bacteria was inactive but became active again on rehydration. A. I. Krasna and D. Rittenberg (Columbia) have found that, in the $H_2/D_2O$ exchange, HD was the first species to appear in the gas phase, and they put forward a scheme for the conversion involving interaction of an enzyme hydride ($E$H) with water,

$$E\text{H} + \text{H}_2\text{O} \rightleftharpoons E\text{OH} + \text{H}_2$$

D. E. Koshland (Brookhaven) showed how isotope exchange may be used for excluding possible mechanisms of action of transferring enzymes, illustrating his methods with experiments on $5^1$-nucleotidase. In this case he was able to exclude an enzyme-phosphate complex as an intermediate in the hydrolysis of adenosine monophosphate. It would seem that both adenosine monophosphate and water must be adsorbed on the enzyme, and also that the adenosine serves to fix the orientation of active groups. R. K. Morton (Melbourne) has investigated the transferring activity of phosphatases with acceptors such as glucose, finding a competition between transferring and hydrolysis reactions, and from this concluding that there is a definite water-site in the enzyme.

G. Weber (Sheffield), in a theoretical paper, considered the transfer of energy between separated enzyme and substrate molecules, and from the protein part of an enzyme-substrate complex into the substrate molecule. He concludes that the latter is probably the way that the enzyme-substrate activated complex is formed. A theoretical paper by A. G. Ogston (Oxford) considered equilibria between enzyme, enzyme-substrate, enzyme-inhibitor and enzyme-substrate-inhibitor complexes and then discussed the free energy of activation $\Delta G^*$ for various limiting conditions. H. Gutfreund (Cambridge) outlined the results of applying the analysis of Gutfreund and F. J. W. Roughton to the initial non-stationary state of several hydrolytic enzymes, using a Gibson stopped-flow apparatus. This method leads to values of $k_1$ for formation of the enzyme-substrate complex, and a later paper by E. C. Slater (Amsterdam) showed how conventional kinetic data may also lead to values of $k_1$. Generally, $k_2$ is not simply a monomolecular decomposition, but is really $k_2{}^1X$, where $X$ is water or some other acceptor. By examining a given enzyme with a range of acceptors, a relation between apparent $K_m$ and $V_{\text{max.}}$ ($= k_2e$) is obtainable, which leads to values of $k_1e$ and $k_2e$, where $e$ is the enzyme concentration.

Sir Rudolph Peters (Agricultural Research Council) compared the toxic properties of the natural fluorocitric acid with the synthetic material, containing unnatural isomers. The synthetic material is the more toxic with soluble aconitase, and less toxic with the mitochondrial preparation, which Sir Rudolph tentatively attributed to stereochemical differences between the preparations. Stereochemistry was a main consideration in the paper by B. Vennesland (Chicago). She has found that deuterated diphosphopyridine nucleotide is stereospecific when formed enzymatically, but not when formed by chemical reduction, showing that in the enzyme case the deuterium atoms must add on to the same side of the pyridine ring.

A further two papers dealt with enzymatic reductions by the reduced diphosphopyridine nucleotide. H. Theorell (Stockholm) examined the kinetics of reduction of aldehyde using liver alcohol dehydrogenase. He has established that the reduction goes through the binary complex of reduced diphosphopyridine nucleotide and liver alcohol dehydrogenase and has obtained values for the four rate-constants concerned. In the case of yeast alcohol dehydrogenase, it was mentioned that a ternary complex is involved. I. W. Sizer and A. Gierer have started from Westheimer's proof, using deuterium labelling, that in the transfer from reduced diphosphopyridine nucleotide to acetaldehyde the hydrogen atom goes to the carbon of the acetaldehyde. Arguing from the observed effects of $p$H on velocity and $K_m$, they conclude that the second hydrogen atom is provided by the enzyme and not by an $H_3O^+$ ion from the solution.

The last three papers at the meeting were concerned with iron porphyrin systems. P. George and G. I. H. Hanania (Cambridge) discussed titration data for myoglobin derivatives, concluding that only one hæm-limited acid group is present. Q. H. Gibson (Sheffield) and F. J. W. Roughton (Cambridge) described work on evaluating velocity constants for the addition of four carbon monoxide molecules successively to the four iron atoms of the hæmoglobin molecule, and similar equilibrium constants with oxygen. The solutions for the equations were obtained using electronic computation. In the absence of differences in reactivity, the velocity constants should be in the ratios 4, 3, 2, 1, where 1 refers to addition of the fourth molecule. In fact, the first three constants do not vary much from this expectation, but the fourth constant is enhanced eighty-fold. Gibson described the experimental method used as an adaptation of the flash photolysis technique of Norrish and Porter. B. Chance (Pennsylvania) described work on determining pseudo first-order velocity constants for the steps of the cytochrome chain occurring within the cell,

$$O_2 \xrightarrow{k_1} \text{cyta}_3 \xrightarrow{k_3} \text{cyta} \xrightarrow{k_5} \text{cytc} \xrightarrow{k_7} \text{cytb} \rightarrow \text{fp} \rightarrow \text{DPN} \rightarrow \text{S}$$

where fp denotes flavoprotein. Using different wavelengths, it was possible to follow the concentrations of the individual components by spectrophotometric means, and Chance concludes that there is a graded series of reaction-rates from left to right along the chain. This fact must be taken into account in any proposed mechanisms for electron transport. Work was also described with nitrate as oxidizing agent and with photosynthetic systems.

It has only been possible to mention points from each paper in the above brief account, and reference to the lively discussions which followed the papers has had to be omitted. The Faraday Society is to be congratulated on its foresight in bringing together biochemists and physical chemists in what has proved to be one of the most stimulating discussions in recent years.

D. D. ELEY

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# PULMONARY CIRCULATION AND RESPIRATORY FUNCTION

## SYMPOSIUM IN DUNDEE

DURING September 15–16, Queen's College (University of St. Andrews), Dundee, organized a symposium on "Pulmonary Circulation and Respiratory Function", which was probably the first of its kind to be organized by a university institution. It was an interesting experiment because the papers read covered a wide range of subjects and the audience was drawn from a wide range of interests—namely, physicians and surgeons, pathologists, physiologists and applied physiologists. The interest taken in the symposium, to judge from the size and enthusiasm of the audience, was in large part due to the development during recent years of human cardio-respiratory studies all over the world. Much of the work discussed has not yet been adequately assessed from the point of view either of its scientific reliability, or its value in assisting in diagnosis.

Dr. de Burgh Daly (Institute of Animal Physiology, Cambridge) opened the programme with a paper o "Pulmonary Vasomotor Nerve Activity and it Possible Functional Significance". He pointed ou that a great deal of careful experimental work o animals is needed to demonstrate the existence o changes in pulmonary vascular resistance due to th action of vasomotor nerves. Valid conclusions ca only be reached from the results of animal experiments where factors such as the pulmonary ventilation and circulation can be controlled adequately Without these precautions, passive changes in pulmonary flow, pressure and resistance may obscur the demonstration of active vasomotor changes The demonstration of vasomotor responses, as Dr Daly remarked, does not imply that they play any part in the responses of the intact animal. The conditions of these experiments are often highly artificial. In the human subject, the control of all the variables is so difficult a task that great care should be exercised in drawing any conclusions about the existence of an independent control of the pulmonary blood vessels. Even in animal experiments, the site of action of pulmonary vasomotor fibres is uncertain.

Dr. K. W. Donald (Department of Medicine, Birmingham) gave a paper on "The Pulmonary Circulation in Health and Disease", from which one gathered that the difficulties in designing appropriate experiments, to which Dr. Daly directed attention, must apply also to experiments on man. For example, though there is agreement that the pulmonary vascular resistance to blood flow is small, the effect of exercise on the resistance of the blood vessels is in dispute even in healthy subjects. Some workers consider that the resistance decreases during exercise, whereas others find that the pulmonary vascular bed acts passively in conducting blood. On this matter, there appears to be no agreement about the facts, so it is superfluous to consider whether any question of vasomotion is involved. Dr. Donald concluded that there is as yet no clear evidence of vasomotor activity in human lungs. The problems of physiology posed by disease are numerous and largely unsolved, and some of these were reviewed.

Prof. A. A. Liebow (Yale) stressed the importance of the bronchial arteries, the azygos and other systemic veins in the circulation. His experiments showed that it is possible to ligate the pulmonary arteries and veins and yet have a collateral circulation of oxygenated blood (the extent of which increased in the course of a few months) adequate to maintain life. He demonstrated these points with the aid of casts of the blood vessels and suggested that his experiments may have some application in the treatment of certain developmental abnormalities of the heart and large vessels, and in coronary occlusion. Sir Russell Brock (Guy's Hospital, London) directed attention to the studies which have been made on the physiology of the infundibulum of the right ventricle. Clinical observation both before and at operation in cases of Fallot's tetralogy, for example, make it essential that detailed information should be available about the conditions existing in the infundibulum before a successful operative result can reasonably be expected. He illustrated his thesis by reference to a number of clinical cases.

Prof. J. Gough (Welsh National School of Medicine, Cardiff) reported on the results of post-mortem examinations made in his Department on Welsh coal miners. There is a high incidence of deaths attributable to cor pulmonale and massive pneumoconiosis.

Prof. Gough described the vascular changes in the ungs in this disease and also indicated the value of tudying the grosser pathology of the lungs with the ld of paper-mounted sections. Prof. P. R. Allison Oxford) described his technique of studying left atrial pressures by puncture of the atrium with a needle inserted down a bronchoscope. His objective was an attempt to distinguish, on the basis of the pressure tracings he obtained, between cases of mitral tenosis and mitral incompetence. The results showed sharp separation between the two groups, but this clear-cut result (as became apparent in the later iscussion) may have been in part due to the selection of patients for a surgical opinion. The view was xpressed by Dr. P. Wood (Institute of Cardiology, London) that the results might well have been less clear if an unselected series of cases of disease of the mitral valve was studied. Prof. A. C. Lendrum Queen's College, Dundee) described his studies on the histology of the small arteries of the lungs in mitral tenosis. The deposition of fibrin in the vessel walls and the distortion of neighbouring nuclei resemble the changes seen in other diseases affecting different rgans of the body. He attributed these changes in the lungs to a raised pressure in the pulmonary rtery and illustrated them with most pleasing colour photomicrographs.

The discussion of all these papers delivered on the irst day of the symposium did not serve to increase our knowledge of the mechanisms involved in the many and complicated effects discussed by the principal speakers, except, perhaps, the contribution of Dr. G. de J. Lee (St. Thomas's Hospital, London), who stated that appropriate measurements made during a Valsalva manœuvre indicate the existence of vasomotor phenomena in the lungs.

On the second day of the symposium, Dr. G. S. Dawes (Nuffield Institute, Oxford) described his xperiments on the pulmonary function of new-born ambs, and the changes which take place during the irst few hours of life. His observations show the mportance of arterio-venous anastomoses (for xample, patent ductus arteriosus) in the new-born amb, which have the effect of tiding it over the period during which its lungs are becoming more distensible and more fully aerated. He emphasized he need for caution in applying his results to babies as we do not as yet know enough about the details of the circulation in the baby immediately after birth. Prof. W. Melville Arnott (Department of Medicine, Birmingham) described a selection of the numerous tests of lung function now available, and assessed their value as aids to diagnosis. Dr. D. V. Bates (St. Bartholomew's Hospital, London) reported on his xperiments on gas diffusion studies as an aid to the ssessment of lung function. He concluded that mpaired alveolo-capillary diffusion is probably best evealed by a study of the 'diffusing capacity' of nitrous oxide. It is difficult to feel convinced about this, because one would imagine that diffusing capacity and ventilation of the alveoli are in some degree interdependent, and his method of calculating the diffusing capacity certainly does not take into account any ventilatory factor. Dr. L. G. C. E. Pugh London) described the numerous devices (volume-cycled and pressure-cycled) now used for maintaining artificial ventilation for long periods. This communication had much topical interest in view of the present rise in incidence of poliomyelitis. Prof. I. Donald (Department of Midwifery, Glasgow) described a patient-cycled respirator which he has used successfully for assisted respiration in new-born babies. His physiological observations seemed to support some of those described by Dr. Dawes.

The discussion on the papers delivered on the second day of the symposium was noteworthy for two reasons. On one hand, it was clear that workers, conscious of the difficulty of human experimentation, were anxious to discover more about the physiological basis of the various tests of pulmonary function. On the other hand, a noteworthy contribution by Dr. R. Coope (Liverpool) reminded one that, in general, the tests of function which had been discussed had, as yet, only a limited application as aids to diagnosis. The symposium was a success both on the academic and the social sides. Queen's College went to great lengths to make the stay enjoyable, and it is no exaggeration to say that all the members of the symposium returned home refreshed in mind and body.

J. L. D'SILVA

# READING TECHNICAL COLLEGE

H.M. THE QUEEN MOTHER opened the new Technical College of the County Borough of Reading on October 26. This College was first foreshadowed by various Science and Art classes (under the South Kensington regulations); and these classes, which were already being maintained in 1882 by the local authority of Reading, themselves arose on foundations laid earlier by various individuals of vision and vigour. By 1892 a new University Extension College, associated with Christ Church, Oxford, had come into being in Reading and had incorporated the former Science and Art classes.

Eventually, the University College received its charter—to become the University of Reading of to-day—but additional evening classes for local students were continued without break for more than fifty years. Thus, by tradition—and no less by the close co-operation of to-day—important and enduring links have been forged between gown and town. During that same half-century, classes for younger students were also being developed at junior evening institutes by the local authority at Reading.

In 1946 the local authority—having already decided to provide a new technical college, and having acquired a building site—recovered from the University full responsibility for evening courses in engineering, building and commerce; and after a transitional session, the new Technical College organization came into being in September 1947. Its first task was to co-ordinate the existing senior and junior evening classes and to provide for their unified direction in the future. The University continued to provide accommodation (and is still so doing), but demand grew rapidly and the local authority found supplementary accommodation at some thirty additional places—thanks in particular to assistance from industry, schools, the Royal Berkshire Hospital, the public libraries, and various undertakings.

The second objective was the development of a service no longer restricted only to evening-work. Lack of accommodation for day-work was a serious difficulty.

The range of local need was wide. Reading is characterized not by any one predominating industry but by a wide spread of interest. Needs were also urgent, and the authority adopted a bold policy in an endeavour to meet them by compromise, adaptation and by co-operation willingly given on all sides.

Meanwhile, adequate new premises were planned in consultation with the appointed architects, Messrs. Lanchester and Lodge, of London. Work on the site began on October 2, 1950; the foundation stone was laid by the chairman of the Board of Governors (who at that time was also mayor of Reading) on October 3, 1952.

Transfer of the widely dispersed work of the College to the new buildings began at Easter 1955, when the top floor of the main block was handed over, and continued throughout the summer. This operation was completed early in September.

The College is at present organized in six departments: art and printing; building; commerce; domestic and women's trades subjects; engineering; science. During the first three weeks of the present session, 3,400 students enrolled and commenced their year's work: 1,700 for full-time and part-time day courses (most of them also attending additional evening classes) and an equal number for evening courses and classes only. In addition, more than 1,200 have enrolled at four associated evening institutes which are under the direct charge of the principal of the Technical College.

During the interim eight years pending completion of the College buildings, the courses of study provided have been steadily augmented in range and progressively developed in level. Provision is now made for Higher National Certificate and corporate membership students in mechanical, electrical and production engineering, in building and in applied physics. Ordinary National Certificate courses are also provided in chemistry and commerce, and the former are developing towards Higher levels and the associateship of the Royal Institute of Chemistry. There is a wide range of crafts courses—many of them based on requirements for the full technological certificates of the City and Guilds of London Institute.

Courses for apprentices and journeymen in the printing industry have now been introduced and are meeting an important local need.

The Art Department, hitherto handicapped by lack of facilities, is now developing, and its policy is greatly strengthened by the interest of the University School of Fine Art.

The Commerce Department, offering courses leading to the intermediate and final examinations of many professional bodies, is also responsible for courses in modern foreign languages, retail distribution, grocery and further general education.

Domestic and women's trade subjects include various needlecrafts, catering, cookery, nursery nurses' work and pre-nursing. Much of this work is based on examinations; but provision is also made—at both the College and its associated institutes—for the housewife.

All departments also provide many short courses, including a number of postgraduate or refresher type which are arranged from time to time in consultation with industry, trade, commerce and various professional institutions.

The newly completed premises comprise a main block of four stories of total floor area about 100,000 sq. ft., and a workshops block of some 25,000 sq. ft. In order to provide, at this stage, the accommodation essential for the present known demands, emphasis has been placed on workshops, laboratories and drawing offices rather than on classrooms. There is no central hall or gymnasium; but a refectory, staff and students' common rooms, departmental libraries and staff studies have been included. There is also one large main lecture theatre. A master plan h been prepared by the architects for future develo ment. The internal arrangements of the new buildin have been carefully planned in respect of both shor term and probable long-term requirements; the have been made as flexible as possible so that chang in the use of rooms and services can be made t simply and economically as possible. Invisible ceilin panel heating is provided, allowing uninterrupte wall space. Filament lighting is used generall except for drawing offices and certain rooms in th Art and Printing Department, where fluorescen lighting is preferred.

In general planning, regard has been paid not onl to the specific needs of each department but als to encourage the closest possible liaison betwee them, in the strong belief that all contribute thei special elements within the total pattern of lif to-day and also that each has much of lastin cultural value to share.

A plinth is provided in the main College forecour for the display of pieces of sculpture, to be replace every three years on the basis of a special com petition arranged in co-operation with the University

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# NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING

THE annual report of the National Institute fo Research in Dairying is a tribute to the remark able variety of work which is being done to improv dairy products. Established in 1912 at the Universit of Reading, the Institute now has eight researc departments. Three of these—the Departments o Dairy Husbandry, Feeding and Metabolism, an Physiology—deal, for the most part, with the prob lems, both immediate and fundamental, associate with the technique and scientific background of mil production. Included in the scope of these thre Departments are questions of dairy farm manage ment, the growing of crops suitable for feeding dair cattle, the nutrition of dairy stock, and control o reproduction and lactation in cattle.

The other five departments—Bacteriology, Chem istry, Physics, Engineering and Nutrition—deal wit the application of science both to farm productio and to the more strictly industrial side of practica dairying. Problems, both *ad hoc* and basic, associate with distribution and manufacture of milk, and wit the quality of milk products, are dealt with in thes Departments, and they are inevitably concerne from time to time with investigations directly affecting the consumer of milk and of other dairy products

Besides these eight Departments, there are Section concerned with isotopes, statistics and psychology as well as an experimental dairy.

Many investigations were begun or continue during the year. Further work on the rate of mil and milk-fat secretion, for example, has confirme that the former decreases with increasing interva since the last milking more rapidly than the latter the positive correlation between the milking-rat of an individual animal and the total lactation yiel has been confirmed. It was also shown that th greatest number of new udder infections occurs i the first month of lactation, and in quarters whic have not previously been infected the new infection rate is found to be approximately 3 per cent in th rst month and 1 per cent for subsequent months ; nce a quarter has been infected and freed from fection, the probability of re-infection increases ith the number of previous infections.

An examination of copper as a growth promoter n pigs indicated that either pure copper sulphate or mineral mixture providing copper sulphate at about ·1 per cent of the weight of the fattening meal gives n increased rate of growth in fattening pigs ; even t this high level there is no suggestion that copper s toxic to fattening pigs. No benefit was obtained ither in live-weight gain or efficiency of food utilization when the floors of styes were kept artificially warmed in winter.

Another inquiry revealed that, when measured in erms of the milk production of grazing cows, meadow fescue has consistently outyielded, in each of two seasons, both perennial ryegrass and cocksfoot. An nvestigation into the production of saliva by the ow showed that a milking cow, on a normal diet, in the course of a day probably produces more than ten gallons of saliva, a large proportion of which appears to be secreted while she is eating.

There are indications that the oestrogenic isoflavone, biochanin A, recently isolated from red clover, is present in other clovers, and also, probably to a lesser extent than in red clover, in timothy, Italian ryegrass, meadow fescue and cocksfoot. This substance is present (along with the related oestrogen genistein) in subterranean clover. It is, however, doubtful whether, in current agricultural practice in Britain, oestrogens in pasture plants have any significant effect on milk production or other physiological activities of livestock.

Claims made abroad that the addition of menadione to raw milk, or to the food of lactating cows, caused a marked improvement in keeping quality of milk could not be substantiated. In certain circumstances, menadione in the milk appeared to have a deleterious effect in cheesemaking. Its use as an additive to milk, in any event illegal, is also undesirable on technological grounds.

It was found that the gut contents of chicks about to hatch are sterile ; but those kept without food after hatching develop a flora in a few hours. When recently hatched chicks are fed, a balanced gut flora is established within two days.

The whitening of milk which occurs at temperatures above 60° C. increases in magnitude with the acidity of the milk, and increases with additions of soluble proteins. On heating milk further, the rate of browning seems to depend only on the *p*H, the rate increasing with alkalinity. Milk sterilized in a plate heat-exchanger at 135° C. is whitened in colour and not browned.

The young calf was shown to be a poor converter of carotene to vitamin A. This seems to be the case for all very young animals examined, namely, calves, rats and chicks. Conversion efficiency increases with age.

A significant improvement in growth-rate and a reduction in the incidence and severity of scouring were frequently brought about in young calves by giving them an antibiotic supplement to the diet. The effect, however, appears to be much smaller where the calves are born and reared under good conditions of health and management.

An interesting finding was that the sense of smell seems to be less sensitive than the sense of taste in discriminating between flavours in dairy products, even when the observers concerned think otherwise.

# SICKLE CELL GENE DISTRIBUTION

DR. H. LEHMANN has recently published two papers. The first is about the distribution of the sickle cell gene (*Eug. Rev.*, 46, 3 ; 1954) ; the second deals with the Andaman Islands (*St. Bartholomew's Hospital J.*, 59, 99 ; 1955). From the observation of Herrick in 1910 of a case of chronic anæmia in a Negro student characterized by 'sickle'-shaped red blood cells, investigations have continually proceeded. It was first shown by Huck in 1923 that sickle cell anæmia behaved as a simple Mendelian character and that heterozygotes or carriers could be identified by the anaerobic incubation of blood, whereupon fresh normal blood would take on the sickle appearance. The chemical aspect was studied by Pauling (1950), who found that sickle cells contain a hæmaglobin which differs in its physical properties from normal adult hæmaglobin. Normal and sickle hæmaglobins could be separated by electrophoresis.

The incidence of the 'sicklæmic' gene was high in American Negroes (about 10 per cent) ; but other races did not seem to possess it.

In 1944 and 1945 Evans initiated a large-scale survey on the frequency of occurrence of sicklæmia in West Africa, and found a 20 per cent incidence in 561 Africans from Nigeria, the Cameroons, Gambia and the Gold Coast.

Further large-scale observations were made in West Africa by Findley and his collaborators, the results showing a frequency not very different from those found by Evans. Sickle cells were reported from East Africa in 1945 by H. C. Trowell and from Northern Rhodesia (12 per cent) in 1946 by Beet. Altmann in 1945 reported their absence in South African Negroes.

In 1949 Lehmann and Milne examined nearly 5,000 individuals of twenty-four different tribes in Uganda. In the Nilotic tribes the incidence of sicklæmia was strikingly homogeneous and varied from 21 to 28 per cent.

Foy and his colleagues (1954) surveyed the southern Sudanese and found that the Nilotics fall into two groups, one allied to the Uganda Nilotics and the other with Half Hamitic affinities.

The former group had a high sicklæmia incidence and the latter usually a low one (0·8–3·9 per cent).

In Bantu-speaking tribes sicklæmia varied in incidence, from 2 per cent in the Bairu tribe to 45 per cent in the Baamba—a secluded pigmoid tribe in the forest of the Mountains of the Moon.

The distribution of the sickle gene in Uganda seems to be connected with the invasion route of the pastoral Half Hamites, being lowest among the Bantu along that route and highest in the less-accessible swamps, jungles and mountain tops.

Allison (1954) put forward another explanation of the variable incidence of the sickling gene in the Bantu. It is assumed that the invaders occupied the healthiest and least malarious zones of the country. It is further assumed that the sickling gene has a selective advantage in malarious tracts, the *S* hæmaglobin being less desirable to the malaria parasite than the normal *A* hæmaglobin. It follows that the sickling gene will be most frequent in malarious surroundings. This theory is supported by the fact that the Half Hamitic tribes all live in the least malarious areas of Uganda and that adjacent Bantu tribes share both low malaria incidence and low sickling. But as Herman points out, the question is complicated by the fact that a large admixture of physical Hamitic features in a Bantu tribe—presumably through intercrossing—is also connected with low sickling.

These researches led to the possibility that the distribution of the sickling and other blood genes (Rhesus, *ABO*, *MNS*, etc.) could as genetical markers throw light on to Haddon's theory of a Neolithic immigration from India into Africa.

Accordingly, in 1952 the Nuffield Foundation financed an expedition to South India, and extensive observations of the incidence of sickling were made by Dr. Lehmann in a number of communities.

The gene was found among the Veddoids, of the Nilgiris—primitive peoples who until recently were food gatherers with no knowledge of agriculture. The incidence in both Pancyans and Irulas was very high—more than 30 per cent—while in the Tamils, Telegus and Canarese the gene was not found.

Further reference is made to the prevalence of the sickling gene in the Veddoids of Arabia, and also in Greece, and to the distribution of other blood genes in relation to migratory movements of populations in past times.

Dr. Lehmann, in a brief summary, assigns high incidence of the sickling gene to three major factors: (1) the anthropological derivation of the population; (2) genetic regulation such as a high mutation-rate or balanced polymorphism (Neel, 1953); (3) a social situation which produces inbreeding.

The discussion is not on the whole well balanced, and no reference is made to a possible high coexistence between malaria and sickling in either South India, Arabia or Greece, though data are probably available. The fact that the highest sickling-rates are found in the socially lowest stratum of a population seems to be significant only in relation to gene introgression from other communities.

The second paper contains a general account of the Andaman Islanders. The results of the blood groupings did not point to any connexion between the Andamanese and the African peoples, but rather indicated relationship with the inhabitants of the Admiralty Islands and New Guinea. S. C. HARLAND

# NATURAL INSECTICIDES IN WEST AFRICA

A SURVEY of the natural insecticides used by the peoples of West Africa has been made by Dr. F. R. Irvine (*Col. Plant and Animal Prod.*, 5, No. 1).

The question of the toxicity to man of preparations used as insecticides is important where food crops are concerned; many of these African insecticides are also used for catching fish. The action of some of them is merely to stupefy the fish which, when afterwards eaten, are quite innocuous.

West African insecticides fall naturally into three groups, those containing (1) alkaloids; (2) rotenone or its close relatives; and (3) resins and oils. A few others are useful on account of an acid, tannin, or latex.

Of those containing alkaloids, the tobacco plants, *Nicotiana tabacum* and *N. rustica*, both probably long known as insecticides to West Africans, are in common commercial use. Species of *Datura*, especially *D. metel*, the active principle of which is hyoscine or scopolamine, are used on floors to destroy a bad pest—the jiggers or sand fleas which bore into th feet.

The powdered seeds of certain *Annona* have bee reported from the tropics both as insecticides and a fish poisons. Water suspensions of the seeds c *A. reticulata* produced a high percentage of kill amon the green bugs, *Lecanium*.

Another and more powerful alkaloid is found i the bark of the sassy bark or red water tre *Erythrophloeum guineense*, which is used for destroying fish, game animals and rats, and as ingredient i arrow poison. The active compound is erythrophleine which resembles digitalis in its action on the huma body. In West Africa insecticidal use is made of th leaves, which are put with stored corn to keep insect away.

A leguminous shrub, *Sophora tomentosa*, contain in its seeds about 2·0 per cent of cytisine. Thi alkaloid has proved to be a relatively potent insecticid to adult *Aphis rumicis*, resembling nicotine in it physiological action.

The leaves of the Indian nim tree, *Melia azedarach*, have been successfully used on the Gold Coast for preventing infestation of cocoa beans by the insect *Ephestia*. Elsewhere they have been found to be repellent to locusts, and it is claimed that extracts can be effectively applied for the protection of fruit, vegetable and cereal crops.

Many plants contain rotenone or allied compounds. About two dozen species of *Tephrosia* are used as fish poisons in various parts of the world and some of them are used as insecticides. Among these, *T. vogelii* is of particular interest. Its pounded leaves and pods, thrown on water, stupefy fish in such numbers that its use had to be prohibited in certain areas. The fish so caught are quite edible. The seeds, too, have been proved by Wilbaux to be toxic to molluscs. (Here may be a substitute, probably innocuous to pets and song birds, for the material used in poison bait to combat the ubiquitous slug in British home gardens.) The leaves, when dried, are widely used by Africans for destroying human insect and other parasites, for example, head-lice and fleas. They are used by Europeans in Nyasaland against dog ticks and fleas and in Rhodesia and elsewhere against lice. *Tephrosia*, in at least five species, contains rotenone and other compounds in common with *Derris* and *Lonchocarpus*.

Another well-known fish poison is the leguminous shrub, *Mundulea sericea*, which kills rather than stupefies; it is risky to eat the fish afterwards. In Mysore, India, the pulverized bark of *M. sericea* has been used against various pests and the bark, roots and seeds as fish poison. East Africans declare the pounded bark to be sufficiently potent to kill man, and put into the water, they say, it drives away crocodiles. Though only small quantities of rotenone have been found in the air-dried bark, its toxicity is thought to be due to the presence of allied compounds. Certain East African tests showed it to be almost as lethal as *Derris* roots.

Allied to *Derris* is the leguminous genus *Lonchocarpus*. In South America this produces the well-known insecticide, cube, which, like derris, is a piscicide.

Some of the preparations which contain resins or oils are toxic by contact methods while others are effective as fumigants.

Certain *Dichapetalum* species are poisonous: their seeds to man, rats and parasites, their leaves to ook. Their poisons are believed to be due to resins nong other extractive matter. Particularly potent *D. toxicarium*, though paradoxically enough its uit pulp and that of certain other *Dichapetalum* ecies is edible. Its seeds are sold as rat poison in reetown, Sierra Leone.

Obnoxious to insects is the bright yellow and partly ater-soluble gum exuding from the cashew (*Ana- rdium occidentale*), and this adds to its value in book- inding. The oil from the nutshells was proved in 938 to be destructive to mosquito larvæ, and has een demonstrated to have distinctly toxic effects n certain grain weevils and moth larvæ.

Among fatty oils are the thick greenish oil from e seeds of the herb, *Gynandropsis pentaphylla*, used gainst human parasites (hair-lice) and as a piscicide, e bitter purgative oil from the seeds, and probably tex of the Mexican poppy, *Argemone mexicana*, hich is used by certain pagan Nigerian tribes for arding off termite attack.

Conspicuous among aromatic insecticides are e essential oils of the Labiatæ. Of these the rongly scented *Hyptis spicigera*, *Leucas martini- nsis* and *Ocimum americanum* are burned in rooms get rid of mosquitoes, and layers of the *Hyptis* re placed below bundles of millet to keep away ermites.

Although African growers have available a variety f materials of insecticidal value, Dr. Irvine does not uggest that these materials are necessarily alterna- ives to modern synthetic insecticides. In making choice, many factors, such as local availability, ersistence, ease of application and cost-effectiveness atio, need to be taken into account. These plant roducts should be considered as useful supplements n the struggle against tropical pests. There is much cope for interesting research into the action of these egetable pesticides, either alone or in combination, s well as into the chemistry of their active principles.

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# D. I. MENDELEIEFF AND THE PERIODIC SYSTEM

DMITRY IVANOVICH MENDELEIEFF (1834–1907), the discoverer of the periodic system of he elements and one of the greatest chemists of odern time, was also a very great Russian, and it inevitable that in the U.S.S.R. much time and nergy have been devoted to his life and work and o establishing his place in the history of science.

Mendeleieff was closely connected with education, esearch in pure and applied chemistry, mining and conomic development of Russia. He was also one f the founders in 1868 of the Russian Chemical ociety. The first Mendeleieff Congress met in ecember 1907, the year of his death. In its scope nd purpose this congress was similar to a meeting f the British Association. Subsequent Mendeleieff ongresses took place in 1911, 1922, 1925, 1928, 1932 nd 1934. The last of these in 1934 was the jubilee ongress in celebration of the centenary of Mende- ieff's birth. For this congress the Academy of ciences published "Selected Works of D. I. Mende- ieff"; but in 1937 it began publishing the complete orks in fourteen volumes, of which a number has lready appeared. Recent literature on Mendeleieff nd on the periodic system in the U.S.S.R. is very xtensive. Six books dealing with Mendeleieff and he periodic system reviewed here are of a particular interest to scientists and historians of science. One of these books is published in English, the remaining in Russian.

The first three are concerned with the life and work of Mendeleieff and the last three with the periodic system of the elements. The book written by Prof. B. G. Kuznetzov[1] is a first-class account of the life and work of M. V. Lomonosov (1711–65), N. I. Lobachevsky (1793–1856) and D. I. Mendeleieff (1834–1907). A more popular account is given by Pisarzhevsky, somewhat lengthy in the Russian text[2] and condensed in the English text[3]. The English edition is a nicely bound volume containing numerous well-produced illustrations, available at a very reasonable price.

Mendeleieff's greatest contribution to science, the periodic system, and its derivatives, has, since its discovery in 1869, played a very important part in the development of chemistry and physics. In 1944 the Russian All-Union Chemical Society, in conjunction with the Chemical Section of the Academy of Sciences, celebrated the seventy-fifth anniversary of the discovery of the Periodic Law (1869) and of the foundation of the Russian Chemical Society (1868). The papers read at these meetings were published as a volume in 1947[4]. The first part of this book (pp. 11–114) is devoted to the periodic law and contains five articles: (*a*) the periodic law of D. I. Mendeleieff and its creator, by the late A. A. Baikov; (*b*) the periodic system as the foundation of modern chemistry, by S. A. Shchukarev; (*c*) the periodic law of Mendeleieff and its significance in natural history, by the late A. E. Fersman; (*d*) the transformation of the elements and the periodic law, by V. G. Khlopin; and (*e*) the physical meaning of the periodic system, by A. F. Yoffe. The second part (pp. 115–265) is by V. V. Kozlov and A. I. Lazarev and deals with the history of the Russian Chemical Society. It includes biographical sketches of Russian chemists and contains numerous portraits and other illustrations. Unfortunately, it is not provided with an index.

A most spectacular achievement of the past decade has been the systematic study and classification of Mendeleieff's archives. A large number of 'scraps of paper' containing rough notes or simply scribbles, rough manuscripts of articles, printed copies with the author's correction and amplification notes, rough copies of letters and other materials—all this, when arranged and interpreted, provides a very valuable contribution to the history of the creation of the periodic system. The task of classifying and interpreting this material has been accomplished by Mendeleieff's daughter, the late M. D. Mendeleieff, T. S. Kudryavtzeva and B. M. Kedrov.

The first book dealing with this material was published in 1950[5]. In it only three documents are given and discussed: (1) the manuscript of the earliest form of the periodic table, scribbled over and altered; (2) the manuscript of the second form of the periodic table, the one which was sent to the printers in February 1869 and published in Russian and in French (March 1, 1869); (3) the original Russian text of Mendeleieff's article (dated July 1871), later translated into German and published in the *Annalen der Chemie und Pharmacie* (Supp. Vol. 8, pp. 133–229; 1872). The reproduction of these items is followed by a detailed account by B. M. Kedrov.

Plans have been made for the complete publication of the newly discovered material in three volumes: Vol. 1, covering the period 1869–71[6]; Vol. 2, period 1860–68; Vol. 3, period 1872–1906. Of these, only Vol. 1 has so far appeared. It was published in 1953 and is a very substantial book of 866 pages, full of photo-reproductions of the original documents, explanatory tables and notes. It contains the three documents published in the previous book[4], but more fully annotated and analysed, and a mass of other documents—various sketches of the periodic table (including rough sketches of the spiral form), notes on various topics connected with the periodic system, manuscripts of articles, amended articles, letters, programmes of lectures, and so on. All these documents and their interpretation and annotation are valuable material for the historians of science.

A short review of this kind does not allow of detailed discussion; but the main process of Mendeleieff's creative activity with regard to the discovery of the periodic system may be summarized as follows. After lecturing on organic chemistry and chemical technology at the University of St. Petersburg from 1861, Mendeleieff at the age of thirty-three was appointed to the chair of inorganic or general chemistry in 1867. The preparation of this new course of lectures led him to write his text-book, "The Principles of Chemistry". He knew about some attempts at classification of the elements; but he had not seen the works of A. E. Béguyer de Chancourtois and J. A. R. Newlands. "When I began to write my text-book," Mendeleieff told Braunor, "I felt that I needed a system which would allow me to classify chemical elements. I had discovered that all existing systems were artificial and therefore useless for my purpose. I was anxious to establish a natural system. With this purpose in mind I wrote the signs of the elements on little slips of cardboard together with their atomic weights, and after this I began grouping them in different ways according to their similarities, but this did not satisfy me, until finally I placed the cards one after the other in order of the increasing weights of the element. Having placed in the table the first row: H = 1, Li = 7, Be = 11, C = N = 14, O = 16, F = 19, I discovered that t following elements form a second row below t first row, beginning with lithium. Further I fou that in this new row—Na = 23, Mg = 24, Al = Si = 28, P = 31, S = 32, Cl = 35·5—sodium repe every property of lithium, and the same applies all other elements. Similar repetition occurs in t third row, after a certain period, and continues in rows" (5, p. 141). This may be a simplified accou of his approach to the problem, because the 'scra of paper' show a much more elaborate scheme arrangements and groupings of the elements. It interesting to note that the first two sketches of t periodic table were variants of the 'long chart', wi vertical columns corresponding to periods, whi later, struggling with the presence of two sets similar elements in the long periods, Mendelei deliberately telescoped the 'long chart' into the 'sho chart'. Subsequent history of the periodic table h shown, however, that the 'long chart' is in a bett agreement with the modern view of atom structure and is more suitable for certain branch of science.

S. I. TOMKEIEFF

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[1] Lomonosov, Lobachevsky, Mendeleieff. By B. G. Kuznets [Russian text.] Pp. 332. (Moscow: Acad. Sci. U.S.S.R., 194 22 r. [10s.] [Mendeleieff, pp. 189–332.]

[2] Dmitry Ivanovich Mendeleieff. By O. Pisarzhevsky. [Russi text.] Pp. 471. (Molodaya Gvardia, 1949.) 8 r. [3s. 6d.].

[3] Dmitry Ivanovich Mendeleyev. His life and work. By O. N. Pis zhevsky. [English text.] Pp. 102. (Moscow: Foreign Langua Publishing House, 1954.) [2s.]

[4] Seventy-five Years of the Periodic Law of D. I. Mendeleieff and the Russian Chemical Society. Edited by S. I. Volfkovich a V. S. Kiselev. [Russian text.] Pp. 265. (Moscow: Acad. S U.S.S.R., 1947.) 16 r.

[5] D. I. Mendeleieff. New Materials relating to the History of t Discovery of the Periodic Law. Edited by N. A. Figurovsk [Russian text.] Pp. 145. (Moscow: Acad. Sci. U.S.S.R., 195 10 r. 35 k. [9s.].

[6] D I. Mendeleieff. Scientific Archive. Edited by A. V. Topchie Vol. 1, Periodic Law. The Natural System of Elements. Man scripts and Tables. 1869–1871. [Russian text]. Pp. 86 (Moscow: Acad. Sci. U.S.S.R., 1953.) 42 r. 40 k. [36s.].

The price given in shillings refers to that payable in London.

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# APPARENT TRANSFORMATION OF COLLAGEN FIBRILS INTO 'ELASTIN'

By PROF. D. BURTON, DR. D. A. HALL, DR M. K. KEECH, DR. R. REED, MISS H. SAXL,
PROF. R. E. TUNBRIDGE, O.B.E., and MISS M. J. WOOD
University of Leeds

THE present communication deals with certain electron microscopical, histological and biochemical observations which appear to indicate a possible transformation of collagen fibrils into elastin-like material. This work forms part of a general study of the properties of connective tissue undertaken in the University of Leeds by the Nuffield Gerontological Unit (Dr. D. A. Hall, Miss H. Saxl) and the Departments of Medicine (Dr. M. K. Keech, Prof. R. E. Tunbridge) and Leather Industries (Prof. D. Burton, Dr. R. Reed, Miss M. J. Wood).

On the basis of electron-microscope[1] and biochemical studies[2], it has been suggested that the material common to all forms of elastic tissue is a complex system, consisting of two types of long-chain molecules, one a mucoprotein, the other a polypeptide chain, coated by a dense cement material—the so-called elastomucin. Morphologically, under the electron microscope, elastin-like fibrils are uniformly dense, ill-defined in shape, with no specifi structural feature, in contradistinction to the fibril of collagen, which have characteristic cross-striation (Fig. 1).

## Electron-Microscope Studies

As a source of collagen fibrils for possible con version to elastin, use has been made of preparation obtained by the modification of Neuman's method described by Keech[3]. These preparations have bee obtained from abdominal skin of patients of variou ages, ranging from nine to eighty-two years. Althoug Neuman[4] claims that this material is the purest an least degraded form of collagen available, there is n evidence that the extraction procedure does no affect the intra-fibrillar constituents, especially poly saccharide. However, it would appear that th ground substance has been removed, and any effect observed arise from the collagen fibrils themselves and not from any extraneous source. For com

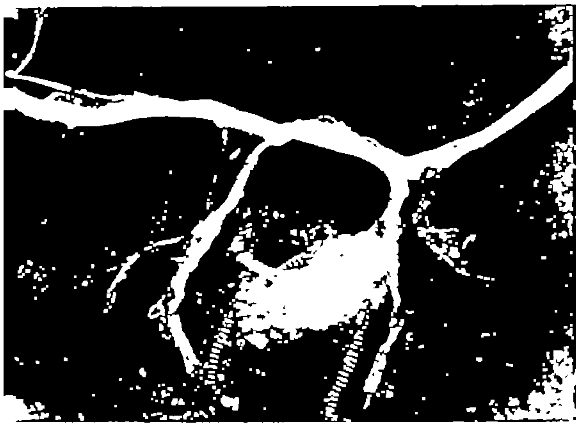

Fig. 1

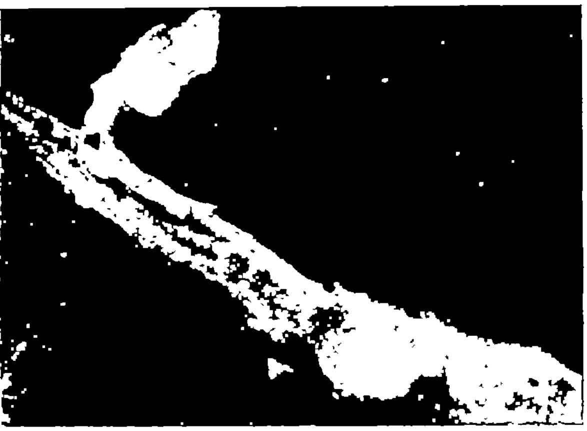

Fig. 2

Fig. 1. Control material from fresh whole dermis (7-year old child) showing striated collagen fibrils and an elastin-like fibre.
Fig. 2. Prepared dermal collagen, from a child aged 9 years, following incubation with borate buffer ($p$H 8·8) for 24 hr. at 37° C. Apparent transformation of bundle of collagen fibrils into 'elastin'

arison, fresh samples of skin were also examined. ll preparations contained a small quantity of enicillin and streptomycin mixture, which successully prevented bacterial contamination.

As part of a general survey of the effects of various eagents, for example, acids, alkalis and enzymes, on ollagen, the substrates were treated with borate uffer solutions ($p$H 7–10·4) at 37° C. for varying eriods of time. The electron microscope revealed a arked increase in amorphous material associated ith degenerate collagen fibrils, and, by comparison ith the controls, an increase in structures closely esembling the fibres of elastic tissue (Fig. 2). Moreover, the longer the time of treatment, the greater he number of such structures. In addition, collagen brils in various stages of modification were observed, anging from the typical banded appearance to fragents of irregular shape, some showing a filamentous tructure. This variety of structures indicated that ertain collagen fibrils had degenerated, with the roduction of large quantities of amorphous material; he latter then apparently coated the many types of brils present, cementing them together and rendering he cross-striations and fibril outline indistinct. A rther finding in collagen treated with alkali was the resence of a large number of dense, fine threads, bout 150–250 A. in diameter and ranging in length from 2000 A. to about 4000 A. Their form varied, being either rod-like or curved with slightly tapered ends, both types occurring together (Fig. 3). These fine threads were randomly distributed on and between the collagen fibrils and were observed in all experiments in the range of $p$H values from 7 to 10·4, but only in the early stages of the treatment. At $p$H 9·8 and 10·4 the threads were longer and slightly thicker than those recorded at lower values, but after 2 hr. treatment at 37° C. they were no longer seen.

As the age of the sample increased, the effects observed, although still apparent, became more difficult to assess in view of the fact that the controls contained larger proportions of elastin-like structures.

Similar morphological appearance, that is, fibres resembling elastin in all stages of formation, were observed following the treatment of collagen with 1 per cent sodium metaperiodate in phthalate buffer of $p$H 5·0 at 37° C. for times ranging from 1 to 6 hr. (Fig. 4). It may be significant, however, that at this $p$H no threadlike structures were produced. Incubation with trypsin and chymotrypsin (each obtained from pig and ox) in phosphate buffer of $p$H value 7·3 at 37° C. for times ranging from 3 to 24 hr. also produced elastin-like structures.

Transformation into elastin-like structures was also observed, although the changes in the adult tissue

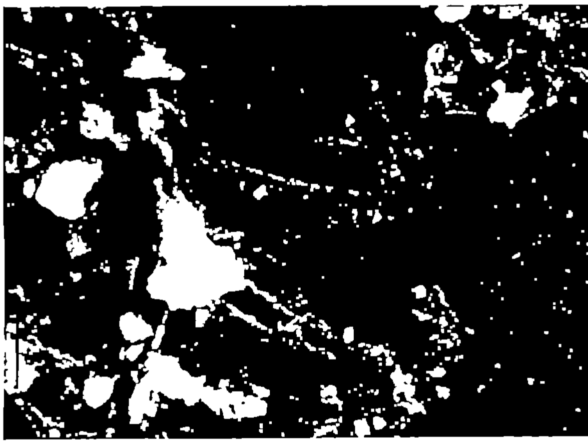

Fig. 3

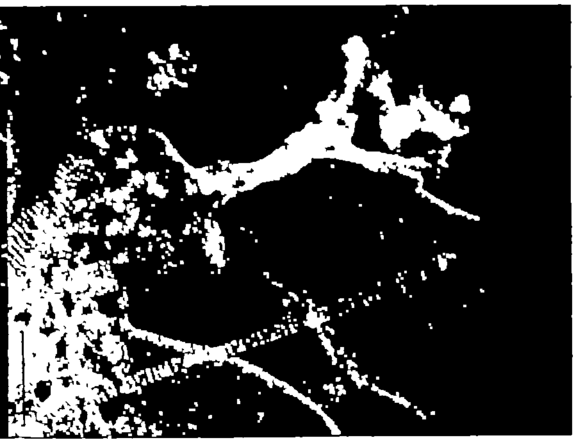

Fig. 4

Fig. 3. Same substrate and conditions as Fig. 2. Incubation time 14 hr., showing collagen, amorphous material and fine thread-like structures randomly distributed throughout the field. Fig. 4. Same substrate as Fig. 2 treated with 1 per cent sodium metaperiodate in buffer ($p$H 5·0) for 1½ hr. at 37° C. The degenerate collagen appears to be changed into 'elastin'

were less marked when fresh whole dermis was treated in borate buffer, pH 8·8 at 37° C.

It appears, therefore, that alkalis and certain pancreatic enzymes in alkaline solution, by acting on collagen at 37° C., may bring about profound changes. In the early stages of the reaction, small, threadlike structures are produced. Later, these can no longer be observed and many of the collagen fibrils appear to disintegrate with the formation of much amorphous material. Thus, there are strong morphological grounds for believing that collagen fibrils, under certain conditions—particularly those which are known to affect mucopolysaccharides—are capable of being transformed into structures closely resembling elastin tissue fibres. It is clear, however, from the electron micrographs, that the conversion of collagen into material resembling elastic tissue is not complete, that is, some collagen fibrils retain their characteristic cross-striated appearance.

## Biochemical Studies

Morphological similarity alone, however, is no proof of strict identity and hence, parallel with the electron microscope work, biochemical studies were also made. Previous work on the amino-acid analyses of collagen and of chemically treated elastic tissue, which from the point of view of the electron microscope was apparently devoid of collagen fibrils, indicated marked differences in the relative amounts of certain amino-acids[5], a fact which in the past had caused us repeatedly to reject the possibility that elastin could be derived from collagen. Hydroxyproline constitutes 10 per cent of the amino-acid residues in collagen, but only 1·6 per cent of those in elastin. Hence the complete conversion of collagen into elastin should involve the removal of about 100 moles hydroxyproline for each $10^5$ gm. of collagen. At the same time, other amino-acids which are also of low concentration in elastin would be expected to be lost.

In the initial stages of this work, since it was impracticable to examine the changes in all amino-acids, hydroxyproline was chosen for immediate study. Collagen preparations were obtained by methods identical to those used in the electron-microscope work; in addition, the treatment with alkaline buffer solutions was taken as the least complicated procedure for which biochemical confirmation of the structural findings might be obtained. After treatment with alkaline buffer, the reaction mixture was centrifuged and the residue separated from the supernatant liquid. The protein content of the supernatant was determined by the method of Lowry *et al.*[6]. Appropriate aliquots of the supernatant were hydrolysed under reflux with 6 *N* hydrochloric acid for 24 hr. and the hydroxyproline determined by Martin and Axelrod's[7] modification of the Neuman and Logan reaction[8]. The reducing sugars in this hydrolysate were estimated by the prussian blue method[9].

In certain cases the residues were re-extracted with further buffer, while in others replicate samples were incubated for varying periods.

Two samples from young subjects (7 and 3 years) were examined after 24 hr. extraction and the hydroxyproline content of the extracted protein found to be 33 and 24 per cent, respectively. After a further 40 hr. extraction, the percentage hydroxyproline in the protein from the latter sample was 18 per cent. Examination of a 15-year old subject demonstrated further the dependence of the hydroxyproline level on the time of extraction (Table 1).

Table 1

| Time of extraction with buffer (hr.) | Protein extracted (per cent of dry weight) | Hydroxyproline content of extracte protein (per cent) |
|---|---|---|
| 12 | 1·30 | 12·9 |
| 20 | 1·66 | 13·1 |
| 41 | 1·85 | 18·3 |
| 65 | 2·25 | 10·8 |
| 118 | 2·60 | 9·7 |

It would appear, therefore, that either the concentration of hydroxyproline of the extracted prote varies, or, more likely, a number of protein fractio are extracted simultaneously, and the varyi hydroxyproline content of the whole is merely function of their varying rate of extraction.

The degradation of the collagen accompanied by variable retention of either hydroxyproline-rich hydroxyproline-poor polypeptides has been borne o by further studies. In a number of other sampl examined, the hydroxyproline content of the extra was very low indeed, remaining less than 6 per cen for the first 24 hr. extraction over an age-range fro 5 months to 61 years, although the amount of prote extracted dropped progressively with age. The san variability was also observed in estimations of th liberated polysaccharide, for on those occasions whe protein with high hydroxyproline content wa extracted during the first 24 hr. the polysacchari content was proportionally high.

Preliminary experiments with fresh tissue throug which buffer was forced under pressure, followed b the fractional collection of the eluate, have produce results completely in conformity with the abov observations. By this procedure, it has been possib to separate a protein fraction rich in hydroxyprolin in a limited volume of eluate. The average hydrox proline content of this material is 40 per cent, an although insufficient material has as yet bee obtained for a complete analysis, it is noteworth that arginine, another of the amino-acids which is a markedly different concentration in collagen an elastin, is also present in the extracted protein i very high concentration.

## Histological Studies

Samples of the skin tissue which had been extracte with alkaline buffer under pressure as above wer examined histologically. Both frozen sections an teased preparations fixed in formol-saline wer examined after staining with Hart's modification o Weigert's stain by normal and by polarized light.

Lamellar structures were observed in both th control and the treated material, but were mor numerous and exhibited a wider variety of stainin properties in the latter. Some of the lamellæ in th treated material were unstained, refractile and highl anisotropic and associated with dark blue-black masse of amorphous material. Other lamellæ in the treate material stained pale blue or pink and were anisotropic whereas others stained like elastin and were no anisotropic. Further structures, histologically indis tinguishable from elastin, in the form of wavy intensely blue-black fibrils were observed. Highl anisotropic lamellar structures of this type have bee described by A. J. Cruise (personal communication in skins of various animals and in human achille tendon. He also reported that they can be split u into fine fibrils by crushing. Occasionally non staining anisotropic lamellar structures have bee observed so arranged that it might be inferred tha hey have been formed as a result of the fusion of collagen fibrils. Since such a wide range of staining properties and degrees of anisotropy exist, it is ossible that this gradation reflects the production f material staining like elastin from collagen. Whether such is the case or not, the fact remains that material staining like elastin is produced from collagen under conditions known to be associated with comparable biochemical changes.

## Discussion

It appears, therefore, that under conditions which lead to the transformation of collagen fibrils into structures closely resembling those found in naturally occurring elastic tissue, protein fractions rich in hydroxyproline and arginine are liberated from the collagen. Such changes in the distribution of amino-acids in the system are those to be expected from a comparison of the chemical composition of both collagen and elastin, and by themselves support the view that the transformation product is indeed elastic tissue. It is clear, however, that if elastin is derived from collagen fibrils, the transformation must involve a deep-seated and complex breakdown of some of the polypeptide chains of collagen, particularly since protein fragments low in hydroxyproline and arginine content are released simultaneously.

This generalized breakdown of collagen followed by recombination of certain of the products to form 'elastin' is consistent with the existence of 'elastins' of varying composition, since the degree of degradation, and the composition of the resultant amorphous elastomucin, can presumably vary over quite wide limits without affecting the ill-defined morphology of the elastin fibre. This possibly explains the varying composition of 'young light' and 'old heavy' elastins (Lansing)[10], and probably accounts for the observation that a third component, apparently intermediate in properties between elastin and collagen, exists in aorta tissue. From its amino-acid content, Hall has suggested that this component resembles collagen[5]. The possibility that collagen fibrils actually form an integral part of certain natural elastins has been suggested by Banga[11], and certain of our preliminary observations support this view.

Elastin supposedly freed from collagen by prior treatment with acetic acid[9] was examined under the electron microscope and found devoid of visible collagen. Following incubation with collagenase at 37° C., the presence of collagen-like fibrils was revealed which were ultimately completely digested by the enzyme.

It would appear from the fact that the transformations occur equally in the case of collagen completely freed from ground substance, that is, prepared by the modification of Neuman's method described by Keech[3], and in fresh tissue, that the transformation is essentially a property of the collagen fibrils themselves and is not dependent on the presence of ground substance or matrix. This does not preclude the participation of the ground substance in any *in vivo* process.

As might be expected, since the transformation conditions are those which are likely to affect the mucoprotein links in collagen, the release of protein fractions rich in hydroxyproline is invariably accompanied by the release of carbohydrate material with a high content of reducing sugars. This not only confirms the importance of polysaccharides in helping to determine the stability of collagen fibrils, but also points to a possible close association of hydroxyproline and polysaccharide in collagen. In any event, the present studies indicate that hydroxyproline residues may also be of particular importance in aiding the cohesion of collagen fibrils, in agreement with the recent work of Gustavson[12], who has shown that the hydroxyproline content of various forms of collagen is an index to their thermal stability.

In 1894, Unna[13] suggested that there exists a family of connective tissue components with differing tinctorial characteristics showing a full spectrum of properties between collagen and elastin. These substances, which were observed in pathological tissue, he named collacin, collastin and elacin, and claimed they were degradation products of collagen on one hand and elastin on the other. There has been much doubt as to the identity of these materials, especially after chemical analyses of so-called typical examples of collagen and elastin had shown how markedly these two differed in amino-acid composition[14]. However, no one has as yet been able to describe any cell to which definite elastoblastic activity could be ascribed, and recently the morphogenetical dependence of elastin on collagen has been emphasized. For example, Robb-Smith[15] says: "In the embryo and in healing wounds elastica appears later than the collagen fibrils, and indeed it would appear that collagen is a prerequisite for its formation".

If some process similar to that induced artificially by alkali described above is operative *in vivo*, many of the anomalous observations of embryology, pathology and histology could be explained. If collagen can be transformed into elastin, there is no need to postulate a separate elastoblast. The presence of elastin in smaller or greater amounts in most sites containing collagen is explained, and degenerate diseased tissues which contain histologically elastin-like structures assume their proper position in the scheme of connective tissue components, since it has been shown that the elastin-like masses in senile elastosis are really degenerated collagen with excess of amorphous material[16].

On the basis of X-ray diffraction studies, Astbury has tentatively placed elastin in the collagen group of fibrous proteins[17]. These observations appear to support this contention.

Full details of the apparent transformation of collagen fibrils will be reported later.

The pancreatic fractions and collagenase (*Cl. welchii*) were kindly supplied by Dr. C. G. Pope, of the Wellcome Research Laboratory, and the collagenase (*Cl. histolyticum*) by Dr. J. D. MacLennon.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Isocitritase in *Escherichia coli*

Isocitritase, the enzyme which splits isocitric acid to succinate and glyoxylate, has been found in *Pseudomonas aeruginosa*[1,2] and *Penicillium chrysogenum*[3]. This communication describes this enzyme in *Escherichia coli*.

*E. coli* cells (strain *B26*) were grown for 24 hr. with aeration on a medium consisting of 1·5 per cent sodium acetate, 0·8 per cent potassium phosphate, 0·4 per cent ammonium sulphate, 10 per cent (by volume) tap water for inorganic ions and 0·1 per cent yeast extract at *p*H of 7·0. Initial experiments with extracts of these cells treated twice with 'Dowex-1' showed that citrate is metabolized to equivalent concentrations of succinate and glyoxylate without the production of carbon dioxide (Table 1). The same extracts, when fractionated to remove aconitase after the procedure of Smith and Gunsalus[1], were found no longer to produce these compounds from citrate or *cis*-aconitate but were active on isocitrate. The stoichiometry of the isocitritase reaction is shown in Table 2. Partially purified preparations required a divalent ion as well as cysteine. Isocitritase does not require coenzyme A or adenosine triphosphate, as indicated by the fact that treatment with 'Dowex' and dialysis which completely removes coenzyme A, and adenosine triphosphate does not alter its activity.

Table 1

Glyoxylate and succinate formation (µmoles) from citrate by cell-free extracts of *Escherichia coli*. Total volume of reactants, 3·0 ml. Each vessel contained the amount of citrate indicated, 1 ml. of an *E. coli* extract treated twice with 'Dowex', 5 µmoles of magnesium chloride, 10 µmoles of cysteine, 0·15 ml. of 1 *M* phosphate buffer *p*H 7·4 and 0·3 ml. of sulphuric acid in side-arm. Conditions completely anaerobic. Temperature, 33° C. Time of incubation, 60 min.

| Exp. No. | Citrate | | Δ Citrate | Products | | |
|---|---|---|---|---|---|---|
| | Initial | Final | | Succinate | Glyoxylate | Carbon dioxide |
| 1 | 19·02 | 11·05 | 7·97 | 7·19 | 7·85 | <1 |
| 2 | 19·02 | 9·99 | 9·03 | 8·11 | 10·64 | <1 |

Table 2

Glyoxylate and succinate formation (µmoles) from isocitrate. Total volume of reactants, 3·0 ml. Each flask contained the amounts of substrate indicated: 20 µmoles of cysteine, 10 µmoles of magnesium chloride, 10 µmoles of phosphate buffer, *p*H 7·4 and 0·8 ml. of enzyme. Time of incubation, 40 min. Temperature, 33° C.

| Substrate | Concentration | | Δ Substrate | Products | |
|---|---|---|---|---|---|
| | Initial | Final | | Glyoxylate | Succinate |
| Isocitrate | 11·5 | 5·7 | 5·8 | 6·0 | 4·7 |
| *cis*-Aconitate | 20·0 | | | 0 | 0 |
| Citrate | 20·0 | | | 0 | 0 |

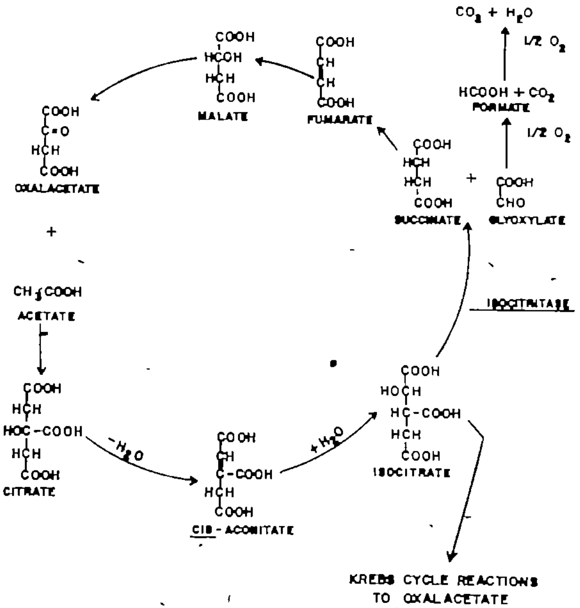

Fig. 1. An alternative cyclic pathway of acetic acid oxidation

Succinate was determined by the conventional succinoxidase procedure and glyoxylate by the method of Friedemann and Haugen[4]. To establish definitely the identity of glyoxylate, a large-scale experiment was performed and the glyoxylate isolated as its 2,4-dinitrophenylhydrazone. The material upon recrystallization from a mixture of ethyl acetate and petroleum ether had a melting point between 189° and 191° C., as did the hydrazone of authentic glyoxylate.

Radioactive citrate, prepared with the condensing enzymes and incubated with isocitritase plus aconitase, cleaved the $C_6$-acid asymmetrically to yield unlabelled glyoxylate and radioactive succinate (Table 3).

The dissimilation of the $C_6$-tricarboxylic acid to succinate and glyoxylate makes an interesting list of important intermediates from the tricarboxylic acid cycle. In this case, succinate can continue through the cycle so long as glyoxylate is available for amino-acid synthesis. According to Campbell[5], the energy produced during one turn of the cycle should be only 40 per cent of that obtained from the conventional scheme. It is also conceivable, however, that the glyoxylate is oxidized to carbon dioxide and water, in which case acetate would be oxidized to completion via a cyclic mechanism depicted in Fig. 1.

The overall picture of this series of reactions is one in which one mole of acetyl-coenzyme A enters the cycle and is oxidized to carbon dioxide and water via glyoxylate, while oxalacetate is first converted to succinate via isocitrate and is then regenerated

Table 3

Formation of radioactive succinate from labelled citrate. Total volume of reactants, 3·0 ml. Each vessel contained 1 ml. of enzyme (aconitase plus isocitritase), 10 µmoles of cysteine, 0·15 ml. of 1 *M* phosphate buffer, *p*H 7·4, 0·3 ml. sulphuric acid in side-arm and 18·52 µmoles of citrate containing 639 counts/min./µmole

| Citrate | | | Δ Citrate (µmole) | Succinate | | Glyoxylate | |
|---|---|---|---|---|---|---|---|
| Initial (µmole) | Final (µmole) | Initial specific activity (counts/min./µmole) | | Conc. (µmole) | Specific activity (counts/min./µmole) | Conc. (µmole) | Specific activity (counts/min./µmole) |
| 18·52 | 11·57 | 639 | 6·65 | 5·53 | 702 | 7·82 | inactive |

by the oxidation of succinate via fumarate and malate. It is interesting to note that some evidence already exists in the literature to support this hypothetical scheme of acetate oxidation. Campbell[6], studying the mechanism of allantoin degradation by an unidentified *Pseudomonas*, presented convincing evidence that allantoin is broken down in the following manner : allantoin → allantoic acid → glyoxylic acid + urea ; glyoxylic acid → formate + carbon dioxide ; formate → carbon dioxide + water. Since various species of the genus *Pseudomonas* contain the enzyme isocitritase and are known to contain all the other enzymes necessary for the conversion of acetate and oxalacetate to isocitrate via fumarate and malate, it is not beyond reason to assume that acetate may indeed be oxidized to carbon dioxide and water by this alternate series of cyclic reactions. Investigations are now being conducted in our laboratories to determine whether *E. coli* might oxidize acetic acid in this manner.

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## Fractionation of the Deoxyribonucleic Acid of *T2r* Bacteriophage

A NUMBER of investigations indicate that the deoxyribonucleic acid (DNA) of *T2* bacteriophage plays a major part during the infection of its bacterial host and in the maintenance of genetic continuity during the multiplication process[1]. Recent work[2] has demonstrated the inhomogeneity of deoxyribonucleic acid from various sources with respect to the content of the purine and pyrimidine bases and the ease of dissociation from complexes with basic proteins. This communication describes results obtained by applying a chromatographic fractionation procedure based on the latter property to the deoxyribonucleic acid of *T2r* bacteriophage.

Large-scale lysates of the *T2r* strain were obtained by growth in aerated bottles and the bacteriophage purified by the method of Herriott and Barlow[3]. Deoxyribonucleic acid was prepared (private communication from A. D. Hershey) from the purified bacteriophage after precipitation in 95 per cent alcohol by resuspending in 0·2 *M* sodium chloride, agitating with chloroform in a blender and centrifuging to remove denatured protein. After three such treatments with chloroform, the process was repeated with a 9 : 1 chloroform – octanol mixture until no further denatured protein precipitate was formed. The deoxyribonucleic acid was then precipitated in 95 per cent alcohol, washed in 75 per cent alcohol and stored in 75 per cent alcohol at 4° C. until required.

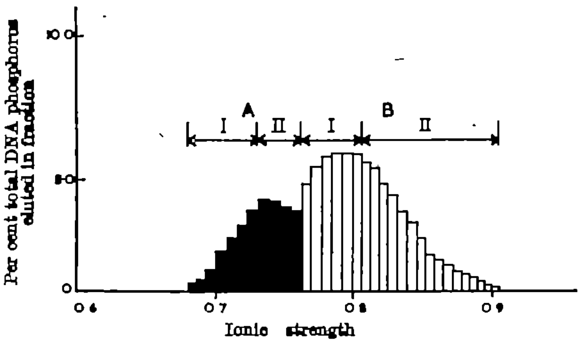

Fig. 1. Elution of *T2r* bacteriophage deoxyribonucleic acid from a column of cellulose–histone by a concentration gradient of sodium chloride at *p*H 6·8. The percentage of total deoxyribonucleic acid phosphorus eluted in a fraction is plotted against the ionic strength of the fraction

Calf thymus nucleohistone prepared by the water-extraction procedure of Crampton *et al.*[4] was extracted with 0·2 *N* hydrochloric acid and the extracted histones fractionated on columns of phosphorylated cellulose prepared by the method of Hoffpauir and Guthrie[5]. Elution by a gradient of *p*H and sodium chloride between *p*H 9·0 and *p*H 13·0 and 0·2 *M* to 1·0 *M* respectively was used, and the fraction coming from the column between *p*H 10·1 and *p*H 10·4 was attached to cellulose after denaturing by heating to 100° C. for 10 min. The diazotization method originally used by Campbell *et al.*[6] to couple albumin to cellulose was used here to couple the denatured histone to cellulose to form a material to which deoxyribonucleic acids are adsorbed at low salt concentrations and from which they can be eluted at high salt concentrations.

5–10 mgm. of the bacteriophage deoxyribonucleic acid were slowly eluted from a column of the cellulose–histone complex, 70 cm. long and 2 cm. in diameter, over a period of 40 hr. by a solution of continuously increasing concentration of sodium chloride buffered at *p*H 6·8. The deoxyribonucleic acid was eluted, as shown in Fig. 1, where it is evident that there are two distinct fractions *A* and *B* ; this was confirmed by repeating the elution on the pooled fractions *A* and *B* separately. Deoxyribonucleic acid prepared from *T2r* bacteriophage after osmotic shock[7] gave the same elution diagram, demonstrating that the method of preparation was not responsible for the bimodality observed.

That *A* and *B* are two distinct deoxyribonucleic acid species was finally confirmed by measurements of the contents of purine and pyrimidine bases which were made on the pooled fractions *A* and *B*, and also on the first and second halves of *A* (*A*I and *A*II), and on the first and second halves of *B* (*B*I and *B*II) to be eluted from the column. The contents of purine and pyrimidine bases in the fractions were measured after hydrolysis with formic acid[8] by two-dimensional chromatography (ref. 1, Hershey, Dixon and Chase). The results of base analysis on fractions from three separate fractionations are shown in Table 1, expressed briefly as the ratio of the content of adenine and thymine to the content of guanine and 5-hydroxy-

Table 1. BASE RATIOS OF *T2r* DEOXYRIBONUCLEIC ACID FRACTIONS

| | Unfractionated *T2r* DNA | Fractions | | | | | |
|---|---|---|---|---|---|---|---|
| | | *A* | *A*I | *A*II | *B* | *B*I | *B*II |
| $\frac{\text{Adenine + thymine}}{\text{Guanine + 5-hydroxymethylcytosine}}$ | 2·06 | 1·89 | 1·88 | 1·92 | 2·14 | 2·15 | 2·21 |

methylcytosine, each value being the mean of six estimations.

It appears, then, that the deoxyribonucleic acid prepared by the above methods from *T2r* bacteriophage contains two fractions, one containing approximately 30 per cent of the total deoxyribonucleic acid phosphorus, with the ratio adenine + thymine/guanine + 5-hydroxymethylcytosine approximately equal to 1·9, and the remaining 70 per cent with that ratio approximately equal to 2·15. As it is unlikely that these distinct fractions would be produced by degradation of a larger single molecule by the preparative methods used, this means that the *T2r* bacteriophage particle contains at least two different species of deoxyribonucleic acid molecule which differ in their ease of dissociation from basic protein and their content of purine and pyrimidine bases.

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# Crystalline Inhibitors of Trypsin from Potato

RECENTLY, Sohonie and Ambe[1] have reported the preparation of crystalline inhibitors of trypsin from field-bean and double-bean. Unlike these inhibitors, which are comparatively stable to heat treatment, the acid extracts of potato (*Solanum tuberosum*) have been found to contain a thermolabile inhibitor[2]. We have now examined the possibility of preparing this inhibitor in quantity in a crystalline form.

A method similar to that described for the crystallization of field-bean and double-bean inhibitors[1] was successfully employed, with the difference that all the operations were carried out in the cold to minimize any loss of activity in the course of preparation. The crude inhibitor, precipitated by ammonium sulphate, yielded two fractions. One was extracted by 2·5 per cent trichloroacetic acid, while the other, insoluble in trichloroacetic acid, was removed from the residue, in 1 per cent saline. Further purification, lyophilization and crystallization were carried out essentially as described in the previous communication.

Both fractions are dirty white in colour, soluble in water and twice as potent as the inhibitors from field-bean and double-bean. These were also found to have a powerful anticoagulant action on citrated human plasma.

Heat treatment resulted in 80–90 per cent destruction of the activity. Both components gave characteristic protein reactions and were found differ widely in lysine, histidine and methionin contents.

A detailed report of the study of the differe physico-chemical properties, etc., of the potat inhibitor fractions will be published in the *Journ of Scientific and Industrial Research* (India). We a grateful to the Council of Scientific and Industr Research (India) for financing this work and for personal grant to one of us (K. S. A.).

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# Interference between Variants of Pseudorabies Virus demonstrable in Tissue Culture

THE results of a series of investigations dealin with the cytopathogenic activity of pseudorabie virus have recently been reported from this Institute In these studies a strain of pseudorabies virus wa serially transferred in tissue suspensions derived fro chick embryos, and these served as a source of viru for the experiments. Destructive effects of the viru on tissue cultures made from fragments of embryoni chicken heart were recorded, and the cytopathogeni titre of virus material was used as a measure of it activity. Our present experiments have demonstrate that the virus became modified in its cytopathogeni activity for chicken cells by passages carried out i tissue suspensions of mouse embryo. The change i cytopathogenicity set in after four or five seria transfers of the virus in this tissue suspension. Th characters of virus materials serially passed in sus pensions of chicken and mouse embryonic tissu respectively are given in Table 1.

As is seen, the most striking feature of mous (*MEC*) virus is its low cytopathogenic effect o chicken cells. It should be noted that the change i properties of virus cultivated in mouse tissue wa not permanent. When *MEC* virus was serially trans ferred in embryonic chicken tissue, its destructiv effect for chicken cells gradually increased, and it ha regained its original properties within three to fiv passages.

The low cytopathogenic effect of *MEC* virus o chicken explants suggests a potential ability of thi

Table 1. CHARACTERS OF PSEUDORABIES VIRUS PROPAGATED I TISSUE SUSPENSION EITHER OF CHICK EMBRYO (*CEC* VIRUS) O MOUSE EMBRYO (*MEC*) VIRUS

| Mode of titration of virus | Virus material *CEC* No. of materials tested | Virus material *CEC* Geom. mean of titres | Virus material *MEC* No. of materials tested | Virus material *MEC* Geom. mean of titres |
|---|---|---|---|---|
| Cytopathogenic effect of virus on chicken cells | 45 | $10^{-}$[illegible] | 46 | $10^{-1\cdot15}$ |
| Cytopathogenic effect of virus on mouse cells | 4 | $10^{-}$[illegible] | 11 | $10^{-}$[illegible] |
| In young chickens intracerebrally | 1 | $10^{-}$[illegible] (*LD*50) | 1 | $10^{-4}$ (*LD*50) |
| In mice intracerebrally | 20 | $10^{-}$[illegible] (*LD*50) | 34 | $10^{-}$[illegible] (*LD*50) |

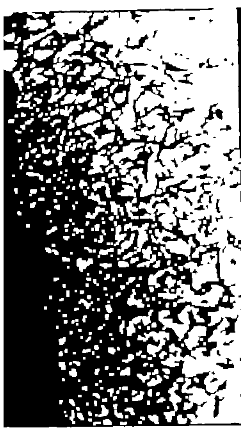

Fig. 1. Explant of embryonic chicken heart previously exposed to $10^{-4}$ dilution of *MEC* virus material and cultivated for 72 hr. with *CEC* virus of $10^{-4}$ dilution. × 75

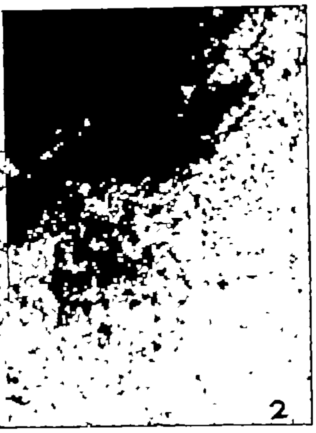

Fig. 2. Control explant cultivated for 72 hr. in the presence of $10^{-7}$ dilution of *CEC* virus. × 75. Note complete destruction of tissue culture

ariant to interfere with virus material highly estructive for chicken cells (*CEC*). To test this ossibility, fragments from embryonic chicken heart ere added to a nutrient medium containing *MEC* irus in a dilution of $10^{-3}$–$10^{-4}$ and kept at 37° for 1 hr. Simultaneously, control tissue material was lso incubated. Next day, sets of tissue explants ere made in chicken plasma from both tubes, in- ected with a serial dilution of *CEC* virus and re- ncubated for three days. As a mean value of eleven xperiments, the cytopathogenic titre for cultures ade from material treated previously with *MEC* irus was $10^{-3.7}$, whereas that of the control was $0^{-7.8}$.

Our observation is in many respects similar to that f Sabin[2], who found that after exposure to a non- ytopathogenic variant of poliomyelitis virus, epi- helial cells derived from monkey kidney had acquired limited resistance to the destructive effect of nmodified virus.

Full details of these observations will be published n the *Acta Microbiologica Hungarica*.

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## Elimination of Adrenaline and Noradrenaline from the Circulating Blood

THE mode, the loci, and the extent of the inactiva- ion of the sympathetic hormones are only partly nown. The liver has been considered of prime mportance. A minor fraction of injected catechols ppears in the urine. Recently, the rather generally occurring enzyme amine-oxidase has been extensively tudied as the agent responsible for a more general, peripheral' elimination.

The method described in this preliminary communication has made possible *in vivo* studies to determine which tissues are capable of eliminating adrenaline and noradrenaline from the blood stream. Furthermore, the extent of this removal over a certain length of time has been evaluated fairly closely. Briefly, the approach was as follows. Cats were used in which any release of endogenous catechol was cut down to a minimum by transection of the cervical spinal cord and extirpation of the adrenal glands. Adrenaline or noradrenaline was administered into the circulating blood at a constant speed, either intra-arterially to the tissue area studied, or intravenously into the brachial vein. The level of contraction of the chronically denervated nictitating membrane was used as an indicator of the concentration of catechols in the systemic circulation. The minimal effective dosage of adrenaline and noradrenaline on the denervated nictitating membrane was explored by intravenous administration at a constant rate. The actual experiment was started with an intra-arterial infusion of the drugs to the tissue area studied. After some minutes, when a steady state had been established, the intra-arterial infusion was momentarily shifted to an intravenous one, without any change of the actual amount administered. From a theoretical point of view, any of three alternatives might show up:

(1) The tissue area studied might not be capable of any elimination of adrenaline or noradrenaline. In this case the amounts infused intra-arterially must reappear quantitatively at the venous side after the steady state is established. A momentary shift of the route of administration of catechols to an intravenous route would therefore not influence the concentration of catechols in the systemic circulation, and thus leave the nictitating membrane unaffected.

(2) If a fraction of the intra-arterially infused catechols was locally eliminated, less would reappear in the venous outflow than entered the area on the arterial side. A shift of the infusion to an intravenous route would then reveal the extent of the local catechol loss by a corresponding increase of the contraction of the nictitating membrane.

(3) A third possibility, recently seriously claimed (see, for example, Granaat[1]), postulates that certain tissues actively secrete catechols when influenced by the sympathetic hormones, and that actually more catechols leave the area than ever entered it.

In most of the experiments of the present series, adrenaline or noradrenaline was infused through the cannulated inferior mesenteric artery into the lower abdominal aorta of the eviscerated animal, and thus primarily directed to an area comprised of skeletal muscle and skin. The results were quite uniform. The shifting of the infusion from an intra-arterial to an intravenous route, without any change of the actual dosage, was followed by a rapid and pronounced contraction of the denervated nictitating membrane, indicating a corresponding increase in the concentration of catechols in the systemic circulation. The extent of the loss of catechols following the intra-arterial administration could then be measured by applying the ordinary procedures of a biological assay. From a quantitative point of view, the elimination of catechols in the tissue area referred to was quite impressive. In the cat the upper limit of catechol release from the adrenals is roughly 5 μgm./kgm./min. However, even during extreme physiological stress, such as asphyxia, the amounts released seldom exceed 2–3 μgm./kgm./min. (ref. 2).

In the present series, the tissue area primarily reached by the intra-arterial infusion into the lower abdominal aorta approximately equals one-third of the animal. From this, it appears that the skeletal muscle – skin area under examination during a single passage of blood eliminates up to 90 per cent of the amounts of catechols infused. This holds true so long as the dosage was kept within the physiological range of adrenal discharge. When higher concentrations of adrenaline or noradrenaline were given, a proportionally larger fraction of the amounts infused intra-arterially reached the venous side, indicating that the rate of local elimination of catechol was no longer able to cope with the increased rate of intra-arterial infusion (Fig. 1).

The extensive loss of the sympathetic hormones in this rather non-specific tissue area can only in part be attributed to amine-oxidase, since all the basic findings were still present after the administration of specific inhibitors of this enzyme. Neither was it possible to find a clear-cut distinction as to the affinity of adrenaline and noradrenaline to the unknown mechanism responsible for the observed elimination of these substances. However, noradrenaline was not eliminated more rapidly than adrenaline; rather, the contrary appeared to be the case.

Additional experiments were carried out on other tissue areas, such as the spleen, the kidneys and the intestines. The basic findings did not vary from those already mentioned, although quantitative differences require further study. In addition, the effects of graded hypoxia are under investigation, since it has been noticed that asphyxia might reduce the extent of local loss of catechol in different regions.

Hence a variety of tissues, including skin and skeletal muscle, which, as regards their status in metabolism, must be considered rather poorly differentiated, are able to eliminate adrenaline and noradrenaline from the circulating blood. It seems fair to assume that the elimination of locally released transmitter substances at postganglionic sympathe nerve endings might be still more successful.

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## Metabolism of Two Aromatic Amines in the Dog

CLAYSON[1] has suggested that aromatic amines a carcinogenic by virtue of their transformation in t animal body into orthohydroxyamines. Walpol Williams and Roberts[2] have shown that 4-amin diphenyl is a potent inducer of bladder tumours the dog, and Spitz (quoted by Walpole *et al.*[2]) h obtained bladder tumours in this species wit benzidine. The purpose of this communication is show that these aromatic amines are in fact converte into orthohydroxyamine derivatives by the dog.

4 : 4'-Diamino-3-diphenylyl hydrogen sulphate an 3-hydroxybenzidine were synthesized as follow 4'-Nitro-4-aminodiphenyl was converted by oxidatio with alkali and ammonium persulphate to sodiu 4'-nitro-4-amino-3-diphenylylsulphate (found: lo on drying, 13·7; S, 8·4; $C_{12}H_{9}O_{6}N_{2}NaS.3H_{2}$ requires loss 14·0; S, 8·3 per cent); 4'-nitro- amino-3-hydroxydiphenyl hydrochloride monoh drate (found: C, 51·2; H, 4·5; N, 10·2 $C_{12}H_{11}O_{3}N_{2}Cl.H_{2}O$ requires C, 50·8; H, 4·6; N 9·9 per cent) obtained by hydrolysis was cha acterized as the diacetyl derivative (found: N, 8·8 $C_{16}H_{14}O_{5}N_{2}$ requires N, 8·9 per cent), melting poin 189–190°. Sodium 4'-nitro-4-amino-3-diphenylyl sulphate was reduced with ferrous sulphate an ammonia to 4 : 4'-diam ino-3-diphenylyl hydro gen sulphate (found: C 51·1; H, 4·2; N, 9·8 S, 11·2; $C_{12}H_{12}O_{4}N_{2}$ requires C, 51·4; H 4·3; N, 10·0; S, 11· per cent), which wa hydrolysed to 3-hydroxy benzidine (found: N 13·8; $C_{12}H_{12}ON_{2}$ re quires N, 14·0 per cent) melting point 182–184° tribenzoate (found: C 77·3; H, 4·8; N, 5·7 $C_{33}H_{24}O_{4}N_{2}$ requires C 77·3; H, 4·7; N, 5· per cent), melting poin 270–271°. 4-Amino-3-di phenylyl hydrogen sul phate and 3-hydroxy-4 aminodiphenyl were pre pared by the method o Boyland and Sims[3].

Urine from dogs fe 4-aminodiphenyl (20 mgm./day) has bee chromatographed o paper in no fewer tha ten solvent systems. I

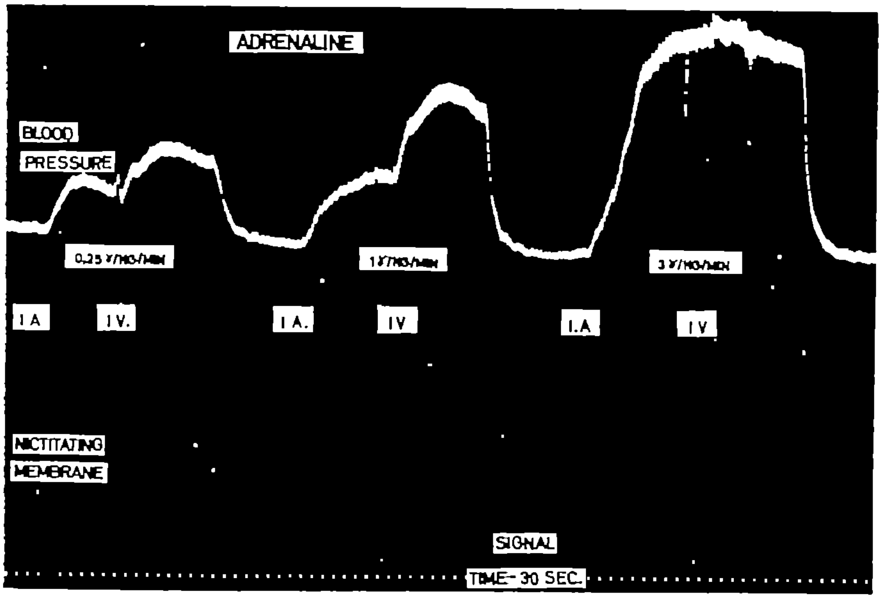

Fig. 1. Spinal cat, 3 kgm. Adrenals extirpated. Blood pressure at outset, 70 mm. mercury. Minimal effective dose of adrenaline on denervated nictitating membrane 0·1 μgm./kgm./min. intravenous. The records show the effects of three successive periods of adrenaline infusion into abdominal aorta versus intravenous infusion of the same concentrations

cases, only two spots could be demonstrated by raying with a solution of *p*-dimethylaminobenz-lehyde. A very faint spot corresponded to 4-amino-henyl. This spot was strengthened when ether tracts of the urine were examined. The second re intense spot travelled at the same rate as amino-3-diphenylyl hydrogen sulphate; hydrolysis the urine by boiling with acid gave a new spot rresponding to 3-hydroxy-4-aminodiphenyl.

Urine from dogs fed benzidine (500 mgm./day) was romatographed on paper in ten solvent systems. ree major and a number of other spots were monstrated with the *p*-dimethylaminobenzaldehyde ray. Benzidine and 4 : 4′-diamino-3-diphenylyl drogen sulphate were shown to be important etabolites of the amine. 3-Hydroxybenzidine was own to be present as a minor metabolite in some mples of urine. The other metabolites have not t been identified.

Continuous ether extraction of the urine of a dog d benzidine (500 mgm./day) for ten days enabled nzidine (400 mgm.; 8 per cent of the dose) and hydroxybenzidine (85 mgm., 1·5 per cent) to be lated. The benzidine, melting point and mixed elting point 124°, was characterized as the toluenesulphonate, melting point 241–242°, mixed elting point 242–243°. The monohydroxybenzidine, elting point 180–183°, was characterized as its ibenzoate, melting point 269°, mixed melting point 0–271°.

This work will be reported in detail later. We wish thank Dr. G. M. Bonser for making available the ological material.

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## Synergism in the Chemotherapy of *Eimeria tenella*

IN 1954, Lux[1] investigated the possibility that tent inhibitors of *Eimeria tenella* might be found nong compounds, other than sulphonamides, which terfered with the *p*-aminobenzoic acid – folic acid etabolic sequence. Lux found that a group of 4-diamino-pyrimidines possessed anticoccidial activity, one of the most active of the series being 4-diamino-5, *p*-chlorophenyl, 6-ethyl pyrimidine Pyrimethamine', 'Daraprim'). He noted, furtherore, that this compound, when used in combination ith certain sulphonamides, had a marked synergistic fect.

At Weybridge, we have extended these observations ith the view of developing effective systems of emotherapy for disease caused by *Eimeria tenella*. the past, 'Sulphamezathine' (sulpha-dimethylrimidine) has in our experience proved most satistory for treatment under practical conditions; t its use can be criticized on the grounds that the ncentration necessary to obtain a maximum theratic effect is sufficiently high to cause some degree of inappetence, that occasional toxicity is observed[2], and that the full therapeutic concentration is liable to cause temporary inhibition of the parasite, development being merely delayed until treatment terminates[3,4]. Our observations, which have confirmed those of Lux[1], have shown that, although 0·01 per cent 'Daraprim' in the food affords only partial protection against *E. tenella*, the synergism between this substance and 'Sulphamezathine' permits the reduction of the concentration of both compounds to a fraction of that ordinarily needed for therapeutic control. Thus, in the presence of as little as 0·0025 per cent 'Daraprim' in the food, the concentration of 'Sulphamezathine' may be reduced to between $\frac{1}{8}$ and $\frac{1}{16}$ of that normally required for complete protection.

Temporary inhibition, with delayed clinical manifestations of disease, occurs with a mixture of 0·01 per cent 'Daraprim' and 0·05 per cent 'Sulphamezathine', but not when the concentration of 'Daraprim' in the mixture is reduced to 0·0025 per cent. This suggests that the combination of drugs at these low concentrations has a markedly selective effect on the later stages in the life-cycle of the parasite, leaving unimpaired the earlier stages, the development of which Kendall and McCullough[3] have shown to be essential for effective chemotherapeutic control.

These findings are likely to be of marked practical importance, and it seems that the use of the synergistic combination will avoid the difficulties associated with the present use of the sulphonamides.

The synergistic action on *E. tenella* of 'Daraprim' and 'Sulphamezathine' can probably be explained as the effect of two antimetabolites which act sequentially at different stages in the same metabolic pathway, at the points at which *p*-aminobenzoic acid and folic and folinic acids are concerned.

This would suggest a close analogy between the metabolism of *E. tenella* and those species of *Plasmodium* on which 'Daraprim' and some sulphonamides also exert a marked synergistic effect[5]. *p*-Aminobenzoic acid has already been shown to be an essential metabolite for *E. tenella* by the observation of Horton-Smith and Boyland[6] that the action of 'Sulphamezathine' may be antagonized by *p*-aminobenzoic acid. No facts are available on the importance of folic and folinic acids for *E. tenella*, although 'Daraprim' is regarded as an antagonist of folic and folinic acids in several other biological systems[7].

If, in fact, the metabolism of *E. tenella* is similar to that of the plasmodia, other anti-malarials may be able to replace 'Daraprim' in synergistic combination with sulphonamides or other drugs of known coccidiostatic value.

Studies on the above lines are proceeding.

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# A Study of Normal Human Cerebrospinal Fluid by the Immuno-Electrophoretic Method

THE immuno-electrophoretic method[1] allows the definition of the constituents of a mixture of antigenic substances by means of their relative electrophoretic mobilities, and their enumeration, by specific precipitation, by means of a homologous immune serum. The study of normal human serum by this method has allowed the enumeration of at least sixteen different constituents[2].

We have studied, by the same method, normal cerebrospinal fluid concentrated by ultra-filtration[3], by using horse immune serum (No. 31) anti-normal human serum, which has been used in the study of human serum. In a parallel manner we have submitted the same samples of cerebrospinal fluid to ordinary electrophoresis on agar under the same conditions as used for immuno-electrophoretic analysis. The agar gels were then dried, and the protein and lipid constituents were stained *in situ* by methods similar to those used previously[4].

The plain electrophoretic analysis in a gelified medium shows (Fig. 1) that the cerebrospinal fluid contains: a substance which migrates more quickly than albumin; much albumin; a small amount of α-globulins; $\beta_1$- and $\beta_2$-globulins and a small amount of γ-globulins.

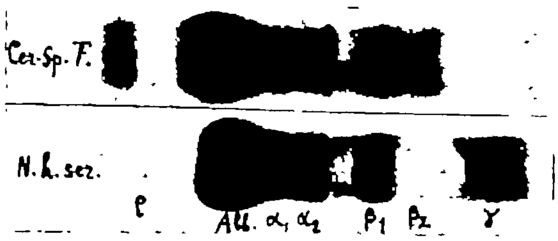

Fig. 1

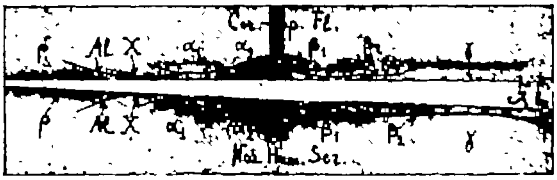

Fig. 2

The immuno-electrophoretic analysis (Fig. 2) allows us to distinguish the following: a constituent which migrates more rapidly than albumin and which would seem identical with the ρ-constituent of blood serum[2]; serum albumin; a constituent having the same mobility as albumin which is probably identical with the χ-constituent in blood serum[2]; one or probably two $\alpha_1$-globulins; three $\alpha_2$-globulins; at least one $\beta_1$-globulin; a single antigenic constituent having, however, two different migration-rates. This latter corresponds to the $\beta_2$-globulins and the small amount of γ-globulins which corresponds to the slow γ-globulins of the serum.

As we have used a total immuno-serum human antiserum, we could only distinguish in the cerebrospinal fluid constituents existing in the serum; there may also be other constituents specific to the cerebrospinal fluid. Our results do, however, demonstrate that the distribution of protein constituents in the cerebro-spinal fluid is not the same as in the ser itself.

Detailed results will be published in the *Bull. S Chim. Biol.*

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# Effect of Heat Stress on Serial Reaction Time in Man

EXPERIMENTAL studies of the effects of ambie temperatures on simple reaction time have suggest that there may be a negative correlation betwe simple reaction time and temperature, but resu appeared to be rather inconclusive. In fact Teichne in a review of studies of simple reaction tin concludes that ambient temperatures between − 5 and 117° F. have little or no effect on either simp reaction time or more complex reaction times.

In a series of experiments on the effects of ambie temperatures ranging from 90° to 104° F. (90–95 p cent saturation), we had occasion to study the effec of such temperatures on both simple reaction tir and serial reaction time. In serial reaction time t signals are presented to the subject continuously wi irregular occurrence of the signals to action, a without the warning signals customary in expe ments on simple reaction time. It may reasonab be argued that serial reaction time is a more realist measure than simple reaction time, since in the ski of everyday life we are seldom given warning of t arrival of a significant stimulus.

The apparatus used in these experiments was t Cambridge visual vigilance test[2], coupled to a phot electric cell and a pulse-height discriminator operatu a clock-starting relay. This gave a very accura measure of reaction time.

Seven subjects were tested over a period of fi days, serial reaction time being measured before ent into the heat chamber, after one hour exposure the above range of temperatures, and after two hou exposure. For each measurement of reaction tin the subject was presented with a large number stimuli in a short time (forty stimuli in 5 min. random order). The mean serial reaction times a shown in Table 1. It will be seen that the rise reaction time under heat stress is small but statistical significant.

Table 1

| | Mean serial reaction time (sec.) | *P* |
|---|---|---|
| Control | 0·247 | |
| First hour | 0·256 | |
| Second hour | 0·267 | |
| Control v. first hour | | 0·05* |
| Control v. second hour | | 0·01† |
| First v. second hour | | 0·05* |

* Significant.
† Highly significant.

From these experiments we conclude that serial action time offers a clear-cut index of psychomotor ange under heat stress of this order.

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## Fixation of Iodine in Selenium

THE following observations were made in carrying t some tracer experiments on the selenium–iodine stem, using the radioactive isotope iodine-131.

It was found that iodine could be adsorbed on to lenium powder from a solution containing iodine-31, and measurements of the total γ-ray activity a sample of the selenium were made: (i) after e powder had been thoroughly dried; (ii) after it d been melted and at once cooled to an amorphous lid; and (iii) after further heating in an open tube r 7 hr. at 550° C.

No significant differences were found among the ree activities, from which it was concluded that s than 1 per cent of the iodine initially present was moved during the heat treatment. An autoradio-raph of a section through the specimen at the end f the experiment showed a macroscopically uniform istribution of iodine-131 activity.

This evidence supports the generally accepted view hat halogen atoms can be bound in the selenium tructure, probably at the ends of chains of selenium toms. If it is assumed that iodine and bromine ehave similarly in this respect, this conclusion does ot agree with that of Nijland[1], who states that o stable bonds exist between selenium chains and romine atoms.

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Nijland, L. M., *Philips Research Reports*, 9, 259 (1954).

## Production of Anisotropy in a Permanent Magnet by Pressure

H. P. J. WIJN and others[1] have described a novel nethod of making 'Ferroxcube' with a square ysteresis loop. Glass with a higher coefficient of xpansion than the 'Ferroxcube' was fixed to a ring-haped sample at an elevated temperature; the esulting strain at room temperature produced a quare hysteresis loop. An experiment has been per-ormed to show that a similar effect is possible with permanent magnet alloy.

Since a large magnetostriction appeared necessary, 5 per cent cobalt steel was chosen for the experiment. The magnetostriction is positive, and in consequence longitudinal tension or a lateral pressure will avour a square loop. A lateral pressure was obtained n a bar of cobalt steel about 1¼ in. long and ¼ in. in liameter in the following manner. A hole 0·002 in. ess in diameter than the cobalt steel was made in a tainless steel block. This block was heated to 450° C., he cobalt steel was cooled in liquid air and the tainless steel block was shrunk on to the cobalt steel pecimen. The cobalt steel had been previously hardened, aged at 150° C. and cooled in liquid air before testing, so that any changes in properties after the shrinking are likely to be due to the pressure and not to the temperature cycle during the shrinking operation.

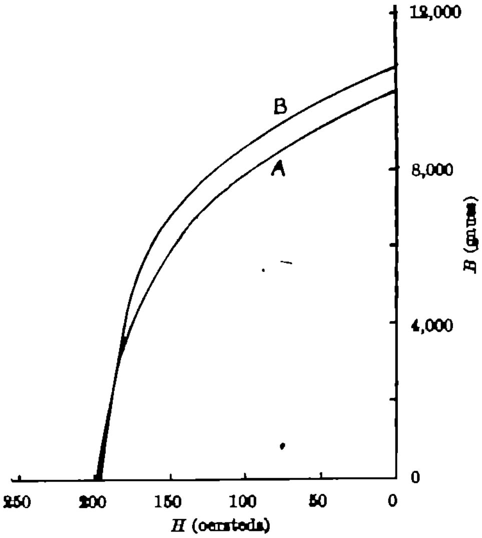

Fig. 1. (*A*) Normal curve; (*B*) under compression

The test values obtained are shown in Fig. 1.

The improvement obtained by pressure, although not spectacular, is amply demonstrated.

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## Localized Corona Discharges at a Negative Electrode

THE form of the d.c. corona discharge in air differs according to the polarity of the electrode near which it occurs. In an electrode system comprising a wire and a coaxially mounted ring, the discharge appeared as a continuous bright sheath around the wire when it was positive, but as a series of separate tufts when it was negative with respect to the ring.

In an investigation of the latter effect, a jet of mercury was substituted for the wire, giving a clean and smooth electrode surface which was also moving rapidly with respect to the electric field. With the jet negative to the ring, no stationary tufts were observed. It was confirmed by photography with a flash of microsecond duration that the jet, though not accurately parallel-sided, was smooth in the region where discharges occurred. The influence of the moving layer of air at the surface of the mercury jet was simulated by blowing air from a nozzle along a wire at the surface of which tufted discharges were occurring, the effect being that the tufts persisted but with some vibration along the wire.

The nature of the light emitted was investigated with a photomultiplier, wide-band amplifier and oscilloscope and was found to be similar in the cases of both jet and wire. It consisted of pulses, of duration about $10^{-7}$ sec., separated by irregular intervals having durations of microsecond order.

These results suggest that the localization of the negative d.c. corona is an effect due to the electrode, and that the mechanism of the discharge is not much different whether it is localized or not. It is surmised that each individual discharge is associated with a cathode spot which, in the case of a stationary electrode, maintains its position by thermionic emission.

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## Specific Heat and Heat of Wetting of Wood

Kelsey and Clarke[1] have recently discussed the variation with temperature of the integral heat of sorption of water by wood ($\Delta H$), and its bearing on the specific heat ($c_m$) of wood containing $m$ gm. of moisture per gm. of dry wood. Empirically, it is found that $c_m$ is greater than the specific heat ($c$) calculated from the specific heats and proportions of the components, assuming a simple mixture law[2]. This effect is not confined to cellulosic materials, but has been observed on starch[3], gelatin[4], dried foods[5] and other hygroscopic substances. The suggestion has previously been made[5] that the excess specific heat could be accounted for in terms of the change in $\Delta H$ with temperature ($T$); Kelsey and Clarke quote the appropriate thermodynamic equation as

$$c_m = \frac{1}{1+m}\left\{mc_w + c_0 + \left(\frac{\partial \Delta H}{\partial T}\right)_{p,m}\right\}$$

where $c_w$ is the specific heat of the water, and $c_0$ is the specific heat of the dry wood. Putting $c_w = 1$, and noting that

$$c = (m + c_0)/(1 + m), \qquad (1)$$

then

$$c_m - c = \Delta c = (\partial \Delta H/\partial T)/(1 + m) \qquad (2)$$

where $\Delta c$ is the excess specific heat.

During the past two years, we have measured the specific heat and heat of sorption of a batch of beech sawdust as a function of temperature and moisture content[2,6]. Our results enable a direct check on equation (2) to be made (Table 1).

Measurements at temperatures of 30, 40, 50, 60° C. gave $c_0$ = 0·31, 0·32, 0·33 and 0·34, respectively. The values of $\Delta c$ in Table 1 were obtained by computing $c$ from equation (1) and subtracting it from the observed specific heat ($c_m$). The values $(\partial \Delta H/\partial T)/(1 + m)$ were obtained by plotting $\Delta H$ a given moisture content against temperature, fitt a curve by eye and differentiating graphically. T error in the measurement of $c_m$ is estimated to about 0·005; but owing to the accumulation errors in the measurements, in drawing the curv and in the graphical differentiation, the uncertain in $(\partial \Delta H/\partial T)/(1 + m)$ is at least 0·01. To the accura of the results, therefore, the values in Table 1 satis equation (2) completely.

Table 1

| $m$ | $T$ (° C.) | $\Delta c$ | $(\partial \Delta H/\partial T)/(1+m)$ |
|---|---|---|---|
| 0·107 | 30 | 0·02 | 0·02 |
| | 40 | 0·02 | 0·02 |
| | 50 | 0·02 | 0·03 |
| | 60 | 0·04 | 0·05 |
| 0·140 | 30 | 0·02 | 0·02 |
| | 40 | 0·03 | 0·03 |
| | 50 | 0·03 | 0·04 |
| | 60 | 0·06 | 0·05 |
| 0·216 | 30 | 0·03 | 0·03 |
| | 40 | 0·04 | 0·04 |
| | 50 | 0·05 | 0·06 |
| | 60 | 0·08 | 0·07 |
| 0·310 | 30 | 0·04 | 0·05 |
| | 40 | 0·05 | 0·06 |
| | 50 | 0·06 | 0·07 |
| | 60 | 0·09 | 0·09 |

Equation (1) is often used for calculating the spec heat of wood for technical applications[7]; but tl procedure can evidently lead to errors of the ord of 10 per cent. The general agreement between o results and those of Kelsey and Clarke, obtained an entirely different species, is good, and sugges that the specific heat of wood containing moistu will not depend greatly on species. This suggesti is supported by the work of Dunlap[8], who found tl specific heat of dry woods to be practically ind pendent of species.

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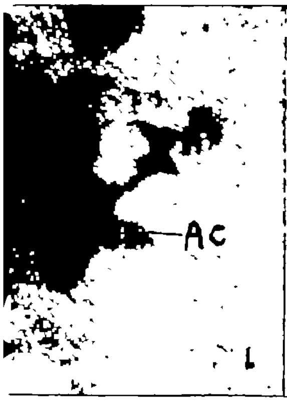
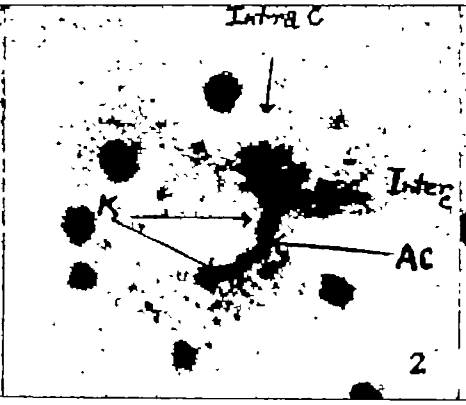
## Canals within Pancreas Cells

THERE have recently appeared in *Nature* and els where articles by Lacy[1] describing canals withi pancreas cells. These he believes represent the Gol apparatus; and he has published[2] an electron phot micrograph purporting to show one of these "Gol canals" in section.

In point of fact, intracellular canals have bee described in the pancreas by numerous observer especially Muller[3] and Holmgren[4]; but the poss bility that the Golgi apparatus of the pancreas cell may be no other than a deposit of silver or osmiu upon the pre-existing canals of a functional intra cellular duct system seems to have been overlooke by most workers, with the exception of Saguchi Lacy, however, has overlooked Saguchi's classic study, though he has undoubtedly re-described th same intracellular canals depicted by the Japanes worker. Further, Lacy assumes in contradistinctio a physiological function for his "Golgi canals" b postulating a role for them in a "lipoidal secretio cycle". He also claims that his discovery of th canals necessarily disproves the Golgi artefact theory

In order to test Saguchi's conclusions, I hav attempted to inject the intracellular canals from th pancreatic ducts with a 'mass' consisting of a lake blood medium. After sectioning, the hæmatin wa revealed by staining the preparations with a hæm atoxylin solution. This procedure was found to giv a brilliancy and precision hitherto unobtainabl





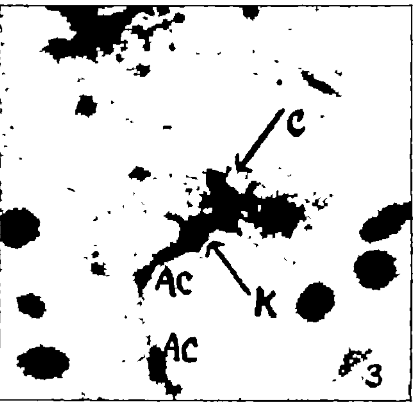


Fig. 1. Injected cat pancreas. Two intracellular saccular 'cisterns' communicate with the acinar cavity ($AC$) by fine canals. × 3,000

Fig. 2. Transverse section of an injected acinus. Acinar cavity ($AC$); vacuoles of Kupffer ($K$); intracellular canaliculi (Intra $C$); intercellular canaliculus (Inter $C$). × 1,500

Fig. 3. Intracellular canals and 'cisterns' ($C$) drain to the acinar cavity ($AC$) through a Kupffer vacuole ($K$). × 1,500

ith simple carmine gelatine media. Details of this ethod will be published elsewhere.

In the sections, in numerous instances, both inter- llular and intracellular canals can be seen clearly mmunicating with the acinar cavity. For the most rt the intercellular canaliculi end blindly but have teral extensions which enter the cells and run among he zymogen granules. In other instances fine canals ring between the zymogen granules unite and drain a a single intracellular canal to the exterior. Some- mes the cells contain a single irregular saccular pace within the cytoplasm and this may receive maller tributaries from among the granules. These ccular spaces then drain to the acinar cavity by eans of a fine canal. Fig. 1 shows two examples f this arrangement revealed within adjacent acinar ells.

The secretion vacuoles of Kupffer, observed also y Müller and Saguchi, occur frequently in my aterial. They usually receive one or more intra- ellular canals (Fig. 2). In Fig. 3 some intracellular ccular spaces together with tributary branches enter Kupffer vacuole before draining to the acinar avity.

The saccular spaces revealed by this method appear be interposed on a more delicate and elaborate ystem of intracellular canals which penetrate the ell in all directions. Their appearance suggests that hey may act as cisterns for the temporary storage f materials destined for secretion. Undoubtedly ese saccular spaces are often preserved in ordinary reparations, but their communications remain in- isible and the isolated spaces give the impression f structures intrinsic to the cytoplasm. Similar aces have often been described in endocrine cells, s in the curious 'signet ring' basophil pituitary cell. hese spaces are possibly homologous structures for e holding of partly elaborated secretions, and would erve a purpose similar to the thyroid vesicle, but n an intracellular scale.

I would suggest that my findings support Saguchi's elief that a functional duct system of exogenous rigin occurs within the acinar cells of the pancreas. he finest ramifications of this system appear com- ensurate with the smallest zymogen granules, and ey thus agree in size with the canals recently hotographed with the electron microscope.

It is becoming increasingly clear from recent udies[6,7] that the metallic impregnation techniques so long used as an indicator of the 'Golgi apparatus' do in fact colour quite unrelated and dissimilar objects in different cells. Lacy has shown that the canals within the acinar cells are preserved and blackened by a number of Golgi techniques, but reliance on the supposed specificity of these methods has, I believe, led Lacy into a mistaken conception of the nature of his canals.

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## Behaviour of Young and Old Females of the Black-fly, *Simulium ornatum* Mg.

CONSIDERABLE attention has been devoted to devising means of determining the age of mosquitoes[1] and tsetse flies[2] in the course of studies on their ecology and behaviour, particularly in relation to disease transmission. By observing the distribution and quantity of fat-body in the black-fly, *Simulium ornatum* Mg. (Diptera, Simuliidae), it has now been possible to achieve some degree of age determination in this blood-sucking insect also.

Female flies taken on cattle in the field can be divided into two main groups on dissection, namely, those with visible fat-body particularly in the anterior abdominal segments (group $A$), and those with no fat-body, except in small amounts in the posterior abdominal segments (group $B$). Some 0–10 per cent of the flies in particular samples were intermediate and could not be allocated to either group. On emergence from the pupa, females invariably possessed abundant fat-body. Laboratory studies on the disappearance of the fat-body in flies of known age suggest that group $A$ consisted of young flies, perhaps not more than seven to ten days old, and that the $B$ group was composed of individuals at least ten days old. Residual ripe eggs, conclusive evidence of a previous complete gonotrophic cycle, were found only among *B* flies. Since in *S. ornatum* a blood feed is necessary before ripe eggs are produced, it is concluded that some, and probably most, of the *B* flies had taken a previous complete blood meal, whereas none of the *A* flies had done so.

It is interesting to note that the changes in the amount of fat-body in female *S. ornatum* appear to form the converse of the situation found in male tsetse flies, where the initially small reserves may be augmented considerably by synthesis of fat after blood feeds have been taken[3].

The practical value of using this method of age classification is seen in the following data, in which the age of flies landing on cattle during a variable period between morning and early evening is compared with the age of those landing on cattle during the last ½–1½ hours of daylight. The pooled results for sixteen days in 1954 show that old flies formed a higher proportion of the catch during late evening (see Table 1). The greater number of flies containing residual ripe eggs in the late evening catches confirms this finding (Table 2). When the days are considered separately, a significant late-evening increase in the proportion of old flies occurred on only eight of these days ($P$ within range 0·01 to < 0·001). On the sixteen days the total catch of *S. ornatum* per unit time on cattle was often greater in late evening than during the day, paralleling the situation shown for *S. venustum* Say on man in Canada[4]. This increase in activity thus coincided with the occurrence of a greater proportion of old flies in the catch, and the number of old flies visiting the cattle per unit time became 1·2–12·0 times greater in late evening than during the day.

Table 1

| Flies taken during 1–3 hr.* within the period 10.00–18.00 hr. | | | Flies taken during ½–1½ hr. in late evening (18.00–21.00 hr.) | | |
|---|---|---|---|---|---|
| *A* Flies | *B* Flies | Unclassified | *A* Flies | *B* Flies | Unclassified |
| 724 | 253 | 29 | 579 | 542 | 23 |

Ignoring unclassified flies, $\chi^2 = 110·88$; $P = < 0·001$.

* The longer period was necessary in order to obtain fly numbers high enough for statistical analysis.

Table 2

| Flies taken during 1–3 hr. within period 10.00–18.00 hr. | | Flies taken during ½–1½ hr. in late evening (18.00–21.00 hr.) | |
|---|---|---|---|
| No. containing residual eggs | Total flies | No. containing residual eggs | Total flies |
| 37 | 1,006 | 111 | 1,149 |

$\chi^2 = 29·08$; $P = < 0·001$.

It would appear that in the case of an organism transmitted by the bite of *S. ornatum*, a susceptible host would have been exposed to a far greater number of potentially infective bites per unit time in late evening than during 10.00–18.00 hr. on the days in question.

The readiness of young and old flies to bite a cow was compared by recording the frequency with which fresh blood was found in the gut of flies of each group, which were given the opportunity to bite during approximately 10 min. of each hour of the observations. The results of dissecting 3,702 flies taken on eighteen days in 1954 (Table 3) show that old flies bit the cow almost twice as frequently as did young flies on average over the period.

Table 3

| | *A* Flies | *B* Flies |
|---|---|---|
| No. flies taken<br>No. containing fresh blood | 2,448<br>80<br>(=3·27 per cent) | 1,254<br>80<br>(=6·38 per cent) |

$\chi^2 = 18·67$; $P = < 0·001$.

This work was financed by a grant from th Agricultural Research Council. The full results wi be published elsewhere.

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## Physiology of the Heart of a Scorpion

IN view of the fact that scarcely anything is know about the physiology of the hearts of arachnid except that of *Limulus*[1], the present investigatio on the nature of the heart of *Palamnaeus bengalensi* C. Koch and the effects of stimuli, *p*H and drugs o it was undertaken. The hearts were isolated in saline (*p*H 6·3) containing sodium chloride, 0·65 gm. potassium chloride, 0·03 gm., and calcium chloride 0·03 gm. in 100 c.c. of distilled water and the *p* maintained with a phosphate buffer. The hæmolymph was found to be on the acid side of neutrality in agreement with Maluf's statement[2]; hence th selection of an acidic saline. Heart-beat after isolation was slow and irregular for nearly ten minutes On recovery, it showed a high degree of automati movement with incessant rhythmic and simultaneou beat throughout the myocardium, at a rate of 56–62 min. at room temperature (25–27° C.), without res pauses. After 10–12 hr. its rate and amplitude fel gradually. After temporarily inhibiting the heart rate by such mechanical stimuli as shaking the salin or pressing the heart, there was acceleration of th rate of beat. Isolated pieces of the heart beat fo some time.

Both increasing and decreasing the *p*H of th saline with phosphate buffers depressed the heart rate, and increase of temperature accelerated th heart-rate. The upper limit was 80–85 beats/min at 42° C.; the lower limit on cooling was 4–5 beats min. at 5° C., but it recovered on increasing th temperature.

Stimulation of the brain and ventral nerve cor by passing electrical current did not affect the rat of beat of the heart *in situ*. It also had no effect o direct application to the heart, up to 2 V. Furthe increase in the intensity of the stimulus in the latte case stopped the heart-beat. On switching off, th heart-beat reappeared after about 15 min. Electricall stimulated hearts were not used for drug experiments

The effects of various drugs were observed on heart both *in situ* and isolated. Acetylcholine at $10^{-5}$ dilution or stronger depressed the rate of beat, but th heart recovered after washing with saline. At highe dilution acetylcholine had no effect. By first treatin hearts with higher dilutions and then graduall creasing the concentration, tolerance to acetyloline up to $10^{-4}$ dilution was observed. The action acetylcholine was potentiated by physostigmine $0^{-4}$). Histamine ($10^{-4}$) accelerated the heart-rate d antagonized the action of acetylcholine. Adnaline ($10^{-3}$) accelerated, atropine ($10^{-4}$) inhibited d ether (half and fully saturated) had no effect the heart-beat. On many occasions the best agent r reviving a collapsing heart was warm saline, which s added in drops to the heart container. The time recovery varied from five to fifteen minutes.

According to the classification of hearts by Needham[3], the scorpion heart may be put among the yogenic types.

A detailed account of this work will be published sewhere. I am indebted to Prof. M. B. Lal, Univerty of Lucknow, for his interest and to Prof. K. N. Jha, Medical College, Cuttack, for help in carrying t some of the experiments. I thank the B.S.I.R., rissa, for financial aid.

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## Apparent Resistance of a Snail to Infection in the Gold Coast

In recent years, detailed studies have been conucted on schistosomiasis and its snail vectors in e Gold Coast. The results of surveys throughout e territory show that although *Schistosoma haematoium* and *S. mansoni* are both endemic, the former fection, together with its snail hosts, *Physopsis fricana* and *Bulinus* sp., *sensu stricto*, is considerably ore widespread than the latter and its planorbid ector, *Biomphalaria pfeifferi*[1].

During snail surveys it was observed that *Bulinus Pyrgophysa*) *forskalii* is widely distributed, and as his species is a vector in the Gambia[2] and in Mauritius[3,4], its role in the local transmission of histosomiasis may well be suspected. The results f field observations in the Gold Coast were equivocal. or example, at Dabala, Adutor and other villages the Tongu district, a high incidence (50–90 per ent) of *S. haematobium* infection occurs in the local hildren. In this area only *B.* (*P.*) *forskalii* could be und, despite a thorough search during both wet nd dry seasons for the principal vectors, *P. africana* nd *Bulinus* sp., *s.str*. Thus in the Tongu district, at east, the results of the field surveys pointed to . (*P.*) *forskalii* as the potential vector. In other istricts *B.* (*P.*) *forskalii* alone were commonly ecorded in ponds used frequently by people in whom . *haematobium* infection is very rare. In these istricts there is no evidence that effective transmission occurs in the presence of *B.* (*P.*) *forskalii* lone. None of several thousand *B.* (*P.*) *forskalii* ollected in the Gold Coast has been found infected ith mammalian schistosome cercariæ.

In view of these findings and the conflicting evidence egarding the susceptibility of *B.* (*P.*) *forskalii* to . *haematobium* in other African territories[4], conrolled transmission experiments using laboratoryred snails are being undertaken in Accra. The esults of four typical observations are described elow.

(1) Twenty half-grown *B.* (*P.*) *forskalii* were exposed for 5 hr. to large numbers of miracidia of *S. haematobium* derived from infected children at Pokoasi, near Accra. At frequent intervals from the twenty-second day until the forty-second day after exposure, the snails were examined for the emergence of cercariæ, but none was observed during the period. Thereafter the snails were killed and dissection showed them to be free of parasites.

(2) Thirty similar snails were exposed on three successive days in the same manner as those in the first experiment. Using the same method of detecting infection, it was again observed that none of twenty-five snails that survived the period of observation was infected.

(3) Twenty *B.* (*P.*) *forskalii* and twenty *P. africana*, bred in the laboratory, were exposed for 4 hr. to *S. haematobium* from Pokoasi children. During the period of exposure, both species were kept in the same dish. Eighteen *P. africana* snails afterwards shed cercariæ, but none of the *B.* (*P.*) *forskalii* became infected.

(4) Twenty-five *B.* (*P.*) *forskalii* and twenty *Bulinus* sp., *s. str.*, were placed together in the same dish and exposed overnight to *S. haematobium* miracidia derived from children in a district where both species are found. All the *Bulinus* sp. later shed cercariæ but none of eighteen surviving *B.* (*P.*) *forskalii* became infected.

In summary, attempts to infect laboratory-bred *B.* (*P.*) *forskalii* from the Gold Coast with local strains of *S. haematobium* were unsuccessful even though it seemed that the parasites could develop readily in both *P. africana* and *Bulinus* sp., *s. str.*, snails also bred in the laboratory.

The varying susceptibility of the Bulininae and Planorbinae to *S. haematobium* and *S. mansoni* respectively is a puzzling problem not yet understood. For example, an important snail host in one country may be refractory or only slightly susceptible to the same species of schistosome from another region[5]. Alternatively, snails of the same species in different regions may be either susceptible or resistant to local strains of the same schistosome. In the Sudan, Archibald and Marshall[6] record that *P. africana* were refractory to *S. haematobium*; yet these snails are the principal vectors of the parasites in the Gold Coast. In respect of *B.* (*P.*) *forskalii* and its relationship to *S. haematobium*, a similar picture seems to exist. As already mentioned, *B.* (*P.*) *forskalii* from the Gambia and Mauritius are susceptible to *S. haematobium*, but in the Gold Coast and in Tanganyika[7] they appear to be refractory.

The explanation of the susceptibility or resistance of the potential vectors to their schistosome parasites must lie either with the snails or with the parasites. First, as our knowledge of the taxonomy of the snail hosts is still rudimentary, it may be argued that the 'species' of snails in the different regions are morphologically or biologically distinct and accordingly are either susceptible or resistant to infection. If this is true, *B.* (*P.*) *forskalii* in the Gold Coast may be different from *B.* (*P.*) *forskalii* in the Gambia and in Mauritius, although this difference, if it exists, is not yet determined. Secondly, it may be argued that several strains of *S. haematobium* exist, each having an affinity—perhaps to the extent of being specific to a certain host—for a particular species of snail. If this is true, it may be assumed that the strain of *S. haematobium* in the Gambia and in Mauritius coincides there with its particular snail host (*B.* (*P.*)

*forskalii*), whereas in the Gold Coast this strain of the parasite is rare or absent.

It is evident that the greatest care must be taken before any bulinid species can be removed from the list of vectors, and at Accra attempts are continuing to be made to infect *B.* (*P.*) *forskalii* with *S. haematobium* derived from many different districts, including that of Tongu. To date, however, there is no direct evidence that *B.* (*P.*) *forskalii* can transmit the parasites in the Gold Coast.

I am grateful to the Chief Medical Officer, Gold Coast, for permission to publish these observations.

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## Unilateral Hybridization

Species hybrids have been reported in *Petunia*[1] and *Lycopersicum*[2] which can only be made in one direction, namely, when the self-fertile species of the pair is used as female parent and the self-incompatible one as male[3]. This phenomenon, which may be called 'unilateral hybridization', also occurs with some species of *Antirrhinum*.

The *Antirrhinum* species have been classified[4] into four groups:

(1) Antirrhinastrum
(2) Orientalis
(3) Orontium } $2n = 16$
(4) Asarina $2n = 18$

In the Antirrhinastrum group, which includes most of the species, all the species are either self-incompatible, or have a history of self-incompatibility. The second group, Orientalis, which is represented by *A. siculum*, and the third which only includes *A. orontium*, are both self-fertile. The fourth group, containing only *A. asarina*, is also self-fertile; but this has a different chromosome number and has never been shown to hybridize with any other species. Six species from the Antirrhinastrum group have been crossed reciprocally with *A. siculum* and *A. orontium* and pollen tube growth observed.

From the results in Table 1, it will be seen that the pollen tubes of the self-fertile *A. orontium* and *A. siculum* species are greatly inhibited in the styles of the self-incompatible Antirrhinastrum species. By contrast, in the reciprocal crosses, when the self-fertile is the female parent, the pollen tubes grow right through the style and in two cases produce viable seed.

The flowers of *A. orontium* and *A. siculum* are much smaller than the self-incompatible species, and *A. orontium* is practically cleistogamous. *A. majus*, a species from the self-incompatible Antirrhinastrum group, needs special mention because intensive cultivation has selected self-fertile mutants with large flowers; but the intrinsic self-incompatibility of both its style and pollen is apparent from the interspecif crosses. Its style rejects the pollen of the self-ferti *A. orontium*, and its pollen grows normally in a the self-incompatible species.

Table 1

| ♂ | ♀ *A. siculum* | ♀ *A. orontium* | ♂ *A. siculum* | ♂ *A. orontium* | ♀ |
|---|---|---|---|---|---|
| Antirrhinastrum | | | | | |
| *A. majus* | ● | + | − | − | *A. majus* |
| *A. ramosissimum* | + | + | − | − | *A. ramosissimum* |
| *A. linkianum* | + | + | − | − | *A. linkianum* |
| *A. meonanthum* | + | ● | − | − | *A. meonanthum* |
| *A. glutinosum* | + | + | − | − | *A. glutinosum* |
| *A. molle* | + | + | − | − | *A. molle* |
| *A. siculum* | ⊕ | + | ● | + | *A. siculum* |
| *A. orontium* | + | ⊕ | + | ⊕ | *A. orontium* |

−, Pollen tubes greatly inhibited.
+, Pollen tubes grow through style.
⊕, Viable seed produced.

The *A. orontium* × *A. meonanthum* hybrid ($S_F$ $S_I$) which in appearance is nearly identical with tl mother parent, is sterile due to failure of chromosom pairing at meiosis. $S_I$ pollen from *A. meonanthu* can grow through the hybrid styles, but pollen fro $S_F$ *A. orontium* is inhibited. This is similar to tl behaviour of the *Lycopersicum esculentum* × *peruvianum* hybrid[2]. In the *Antirrhinum* allotetr ploid, chromosome pairing is restored and 16 b valents are found; but the plant is self-incompatibl The allotetraploid produces $S_{FI}$ pollen and this inhibited in $S_{FFII}$ styles. This could be due to eith the self-incompatibility alleles from *menonanthum* st functioning in the allotetraploid's genetic backgroun and/or the inhibition of *orontium*'s self-fertility alle by the self-incompatibility allele of *meonanthu* both alleles being present in the pollen grains an styles of the allotetraploid.

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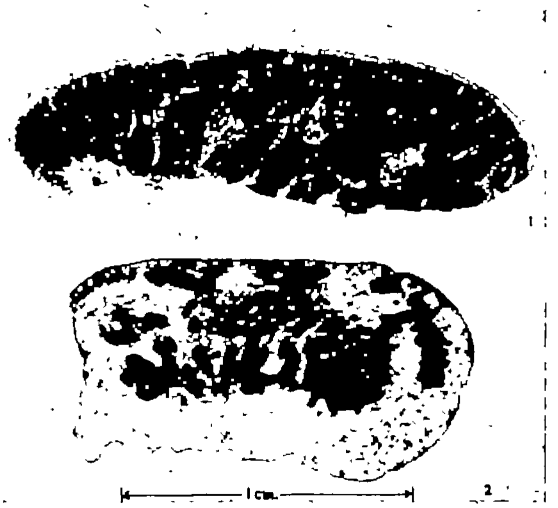
## Reproductive Organs of Foetal and Juvenile Elephant Seals

Between 1953 and 1955, I was serving with th Falkland Islands' Dependencies Survey in Sout Georgia and material was collected from the souther elephant seal, *Mirounga leonina*. Histological an histochemical examinations are being made of part of the reproductive tracts and various endocrin organs from foetal, juvenile and adult seals. Materi fixed in acetone for fourteen months and kept withi a few degrees of freezing point is still giving stron alkaline phosphatase reactions.

A hypertrophy of the gonads of the elephant se occurs in foetal life, similar to, but less marked tha that observed by Amoroso, Harrison, Matthews an Rowlands[1] and Harrison, Matthews and Roberts[2] the common seal, *Phoca vitulina*, the grey se *Halichoerus grypus* and various antarctic species.



(1) Section of ovary of fœtal elephant seal, about ten days ante-partum. (2) Section of ovary of elephant seal 29 days old. Both sections stained to show localization of alkaline phosphatase (black). The scale represents 1 cm.

The ovaries of a full-term fœtus, 142 cm. in length, eighed 6 gm. each; an ovary from a 2-day pup eighed 4·5 gm.; the right ovary of a 29-day pup eighed 3 gm. The ovaries of a yearling elephant al weigh 5·5 and 6 gm. each. In the adult, the verage weight (six measurements) of the ovary not ontaining either a corpus luteum or a ripe follicle nearly 7 gm. Thus the ovary of the full-term etus is nearly as large as the inactive ovary of the ature animal.

Similar changes are apparent in the male gonad nd prostate. A full-term male fœtus had testes eighing 18 gm. and 18·5 gm., and the prostate weighed 5·5 gm.; in a neonatal specimen the testes weighed 0·5 gm. each and the prostate 20·5 gm.; in a -day pup the right testis weighed 17 gm. and the rostate 13 gm.; in a 2–3-week old pup the testes eighed 15·5 gm. and 15 gm. and the prostate 2·5 gm. The adult gonad weighs about 500–600 m. and the prostate 300–600 gm.

A reduction in the size of the infantile adrenals akes place in the first few days after parturition. he adrenals of a full-term female fœtus weighed ·5 and 12·5 gm.; those of a 2-day pup, 9 gm. and ·5 gm.; of a 14-day pup, 4 gm. and 4 gm.; of a 9-day pup, 5 gm. and 6·5 gm. The adrenals of a earling cow weighed 7·5 gm. and 10 gm. and those f an adult cow (not pregnant or lactating) 7 gm. nd 7·5 gm. In the male, the fœtal adrenals weighed 2·5 gm. and 14 gm.; at 7 days, 8 gm. and 7 gm.; t two to three weeks, 6·5 gm. and 8 gm. The drenals of an adult male weighed 41·5 gm. and 1 gm.

In the full-term fœtal ovary, the main bulk of he gland is composed of interstitial tissue surrounded y a narrow fibrous tunic about 150–200μ across nd containing scattered young follicles. The inter-titial cells show great phosphatase activity, but the ortical region is practically free from phosphatase. he follicles are generally free from phosphatase, ut occasional ones show slight activity; these are elieved to be atretic. Subcortical crypt formation slight compared to that observed by Harrison and Matthews[3] in other seals. Ovaries from older seals how a decline in the amount of interstitial tissue nd a reduction in phosphatase activity. In a three-week ovary the interstitial cells are separated by fibrous tissue into small islets. At this stage healthy Graafian follicles have all but disappeared, though a number of primary follicles are to be found.

The testis of a full-term elephant seal is surrounded by a tunic 1·0–1·2 mm. in thickness. The gland is composed almost entirely of closely packed convoluted tubules. These are between 50 and 60μ in diameter and have no lumina. The interstitial tissue is very scanty and the individual cells are small. The development of this tissue is not nearly as marked as in the common and grey seals[2]. Testes of 7-day and 21-day pups present a not dissimilar picture, the rapid involution in the female gonad not being nearly as marked in the male.

The prostate of the full-term fœtus shows considerable activity. Most of the tubules have irregular lumina and contain inclusions, in some cases cellular debris. In the 21-day old specimen the tubules are smaller, the lumina have become more nearly circular in section and the amount of connective tissue has increased greatly so that it forms the bulk of the gland. The tubules are either empty or contain a little eosinophilic substance, not found in younger specimens.

In the epididymis of the full-term fœtus the tubules are about 150μ in diameter with a columnar epithelium 20–30μ in height. In the 21-day old epididymis the tubules are reduced in size; the epithelium is only about 10μ in height and the tubules contain a number of cells in their lumina.

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and
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London Hospital Medical College.
July 8.

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[1] Amoroso, E. C., Harrison, R. J., Matthews, L. H., and Rowlands, I. W., *Nature*, 168, 771 (1951).

[2] Harrison, R. J., Matthews, L. H., and Roberts, J. M., *Trans. Zool. Soc. Lond.*, 27, 437 (1952).

[3] Harrison, R. J., and Matthews, L. H., *Proc. Zool. Soc. Lond.*, 120, 699 (1951).

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## Plant Growth on 'Fly Ash'

In a communication outlining research on plant growth on 'fly ash' published in *Nature* of August 20, p. 352, by Rees and Sidrak[1], the following statement was made: "but as yet no attempt seems to have been made to examine its plant nutrient properties as compared with those of a normal soil". Work on various aspects of reclamation of land covered with 'fly ash' is, however, in progress at Leeds under a grant made available for the purpose by the Central Electricity Authority.

The investigations are following two main lines: (*a*) field-plot experiments designed to test the effect on plant growth of using soil coverings of various depths, together with incremental fertilizer dressings, upon 'fly ash' settling ponds; various crop plants are used in the experiments; (*b*) pot, and afterwards plot, experiments investigating the possibility of rendering the 'fly ash' in itself a medium suitable for plant growth.

Under the second heading possible methods of ameliorating the toxic properties of the material are being tried out, along with the effects of adding combinations of plant nutrients in standard factorial experiments. The work at Birmingham reported by

Dr. Rees has provided valuable information for this work. While it would be premature to report the result of the experiments, it can be stated that confirmation of the presence of manganese and aluminium toxicity has been obtained at Leeds.

A matter of general interest is that the manganese and aluminium toxicities found in the 'fly ash' are associated with high alkalinity, namely, $p$H 8·5 and higher in the Leeds samples. Manganese and aluminium toxicities in Britain are usually part of the 'toxicity-deficiency' complex of acid soils. There are reports of aluminium toxicity from some of the alkali soils of the United States, however[2]. Preliminary results in pot-experiments suggest that reduction of the $p$H by various means has a considerable effect upon these toxicities and can lead to increased plant growth.

R. HOLLIDAY
W. N. TOWNSEND
D. HODGSON

Department of Agriculture,
University, Leeds 2.
Oct. 3.

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[1] Rees, W. J., and Sidrak, G. H., *Nature*, 176, 352 (1955).

[2] Magistad, O. C., *Soil Sci.*, 20, 181 (1925).

## A New Imino-Acid in some Liliaceae

LINKO and I[1] isolated, last autumn, from *Polygonatum officinale* (and also from *Convallaria majalis*), a new imino-acid which on acid hydrolysis gave mostly homoserine. The elementary composition of the new compound corresponded to the formula $(C_4H_7O_2N)_n$ and had $[\alpha]^{20}_D$ − 118·4° (in water). The compound had all its carboxyl groups free and contained no primary but only secondary amino-groups. Because the compound contained no double bonds, it must have a cyclic structure. A 4-membered ring containing an imino-group and a free carboxyl group linked to the ring could have satisfied the formula, but using the method of Wendt[2] a molecular weight of approximately 300 was found, which is three times as high as that calculated for the simple molecule (six determinations in concentrations of 0·63–2·22 per cent in a non-polar solvent, the lactam of 4-amino-*cyclo*-hexane-carboxylic acid; calculated for $(C_4H_7O_2N)_3$, 303·3). On the basis of the molecular weight found, the compound seemed not to contain a simple 4-membered ring, even if all other known facts suggested this structure, but a corresponding ring three times as large and with three imino-groups in a ring to which three free carboxyl groups were linked. There was no other possibility of explaining the high molecular weight.

Fowden[3] isolated recently the same compound from *Convallaria majalis* without knowing of our work. His results are in good agreement with ours, with one important difference. Using the method of Barger, he found a molecular weight of approximately 100 for the compound, which thus probably contained a 4-membered ring containing an imino-group, and also a free carboxyl group. He has confirmed this conception by comparing the isolated compound with synthetic azetidine-2-carboxylic acid.

There is no doubt about the identity of the compounds isolated by us and Fowden. The three-fold molecular weight found by us is apparently wrong. The method of Wendt gave a correct molecular weight for some dipeptides and amino-acids in control experiments, but seems for an unknown reason not be suitable in the present case.

ARTTURI I. VIRTANEN

Biochemical Institute,
Helsinki. Aug. 30.

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[1] Virtanen, A. I., and Linko, P., *Acta Chem. Scand.*, 9, 551 (1955).

[2] Wendt, G., *Ber.*, 75, 425 (1942).

[3] Fowden, L., *Nature*, 176, 347 (1955).

## Use of a Computing Machine as a Mechanical Dictionary

THE method for locating 'words' in a 'dictionai
proposed by Booth in his recent communication[1] b
been standard practice for a long time in codi
edge-punched cards used for indexing scienti
literature and for many other purposes. Thus, if o
denotes a consecutive series of holes 1, 2, 4, 8, . .
any number may be represented by punching t
appropriate combination of holes with a ticket pun
so that they become slots communicating with t
edge of the card; for example, the number 6
would be indicated by slotting 2, 4, 32, 128, 51
To find a desired card, it is necessary to ask
'questions' if the numbers run up to $(2^N - 1)$;
practice, one inserts a knitting needle into each ho
in turn, rejecting or retaining (as appropriate) car
which remain hung up on the needle when the pa
is lifted from the table and shaken.

The system has another interesting property
that $(2^N - 1)$ cards can be sorted into perfect seri
order by only $N$ successive operations of one needl
Thus if there are up to 1,023 cards, the code w
consist of ten holes, denoted 1, 2, 4 . . . 512.
sort the cards, one inserts a needle in the hole
all cards which drop out of the pack when it is lift
are replaced behind it without disturbing their orde
This operation is repeated with the hole 2, the ord
of the cards being carefully preserved, and so
along the series. After the hole 256 has been dea
with, it will be found that the pack is in exa
numerical order; to sort the 1,023 cards require
only ten operations. It is a consequence of th
method of representation of the numbers that i
theory the economy of the method increases as th
number of cards become greater—even though in pra
tice the mechanics may become more difficult.
take the example of Booth's lecture demonstration[1],
set of cards, on each of which was written a sing
entry of the Concise Oxford Dictionary, could
arranged in alphabetical order in fourteen operation
and even the half-million entries in the thirteen
volume Oxford English Dictionary would need onl
nineteen operations.

At the cost of using a few more holes and a numb
of knitting needles simultaneously, a more rapi
'selecting' procedure is possible; with $n$ holes or
can code $_nC_{n/2}$ items (if $n$ is even) and select an
desired card in a single operation using $n/2$ knittin
needles simultaneously (for example, 924 items wit
a twelve-hole code using six needles: twenty-tw
holes and eleven needles for the Oxford Englis
Dictionary). On the other hand, serial sortin
becomes more complicated.

J. C. KENDREW

Cavendish Laboratory,
Cambridge. Sept. 18.

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[1] Booth, A. D., *Nature*, 176, 565 (1955).

[2] Casey, R. S., Bailey, C. F., and Cox, G. J., *J. Chem. Educ.*, 23, 4
(1946).

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, November 21

Institution of Electrical Engineers, Radio and Telecommunication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Reception of Band I and Band III Television rogrammes".

University College, London (in the Physiology Theatre, Gower reet, London, W.C.1), at 5.30 p.m.—Mr. J. W. Trevan, F.R.S.: The Pharmacology of Respiratory Regulation".*

Manchester Literary and Philosophical Society (in the eynolds Hall, College of Technology, Manchester), at 5.45 p.m.—r Edward Bullard, F.R.S.: "Structure of Ocean Basins" (Joule emorial Lecture).

Royal Society of Arts (at John Adam Street, Adelphi, London, .C.2), at 6 p.m.—Dr. A. H. Cook, F.R.S.: First of Three Cantor ctures on "The Science of Brewing". (Further Lectures on Novemr 28 and December 5.)

Institute of Metal Finishing (at the Imperial College of Science d Technology, South Kensington, London, S.W.7), at 6.15 p.m.—r. A. Mohan: "The Use of the Electron-Microscope in Electroemical Research", Mr. D. I. C. Kapp: "The Application of Techical Studies to Industrial Experience"; Mr. D. M. Gilbey: "The inetics of Electrodeposition of Metals".

Pharmaceutical Society (at 17 Bloomsbury Square, London, .C.1), at 7.30 p.m.—Mr. F. Atkins: "Some Pharmaceutical Aspects Modern Cosmetics".

Royal Geographical Society (at 1 Kensington Gore, London, W.7), at 8.30 p.m.—Mlle. Ella Maillart: "Along the Malabar oast".

## Tuesday, November 22

Arthur Stanley Eddington Memorial Trust (at the Examina- on Schools, Oxford), at 5.15 p.m.—Prof. R. B. Braithwaite: "An mpiricist's View of the Nature of Religious Belief" (Ninth Eddington emorial Lecture).

University of London (at Bedford College, Regent's Park, ondon, N.W.1), at 5.15 p.m.—Prof. N. Millott: "Studies on Tropical chinoderms and Primitive Light Perception".*

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, eppel Street, London, W.C.1), at 5.30 p.m.—Dr. R. D. Harkness: Metabolism of Collagen". (Eighth of fifteen Lectures on "The cientific Basis of Medicine".)*

Illuminating Engineering Society (at the Lighting Service ureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. T. Catten: Ship Lighting".

Institution of Electrical Engineers, London Graduates and tudents Section (at Savoy Place, London, W.C.2), at 6.30 p.m.—r. D. H. Mullinger: "Electrical Measurement of Mechanical Vibra- ions".

Royal Aeronautical Society (at 4 Hamilton Place, London, .1), at 7 p.m.—Mr. Charles Gardner: "Aviation Journalism".

## Tuesday, November 22—Wednesday, November 23

Institution of Gas Engineers (at Church House, Westminster, ondon, S.W.1)—21st Autumn Research Meeting.

## Tuesday, November 22—Friday, November 25

International Congress on Documentation of Applied hemistry (at the Institut Français du Royaume-Uni, Queensberry lace, London, S.W.7).

## Wednesday, November 23

Textile Institute (at the Walker Art Gallery, Liverpool)—onference on "Raw Cotton: Its Properties and Distribution".

University of London (at the Postgraduate Medical School of ondon, Ducane Road, London, W.12), at 2 p.m.—Dr. P. Bishop: Endocrinological Investigations". (Further Lecture on Novemr 30.)*

Royal Society of Arts (at John Adam Street, Adelphi, London, .C.2), at 2.30 p.m.—Dr. B. K. Blount: "Research in Industry" E. Frankland Armstrong Memorial Lecture).

Institution of Post Office Electrical Engineers (in the onference Room, 4th Floor, Waterloo Bridge House, London, S.E.1), t 5 p.m.—Mr. L. S. Hughes: "English in the Engineering Depart- ent".

Institute of Fuel (at the Institution of Civil Engineers, Great eorge Street, London, S.W.1), at 5.30 p.m.—Mr. C. J. Stairmand: Modern Industrial Dust Collection".*

Society of Chemical Industry, Food Group (at the Chemical ociety, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—r. W. G. Wearmouth: "The Production of Processed Cheese in rance and Switzerland"; Mr. A. G. Sansome: "Airborne Con- amination of Foodstuffs by Rodent Hairs".

British Association of Chemists, London Section (at the Well- ome Institute, 183, Euston Road, London, N.W.1), at 7 p.m.—Dr. Gorringe: "Applications of Photography in Research and ndustry".

## Thursday, November 24

Institute of Refrigeration (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. L. Cowley: "Problems Connected with the Cooling of the Human Body by Means of Mechanical Refrigeration".

## Friday, November 25

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "Winds in the Upper Atmosphere (including Drift and Irregularities in the F-Layer)". Chairman: Mr. J. A. Ratcliffe, F.R.S.

Royal Meteorological Society (in the Conference Hall, County Hall, London, S.E.1), at 5.30 p.m.—Mr. P. J. Meade: "Fog and Atmospheric Pollution" (Lecture open to sixth-form scholars).

North East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre, Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. A. R. Flint: "An Analysis of the Behaviour of Riveted Joints in Aluminium Alloy Ships' Plating".

Institute of Physics, Non-Destructive Testing Group (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Discussion on "Outstanding Problems in Industrial Radiology". Opening Speakers: Mr. R. Halmshaw and Dr. L. Mullins.

University of London (at Royal Holloway College, Englefield Green, Surrey), at 8.15 p.m.—Prof. P. M. S. Blackett, F.R.S.: "The Peaceful Uses of Atomic Energy".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. B. F. J. Schonland, F.R.S.: "Lightning and the Long Electric Spark".

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with an honours degree and teaching, industrial or research experience) in Chemistry, at the Rutherford College of Technology, to teach to H.N.C. and A.R.I.C. level—The Director of Education, Northumberland Road, Newcastle-upon-Tyne 1 (November 26).

Metallurgist (with a recognized metallurgical qualification and with sound experience, preferably in the electricity supply or associated industry) for the Chief Engineer's Department, Central Electricity Authority, London, to guide the branch on all metallurgical problems, co-ordinate metallurgical work in the various Divisions, and represent the Authority at technical meetings—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting AB/691 (November 29).

Lecturer (with an honours degree in zoology, and preferably special knowledge of agricultural entomology, and with research and teaching experience) in Agricultural Entomology—The Secretary, School of Agriculture, Downing Street, Cambridge (November 30).

Lecturer (graduate in science or medicine with postgraduate experience in some branch of physiology) in Physiology—The Assistant Registrar, Medical School, Birmingham 15 (November 30).

Senior Physicist (with a university degree in science, preferably with honours, with physics as the major subject, and considerable experience of applied research in physics), to be responsible for the planning and execution of research and related work in physics—The Director, Institute for Industrial Research and Standards, Glasnevin House, Ballymun Road, Dublin (November 30).

Assistant Lecturer, Grade B (with an honours degree in physics and preferably with some teaching and/or industrial experience) in the Department of Mathematics and Physics—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (December 1).

Lecturer in Geography—The Secretary of University Court, The University, Glasgow (December 1).

Research Assistant (with an honours degree in physics) for work in connexion with the study of the upper atmosphere by means of rockets—Prof. D. R. Bates, F.R.S., The Queen's University, Belfast (December 1).

Soil Physicist (graduate in physics or chemistry) at the Sabi Valley Experiment Station, to investigate the behaviour of soil and water under irrigation and water requirements of crops—The Secretary, Government of the Federation of Rhodesia and Nyasaland, Rhodesia House, 429 Strand, London, W.C.2 (December 3).

Assistant Lecturer in Mathematics (Pure or Applied)—The Principal, Royal Holloway College, Englefield Green, Surrey (December 5).

Lecturer in Mathematics—The Secretary of the Appointments Committee of the Faculty of Mathematics, The Arts School, Bene't Street, Cambridge (December 8).

Lecturer (preferably with experience with internal combustion engines or gas turbines) in Mechanical Engineering, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 10).

Lecturer (graduate in science with special qualifications in botany or agricultural botany) in Botany—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (December 12)

Research Fellow in Animal Ecology—The Registrar, University of Adelaide, Adelaide, South Australia (December 15).

Lecturer in History and Philosophy of Science in the Department of History and Methods of Science, University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (December 16).

Lecturer (with good academic qualifications and practical experience, and with particular interest in developing improved methods of teaching engineering drawing and design) in the Department of Mechanical Engineering—The Registrar, The University, Bristol 8 (December 20).

Chair of Organic Chemistry at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 14).

Biochemist to investigate biochemical pathways in the development of cellular damage by ionizing radiations—Dr. L. H. Gray, Director, British Empire Cancer Campaign Research Unit in Radiobiology, Mount Vernon Hospital, Northwood, Middlesex.

Economic Assistant (with at least a second-class honours degree in economics or similar subject, preferably with a mathematical or statistical background; one or two years postgraduate experience of economics work and an interest in science an advantage), with the United Kingdom Atomic Energy Authority, London, for duties including work on the economic aspects of nuclear power and on the general co-ordination of the nuclear power programme—Room 22, United Kingdom Atomic Energy Authority, 14 Ormond Yard, St. James's, London, S.W.1.

Industrial Chemist (with an honours degree in chemistry or Member of the Institution of Chemical Engineers, and at least ten years experience as a chemist in industry) in the Department of Heavy Industries, Eastern Region, Nigeria, to advise on the design of a laboratory and afterwards direct its work, to undertake research into local raw materials, organic and inorganic, and their potential utilization either alone or in combination with imported materials—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.461/411/02.

Physicist (with an honours degree in physics) in the Clinical Physics Department—The Administrative Officer, Christie Hospital and Holt Radium Institute, Manchester 20.

Plant Breeder (with at least a second-class honours degree and experience in plant breeding) at the West African Maize Rust Research Unit, Nigeria, to carry out research into maize breeding with special reference to resistance to pests and diseases—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/376/01.

Research Engineer (with an honours degree in engineering and one or two years practical experience) at the Research and Development Division of the Cement and Concrete Association, Slough, for work on concrete materials and methods of construction—The Secretary, Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

Senior Geneticist (with at least a second-class honours degree in botany or other natural science, with some years experience of plant breeding and genetics and preferably acquainted with tropical perennial crops, particularly oil-palm or coconut-palm and maize breeding; cytological experience especially valuable) as Head of the Plant Breeding Division, West African Institute for Oil Palm Research, Nigeria, to plan and execute the research programme of the division, which is directed towards improving the oil-palm by selection and breeding, and includes investigation of the genetics and cytology of the crop—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/199/08.

Senior Scientific or Scientific Officers (with a first- or second-class honours degree in mathematics, physics or engineering, or equivalent qualification, preferably with experience in aeronautical research or development work in aircraft industry) at the London Headquarters, Ministry of Supply, for co-ordination of aerodynamic research at Research Establishments, and of research projects at aircraft firms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.396/5A.

Soil Scientist (Analyst) (with at least a second-class honours degree in chemistry with one or two years postgraduate experience) in the Western Region, Nigeria, to carry out soil analyses and nutritional studies of cocoa and annual crops as a member of a team engaged in the systematic classification, mapping and characterization of soils and studies of their fertility—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/410/015.

Theoretical Nuclear Physicist (with a first-class honours degree in mathematics or physics and several years postgraduate research experience in nuclear physics), to carry out fundamental research in nuclear physics, particularly on the theory of nuclear structure, and to advise on the best values of nuclear constants to use in numerical calculations and on the design and interpretation of nuclear physics experiments—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 799/2.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

The Registrar General's Statistical Review of England and Wales for the two years 1950–1951—Supplement on Hospital In-Patient Statistics. Pp. iv+151. (London: H.M. Stationery Office, 1955.) 7s. 6d. net. [228

Aero Research Technical Notes. Bulletin No. 150: Modern Production Techniques with "Aerolite" K, KL and R. Pp. 5. (Duxford: Aero Research Limited, 1955.) [228

*The Dogs' Champion.* Vol. 1, No. 1 (July, 1955). Pp. 2. (London Canine League Defence Fund, 1955.) Free to Supporters. [228

Anti-Locust Bulletin 20: The Vegetation of the Outbreak Areas of the Red Locust (*Nomadacris septemfasciata* Serv.) in Tanganyika and Northern Rhodesia. By D. F. Vesey-Fitzgerald. Pp. ii+31+8 plates. (London: Anti-Locust Research Centre, c/o British Museum (Natural History), 1955.) 3s. 6d. [228

*Automation Age.* Vol. 1, No. 1 (August, 1955). Pp. 6. (London: United Trade Press, Ltd., 1955.) Annual subscription 10s.; Single issues 1s. [248

Regulations for the Electrical Equipment of Buildings. Thirteenth edition. Pp. viii+182. (London: Institution of Electrical Engineers, 1955.) Paper 6s.; Cloth 8s. 6d. [296

Amateur Entomologists' Society. Leaflet No. 27: A Study of Insects Living on the Wayfaring Tree. By K. C. Side. Pp. 20. (L don: Amateur Entomologists' Society, 1955.) 1s. 6d. [

The Atom: Servant of Man. Pp. 13. (London: United Sta Information Service, 1955.) [

Modern Apparatus for Sterilization: an Address given to an Ev ing Meeting of the Pharmaceutical Society of Great Britain in Ed burgh on February 16, 1955. By J. H. Bowie. (Reprinted from *Pharmaceutical Journal*, June 11 and 18, 1955.) Pp. 24. (Londo The Pharmaceutical Press, 1955.) 2s. 6d. [

## Other Countries

Museum of Comparative Zoology at Harvard College. Brevio No. 45 (June 13, 1955): *Palaeotaricha Oligocenica*, New Genus a Species, an Oligocene Salamander from Oregon. By Richard V Frank. Pp. 12+3 plates. No. 46 (June 24, 1955): Cave-Fossil Ver brates from Camaguey, Cuba. By Karl F. Koopman and Rodo Ruibal. Pp. 8. (Cambridge, Mass.: Museum of Comparative Zool at Harvard College, 1955.) [2

Publications of the Kapteyn Astronomical Laboratory, Groning. No. 56: Proper Motions of Stars in the Selected Areas at the Equa derived from Plates taken at the Algar Observatory. By P. J. V Rhijn and L. Plaut. Pp. ii+100. (Groningen: Kapteyn Astronomi Laboratory, 1955.) [2

Universidad Nacional de Tucuman: Facultad de Ciencias Exac y Tecnologia. Revista. Serie A: Matematica y Fisica Teorica. V 10, Nos. 1 y 2: Resultados Generales Referentes a la Descripcion de Foton en un Medio Material, Por A. Battig. Pp. 111–136. (Tucuma Universidad Nacional de Tucuman, 1954.) [2

East African Meteorological Department, Memoirs. Vol. 3, No. Report on Experiments on Artificial Control of Rainfall at Ambo Kenya and Dodoma, Tanganyika, 1953–54. By D. A. Davies, Dr. H. Sansom and G. Singh Rana. Pp. 21. (Nairobi: East African Meteo logical Department, 1955.) Sh. 4. [2

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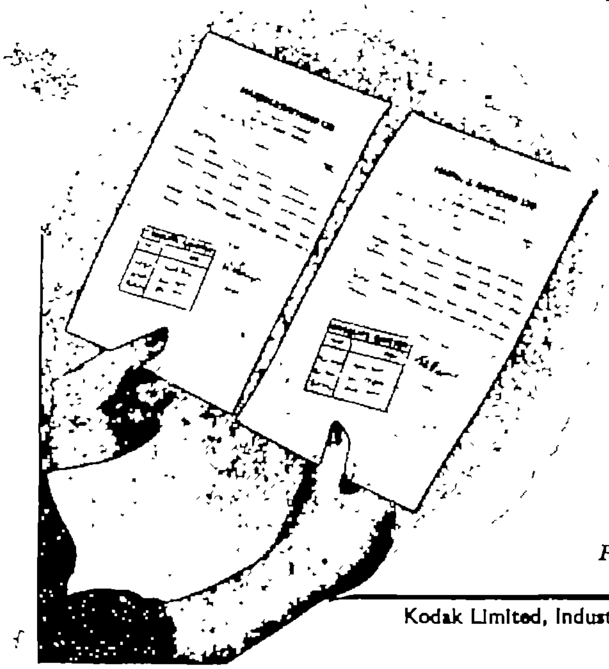

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# THE SPIRIT OF SERVICE AND THE WELFARE STATE

NDIVIDUALISM," wrote Lord Keynes, "if it can be purged of its defects and its abuses, is the t safeguard of personal liberty in the sense that, npared with any other system, it greatly widens field for the exercise of personal choice. It is o the best safeguard of the variety of life, which erges precisely from this extended field of personal oice and the loss of which is the greatest of all the ses of the homogeneous or totalitarian state. For variety preserves the traditions which embody most secure and successful choices of former erations; it colours the present with the diversiation of its fancy; and being the handmaid of periment as well as of tradition and of fancy, is the most powerful instrument to better the ure."

Lady Morris has set out in her book, "Voluntary ganisations and Social Progress"*, to examine the t played in social progress in Britain by the luntary bodies. The book is less detailed than rd Beveridge's survey, "Voluntary Action", and e misses the vivid vignettes with which, in his apter on pioneers', Lord Beveridge displays the ilanthropic motive in action; nevertheless, Lady orris sometimes probes further back into history, for ample, when discussing political movements; and touching on education and the churches, she deals th aspects Lord Beveridge largely ignores. Apart m occasionally bringing a closer and more personal uch into the discussion of particular problems than rd Beveridge did, the seven years that have passed ce Lord Beveridge's book was published enable dy Morris to testify more emphatically to the ntinuing value of the voluntary association in the cial Welfare State.

Her book, in fact, is essentially an exposition of e thesis Lord Keynes enunciated in the words ready quoted, and passage after passage in Lady orris's book recall those words to mind. In ilanthropy, in politics, in associations of working en in education, in the churches and in voluntary cial service, she traces progress to the vision and termination of individual men and women, sometimes as lonely pioneers, but generally as leaders and embers of groups, who were prepared to accept sponsibility and to devote time and energy to hieving social progress by means of democratic sociations outside the machinery of government. lieving that a society in which each person has the portunity of leading the good life can only be hieved if the proper spheres of action of State and dividual are discovered and respected, she is not ntent to display the past and the present, but oceeds to ask the leading questions which determine e realization of such a society.

What are the proper spheres of action for State d individual if such a society is to be possible? es the division of function now being evolved in itain conduce to the good life? And, if it is true, as Lady Morris's book, like Lord Beveridge's report, indicates, that social progress in the past has been largely due to the activities of individuals and groups outside the organization of government, what will happen if the parts played by statutory and voluntary action continue to change in the way in which they appear to be doing now? These are the questions that should be under examination, and although Lady Morris does not discuss them in any detail, at least in her introduction and in the second part of her survey of voluntary social service in the twentieth century, she indicates where the answers are to be sought. She also notes some of the factors that require further study, and directions in which our ideas should turn in considering the structure of society and the needs to be met by State action and those which should be left to the action of the individual or the voluntary group independent of statutory authority.

By and large, these questions are not being publicly discussed in the way their importance demands. Particular issues in which they are involved are apt to be determined in the light of partisan debate or the *ad hoc* circumstances rather than with regard to the long-term effects and their bearing on the intrinsic health of a democratic society. The warning notes sounded so clearly by Lord Beveridge as to the need to keep room, opportunity and encouragement for voluntary action in seeking new ways of social advance, for command of resources for social purposes being in the hands of some body other than the Government or the State, or, again, the need to make and keep something other than the pursuit of gain as the dominant force in society, have largely been ignored. Little has yet been done to influence directly in this way, not a few leaders, but the mass of the people; and democracy has still to show that, in discarding the inequalities, it can learn the virtues, of aristocracy.

For that reason alone, however much the present book by Lady Morris overlaps Lord Beveridge's report, the appearance of a fresh statement of the vital importance of voluntary effort, free to experiment, and endowed with the material resources which make effective service possible, would be welcome. Her book, however, bears the stamp of her own personality, and the arguments with which she challenges fresh thought on these vital issues are no re-statement but flow freely from the fountain of her own experience. Her story of the part voluntary groups have played in building the Britain of to-day, and in the achievement of reform and the elimination of injustice, is told in a way which shows clearly not merely that the opportunities for such voluntary effort persist into the welfare State, but also that without the help of such voluntary groups the individual and society will be the poorer, and even the security of the State endangered.

The survival of a society which provides its members with the opportunity to lead the good life depends, writes Lady Morris, "on there being enough people in it who understand what is at stake, who mind what happens to it, and who are prepared to take action in its service, not only by defending it in war but by striving in war and in peace for social progress". The work will, however, only be done successfully if the voluntary bodies continually re-examine their position, to see what aims and methods are demanded by actual needs and conditions; and Lady Morris pointedly directs this remark at the political parties and the trade union and co-operative movements, no less than at those engaged in social service in the more limited sense. All kinds of voluntary bodies need to adjust themselves continually to changing conditions if they are to render effective service and avoid setting up disruptive strains in the society in which they exist; and one of the great needs of to-day is not simply for self-examination of their functions and purpose by the voluntary bodies, but also for keen, unprejudiced thinking as to the limits of State action and the respective functions of voluntary and State effort.

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* "Voluntary Organisations and Social Progress". By Lady Morris. . 224. (London: Victor Gollancz, Ltd., 1955.) 18s. net.

There is, however, a second need, and perhaps an even graver danger. What is achieved in Great Britain through the voluntary bodies depends on there being enough people able and willing to give them the necessary time and energy. This is recognized by Lady Morris, and she rightly emphasizes that public spirit and the desire to work with a group for a chosen cause have persisted into the welfare State with at least some recognition that without personal effort that State may atrophy.

Women are now playing a much greater part in voluntary service and organization. In spite of home ties, married women have, during the past twenty-five years, come to the fore. It is, perhaps, significant in this connexion that the author of "Voluntary Organisations and Social Progress" is a woman. Another outstanding living example of a woman voluntary worker is Lady Petrie, wife of the historian, who is not only a member of the London County Council and councillor (and, at present, mayor) of a London borough, but has also become known far beyond the boundaries of her borough as an effective voluntary worker especially in such fields as hospital organization, public health, education, care of the aged, maternity and child welfare. It is certain, therefore, that though half a century ago we looked to the leisured classes for voluntary work, this is not the case to-day; yet all have more leisure at their disposal.

The voluntary services have, it is true, a problem in learning to use part-time help on an increasing scale; but the major problem is in cultivating the spirit of service among the new leisured thousands—a spirit which runs counter to the whole climate of the Welfare State as often expounded in political doctrine. They are faced, however, with an even graver problem. Lord Beveridge himself emphasized the vital importance of voluntary action being dependent on current giving rather than on endowments from the past or favours from the State, and emphasized the need for exploring new channels for the impulse of giving among the mass of the people. He asked, in writing of our need for a never-ending line of successors to the Webbs: "By what device will the society of the future be able to ensure that the spiritual success of the Webbs will have their material resources research, untrammelled by other duties, by orthodo or by prescription of topics ?"

The point was put equally forcefully by Ro Wilson in the notes on the future of voluntary soc work included among the "Evidence for Volunte Action"; though, referring to the drying-up traditional sources of money, he expresses t opinion that of the three problems—the use of t part-time volunteer in official administration, t finding of money, and the finding of time—t finding of time is the most important. What nee to be emphasized, however, is that the problem money for voluntary work, and equally that of tin is largely the resultant of Government policy. T difficulties to which Lord Beveridge and Lady Mor direct attention are not the result of blind forces b to some extent are due to factors within our o control.

This is a matter for the scientist who is concerned to the future of the independent research institutio whether engaged in the physical, the biological the social sciences, with the resources available f such institutions and with the autonomy of t universities in view of their increasing dependence State support (and Lady Morris in her chapter education glances in passing at the independence the universities and at the future of adult educatio He may also turn to the challenging article *Lloyds' Bank Review* of October, in which Prof. Robbins asks some pertinent questions as to whe the present taxation policy of Britain is leading Prof. Robbins's "Notes on Public Finance" ran over a wide field, but their general interest, as w as their interest for the scientist, is derived not fro the discussion of the detailed effects of the Briti system of taxing, but from the searching inquiry in the long-term effects of financial policy and the fra advocacy of its use to promote changes in the structu of society that are desirable. Prof. Robbins maintai that the operation of the present tax structure not neutral, but that year by year it is pushing relentlessly towards collectivism and property-le uniformity.

We are not here concerned with the details of Pr Robbins's argument, or with the instances he choos to illustrate it. Its relevance in the context of t future of voluntary effort, and of the independe institutions where the creative thought and inqui upon which social and scientific advance alike depe can proceed unrestrained, is that he directs attenti to a political formative factor in our society which not being used as it might be. If, for example, o ideal is a property-owning democracy, we are allowi our tax system to work the other way; nor are using it to facilitate the solution to many social a industrial problems which might be possible instead of profit-sharing we used tax policy encourage industry to make its workers equi owners on a large scale.

What is important is that preconceived ideas a challenged, and an attitude to the death duties a to the present tax on marriage advocated which listic and related to the kind of State desired, her than to particular political doctrines or short- m Treasury dictates. Here, as in our attitude to e future of voluntary action, we are faced with a allenge to thought. If we really wish to build the od society, to safeguard the institutions which pro- le the growing-points and starting-points of creative vance in whatever field, we are taken back to is imperative and inescapable duty of re-examining, d where necessary re-shaping, the institutions hich at present minister to our needs, so that they rve our purposes more effectively in the conditions to-day. We need to be clear as to what those urposes are, and we need to be sure, as Prof. obbins reminds us, that we are not allowing factors der our control, by neglect or default, to carry us rther from our goal. Lady Morris's book and Prof. obbins's notes on public finance have this in mmon, that they challenge us to such examination d to constructive thought. They can equally mind us of Lord Beveridge's words: "Emphasis duty rather than assertion of rights presents itself -day as the condition on which alone humanity can sume the progress in civilization which has been terrupted by two world wars and which remains alted by their consequences". Much has happened the seven years since Lord Beveridge wrote those ords to attest their truth; and if Lady Morris's ook may be expected to engage more particularly e attention of professional associations of scientists, rof. Robbins's article will at least remind them that en fiscal policy can be such as to foster rather than discourage initiative, enterprise and the free inter- urse of minds and exchange of ideas, which are the ot of creative activity and the advancement of nowledge in every field.

## HE PERSONALITY OF A GENIUS

### arwin Revalued

y Sir Arthur Keith. Pp. x+294+5 plates. London: C. A. Watts and Co., Ltd., 1955.) 25s. net.

THE title of this book by the late Sir Arthur Keith is, perhaps, something of a misnomer. e does not attempt any major revaluation of arwin's scientific work but, rather, is concerned in he main with Darwin the man, with the events and mpo of his life and his habits of mind and body. gain it is not so much a revaluation of these hat we are offered, but rather a condensation of the normous mass of data which Darwin left behind im in the form of letters and other writings. Few ves are better documented; the very richness of he sources makes it a laborious task to extract out f them a fair and complete view. Sir Arthur writes: I have tried as far as possible to make Darwin tell he story of his life in his own words, while I am erely playing the part of a 'cinema-operator' ".

I think most readers will agree that this endeavour as been very successful. But what an astonishing nd complex character Darwin was, and how difficult o form a just picture of him! Towering above verything else is his majestic grandeur as a scientist nd as a thinker who changed the whole of man's iew of his position in the universe. But at the same time his weaknesses as a human being are very obvious. He remained a devoted parent, and a kindly and helpful colleague to his scientific contemporaries; but throughout most of his life, his devotion to natural history reached a pitch which can only be called obsessional. For the rest, he cut himself off from most social contacts, and from almost the whole non-scientific area of human interest—poetry, art, politics and, to a large extent, religion. Or perhaps one should say he was cut off, by a chronic digestive illness against which the only effective remedy seems to have been work, but which often left him too incapacitated even for that. It is Darwin, the pillar of Victorian achievement, rather than Proust, the recorder of Victorian society in decay, who is really the example of the invalid genius, whose intellectual life was passed on a sofa. But for all that, he possessed in full measure another solid Victorian virtue—he was an excellent man of business and managed his investments (largely in railways) so that at his death he left a very sizable fortune.

How did this character—physically tortured, one must suppose, by some psychosomatic trouble, and retaining an unruffled intellectual assurance at the expense of extreme concentration on observing the external world—grow out of the relatively straightforward and energetic young man we meet in the "Voyage of the Beagle", with his enjoyment of a dinner of freshly killed beef grilled at the campfire of the Gauchos on the Argentinian pampas? And what influence, if any, did the peculiar forces which must have been buried in Darwin's odd personality exert on his scientific theories, which, it must not be forgotten, carried with them consequences of the most profound importance for our philosophies both of society and of the individual? Sir Arthur Keith does not attempt to answer such questions, although he allows himself a few asides which touch on them. But he stage-manages the appearance before us of a historical personage of great magnitude and complexity, whose personality undoubtedly deserves much fuller study and discussion than has yet been given to it.

C. H. WADDINGTON

## WEATHER OF THE TROPICS

### Tropical Meteorology

By Herbert Riehl. Pp. x+392. (London: McGraw-Hill Publishing Company, Ltd., 1954.) 61s.

IT is not a little odd that text-books on general meteorology rarely make much reference to tropical meteorology (the hurricane or typhoon may be a notable exception) and even provide rather little in the way of theory which may be usefully applied to the weather and winds of tropical regions. Yet the tropics embrace almost a half of the earth's surface, contain a large number of its people, and have weather which differs notably in style from that of extra-tropical regions. The Second World War, with important theatres of operation in lower latitudes, brought home to many our humiliating ignorance of tropical meteorology and spurred some to a considerable effort of research on the subject. Accepting, for the moment, a purely utilitarian point of view, it is clearly to our interests to further the work then started; for it is within the tropics that solar energy is most freely available—if we can make effective use of it—and, not unrelated, that the most substantial increase in world crops could occur. That the tropics or, rather, the sub-tropics (±30° latitude), which form the more natural meteorological boundaries, contain both the driest and wettest latitudes of the world is not the least part of the practical challenge, and this can scarcely be met until we can describe and understand more fully than at present the atmospheric processes within those latitudes. The problems are much more than those of geography, though geography is inevitably involved.

Tropical meteorology suggests to many, I suppose, trade winds and monsoons, the former blowing with great and, in an earlier day, useful regularity, though with seasonal variations, and the latter with well-defined onset and appropriate precipitation in their season. The picture is not wholly false; but the great irregularity of the incidence and amount of rainfall in both systems, day to day, and year by year, indicates that the weather is not to be explained wholly or even largely in terms of climate. In other words, it is the variations about the climatic norm as well as the norm itself which demand inquiry in low as in temperate latitudes. Moreover, since the temperate and high latitudes rely ultimately for their winds and rain on a source of energy within the tropics, we must suppose that variations in the tropics are somehow reflected in extra-tropical weather and climate.

Prof. Herbert Riehl was one of the war-time workers who was impressed by the variability in tropical weather and who has made substantial contributions to its study. He has now written a book which, while giving due weight to the geography and climate, is most concerned to present a physically co-ordinated account of the whole sequence of weather in low latitudes. His book is thus descriptive and theoretical, but only partly deductive; more description and more theory are required before a satisfactory deductive treatment will be possible. The skill with which he has combined description with theory is masterly, so that reading is a great joy as well as a good discipline.

There are twelve chapters, in which spatial and temporal variations in pressure, wind, temperature and rainfall are first presented and discussed, the accent being on climate. Due regard is paid to vertical variation where appropriate, for although upper-air stations are still woefully sparse in the tropics, the War and subsequent years have added considerably to knowledge of conditions aloft. Diurnal and orographic effects are treated next, and then follows a most successful chapter on convection. Its terms extend well beyond the tropics and should be read by any interested in this field; its relevance to the book is, however, unquestionable, since convection is so important a part of the motion of the tropical atmosphere. A rather irrelevant chapter on the physics of tropical rain is then interpolated from another hand, and the remainder of the book (six chapters) is devoted to synoptic disturbances and the general circulation. The treatment is unquestionably successful, both in description and in making the reader aware of how much may be explained on dynamical and thermodynamical grounds and of how much for the moment may not. The author's own researches on waves in the Easterlies guarantee successful treatment of that subject, and I found the chapter on hurricanes particularly cogent writing.

The book is so successful on the whole that one major criticism, related to the author's treatment of hydrodynamical problems, will not be misconstru While the book is addressed to a graduate in phys the author has decided to avoid mathemati equations as far as possible—but not complete This leads him to talk of unfamiliar concepts such vorticity without the introductory formal treatm which shows how they arise in meteorological hyd dynamics, and to proceed in a few lines to a math matical statement of the theorem of conservation potential vorticity without allowing the reader know quite how he got there. It is doubtful wheth a subject like hydrodynamics, which is certain difficult of simple exposition, and yet so importa for the author's purposes, is to be apprehended such methods—or by such 'wilful' remarks as "t current meets the *opposition* of the low-level ma time air" (my italics). Again, the author's int pretation of differential equations, in the intere presumably of simplicity, has a touch of eccentrici here and there and is likely to confuse more th clarify.

But this will prove to be an important book in t development of meteorology and is greatly to welcomed. It is well produced, well referenced a well indexed, and the misprints, though rath numerous, are not serious. Its price is rath forbidding to most individuals who might hope buy it from a sterling purse. P. A. SHEPPARD

# LETHAL FACTORS IN GENETICS

## Letalfaktoren

In ihrer Bedeutung für Erbpathologie und Ge physiologie der Entwicklung. Von Prof. Ern Hadorn. Pp. 388. (Stuttgart: Georg Thieme Verla 1955.) 39 D. marks.

LETHAL genes or chromosome rearrangemen with lethal action are not essentially differen from other genes or chromosome rearrangement All genes and many chromosome rearrangemen affect development, and whether this results in dea before reproduction depends equally on the gen themselves as on the organization and living co ditions of the individual in which they occur. study of the action of lethal genes can therefo scarcely avoid dealing with questions of general ge physiology. In the present book, as shown by i subtitle, this aspect has been emphasized, and t result is a most valuable contribution to gener developmental genetics.

The larger, and by far the most important, part the book uses lethals for illustrating and analysi general principles of gene action. The example range far and wide through the realm of livin beings from bacteria to man, although the emphas is on higher animals. Much of the material come from the impressive work of Prof. Ernst Hador himself and his school. The chapter on the bio chemical analysis of lethal development deals wit a new and promising field in which the author ha done pioneer work. Among the discussions of wide questions, three seem particularly interesting to me The first deals with the value of phenocopy studie as tools for elucidating gene action. Prof. Hadorn' attitude is here mainly one of caution; he thinks i unlikely that these studies will shed much light o primary gene effects. The second concerns th specificity of gene action. In contrast to Grüneberg author admits the possibility of true organ cificity caused by gene action on a field of differ- iation or on the integrative processes which precede an formation. The third is pleiotropy, of which penetrating analysis is presented. Primary pleio- py, that is, the existence of multifunctional genes, considered as a possibility. Other types of intra- lular or intercellular reaction chains that may lead pleiotropism are illustrated diagrammatically. For e of these, namely, the selective activation of genes the cytoplasm, Beale's work on *Paramecium* anti- ns might have been quoted as evidence. The minology of pleiotropic mechanisms matches the btlety of this analysis, and it leaves me wondering ether a simpler, though less precise, terminology ght not be preferable? Some new terms, such as tophene' and 'allophene' for phenotypic traits at are determined respectively by the genes in the ected cells themselves or by genes in other cells, e useful and merit a place in the vocabulary of velopmental genetics. For readers who are timidated by the abundance of technical terms, a ll glossary is provided.

The first third of the book treats more purely netical questions, such as the detection of lethals, utation-rates, and the frequency of chromosome arrangements with lethal effect. These lucidly itten chapters, although less stimulating and iginal than those dealing with gene action, should very useful for the beginner in mutation work.

The clear writing and logical presentation make e work easy to follow and pleasant to read. It has en beautifully produced, and the paper does justice the many excellent diagrams, most of them drawn the author's son, which form a specially attractive ature. There is an extensive list of references. ltogether, this is an admirable book, interesting and imulating for the experienced geneticist and yet mple and clear enough for a newcomer to the field genetical research. One minor mistake may be rrected in the next edition: the hormone therapy gainst teleangiectasia, mentioned on p. 286, is used heterozygotes, not on homozygotes which, as plained on p. 138, are probably inviable.

C. AUERBACH

# THEORETICAL ORGANIC CHEMISTRY

heoretical Principles of Organic Chemistry
y Prof. Walter Huckel. Vol. 1. (Translated from e corrected seventh German edition by Prof. F. H. athmann.) Pp. xi+904. (Amsterdam: Elsevier ublishing Company; London: Cleaver-Hume Press, td., 1955.) 77*s.* 6*d.*

THIS English version of Prof. Walter Hückel's text-book, which has been given a clear, if pparently at times rather literal, translation by Prof. . H. Rathmann, will be of interest to all organic emists. The topics considered in this first volume, fter a preliminary chapter on valency, include ereochemistry, oxonium compounds and molecular mplexes, compounds with abnormal valencies, utomerism, intramolecular rearrangements, steric arrangements, unsaturated compounds, aromatic mpounds, and the course of chemical reactions. he material is dealt with largely in chronological rder, from the point of view of the problems which arise directly from classical studies of organic reactions. Those aspects which require considerable knowledge of physical chemistry—particularly the relationships between constitution, physical properties and reaction velocities—have been deferred to the second volume.

Modern theories of organic chemistry derive some of their attraction from their power to enable, first, the correlation, within a consistent theoretical framework, of many of the at first sight diverse phenomena of organic chemistry, and secondly, the recognition of recurring patterns of behaviour, even though these may not always be quantitatively predictable. Not only do these theories rely on physical principles in discussing molecular properties and reactivities, but also they allow an extensive correlation of the physical properties of atoms and molecules with their chemical structures and reactivities. The impact on chemical theory of the ideas derivable from atomic and molecular spectroscopy, for example, has been very great, and the overlapping, in this kind of way, of pure chemistry, on one hand, and pure physics, on the other, is a striking and particularly happy feature of modern chemical thought.

The method adopted by Hückel suffers from the disadvantage that a considerable separation is made of the organic from the physical approach to the subject. Although the author himself has obviously such a thorough understanding of both aspects that he finds it necessary frequently to make references forward to more complete discussions which presumably will appear in Vol. 2, the result is still not entirely satisfactory.

Even within the adopted framework, considerable criticism is possible, particularly of the treatment of recent work. Many of the more significant advances of the past twenty years have been neglected, or are mentioned only in footnotes. The treatment of the Walden inversion is but one example of a limited recognition of recent advances. The rule is given that "the replacement of negative groups by anions gives a Walden inversion"; but it is stated that otherwise "for the greater portion of the yet known reaction processes, the riddle of the Walden inversion is not yet solved". Many would have considered that this was a conservative point of view even in 1938, when E. D. Hughes (*Trans. Farad. Soc.*, **34**, 213) discussed, in the course of a general survey of the Walden inversion, the effects of substituents in determining the steric course of unimolecular nucleophilic substitutions. To retain this attitude to-day, without even a passing reference to the development, by S. Winstein and his school as well as by British and by other American workers, of the stereochemical effects of substituents *beta-* to centres at which nucleophilic displacements occur, renders the whole discussion of this important aspect of aliphatic chemistry completely out of date.

Few authors, perhaps, succeed in putting the theoretical developments of their subject into completely proper historical perspective. As a source of references to the relevant experimental and theoretical contributions from the German schools of chemistry, this work is probably unexcelled. As a discussion of the phenomena of organic chemistry, and of the deductions which can logically be derived therefrom, it should be of some value to those prepared critically to compare this treatment with that preferred in other works. As a modern discussion of theoretical organic chemistry, it is disappointing.

P. B. D. DE LA MARE

### An Introduction to the Theory of Seismology

By Prof. K. E. Bullen. Second edition. Pp. xv+296. (Cambridge: At the University Press, 1953.) 35*s*. net.

THE first edition of Prof. K. E. Bullen's "Theoretical Seismology" was so clearly and concisely written that within a short time it had become the accepted standard treatise on the subject. The only substantial point of criticism of that edition was the absence of references; evidently with the idea of brevity. This defect has been remedied in the second edition, which concludes with twenty pages of references to treatises and original papers, classified under chapters, or sections of chapters, instead of the more usual kind of reference to a specific sentence or phrase in the text. Actually, this method has the advantage of serving both as a list of references (with the name of the author of a paper as a sufficient connecting link) and as a bibliography for each subdivision of the subject.

The second edition follows the pagination of the first, but sentences and short paragraphs have been inserted which bring the book up to date. As examples mention may be made of the application by F. Birch of Murnaghan's theory of finite strain, and B. Gutenberg's discussions of Californian earthquakes (which have suggested the idea of 'low-velocity layers'). Prof. Bullen might well have enlarged on his own recent contributions to the theory of the structure of the Earth's interior; in fact, however, he does little more than mention his 'Model *B*', in which the coefficient of incompressibility is taken as a smooth function of the pressure $p$ below the region *C*—that is, below about 1,000 km. An account is given of W. H. Ramsey's theory of phase transitions, in which the Earth and the terrestrial planets are assumed to have the same primitive chemical composition, with phase changes induced by pressure. Bullen has shown that the use of his Model *B* gives a closer fit with the data than does his Model *A*, as used by Ramsey.

Other additions are an account of the recent work of Jeffreys on the thicknesses of the continental layers, and a brief statement of Willmore's discussion of the observations made on the Heligoland explosion. The author is to be congratulated on the freedom from misprints and on the maintenance of the standard of conciseness despite the development of the subject.

R. STONELEY

### Plant Climate and Irrigation

Edited by Sidney A. Searle. Pp. xi+155. (Chichester: Chichester Press, Ltd., 1954.) 20*s*.

THE title of this book is misleading; it suggests a work on the relation of plant growth to regional climates and the application of irrigation principles to all kinds of crops. In fact, the book refers almost exclusively to glasshouse crops and mainly to tomatoes.

As so often happens with symposia, the contributions by the different authors are very unequal in quality and value. Scientifically, the most valuable contribution is the chapter reviewing the measurement of soil moisture, since, apart from the contributor's own more extensive review published elsewhere, this information has not previously been collated. A large section of the book is a reprint of a thesis submitted for a higher degree and is, *ipso facto*, unsuitable for publication, in spite of the useful work described. Elsewhere there are some bad errors in plant physiology and a number of theories be on slender evidence. A chapter entitled "Growin a Microclimate" turns out to be an *ex parte* argum in favour of a particular system of heating for gl houses. In passing, it may be remarked that i difficult to imagine how plants in a glasshouse wo be considered as growing in anything other tha "microclimate"—a much overworked word at present time.

The book is intended for the commercial grow but in the reviewer's opinion it might well be n understood by such a reader if he were not scienti ally trained and could sift the grain from the ch

R. H. STOUGHTO

### Freshwater Microscopy

By W. J. Garnett. Pp. xii+300+50 plat (London: Constable and Co., Ltd., 1953.) 30*s*. n

THIS book is intended as a simple introducti to the microscopical study of the plants a animals of the fresh waters of Great Britain. It written in a popular style and the author no dou had the amateur microscopist mainly in mind wh writing it; but it could be used also by students biology at schools and universities. It can recommended to anyone taking up this branch study. Not very many species are dealt with, b the distinguishing characters of the selected orga isms are given clearly, so that it should be possil to achieve at any rate an approximate identificati of many of the common microscopic organisms fresh water. Recognition will be greatly helped the numerous photomicrographs, most of which very characteristic of the living specimens.

The author makes quite a number of mistakes matters of fact (as well as in spelling); but ma who could easily correct the slips could not wr nearly such a good book as this. It is obvious th the author has first-hand acquaintance with subject and a lively interest in it, and he writes wi infectious enthusiasm. He is essentially an observ of the living organism and its activities. T practical advice is on the whole good, though o regrets that he does not mention the valuab mounting media introduced by Amann.

JOHN R. BAKER

### Cells and Societies

By Prof. John Tyler Bonner. Pp. iv+234+ plates. (Princeton, N.J.: Princeton Universi Press; London: Oxford University Press, 195 25*s*. net.

IN this lucid and entertaining exposition, t author's central theme is that in animals a plants at all the levels of development in the sca of evolution, including that of man himself, a certa recurrent sameness can be discerned, in particular such activities as the intake of food, reproductio and co-ordination; and this is demonstrably tr whether we make an analysis of life processes in a animal society or in an individual unicellular organis While the details of how these needs are met a endlessly varied in different groups and organism a scrutiny of the wide range of materials which t author discusses shows how general and pervasi are certain basic phenomena. Because of t simplicity and clarity of the exposition, and t effort that the author has made to formulate an discuss general ideas on life processes, this book ca be commended both to the interested lay reader an to the student of biology.

C. W. W.

# WEATHER FORECASTING: THE FUTURE OUTLOOK[*]

By Sir GRAHAM SUTTON, C.B.E., F.R.S.

Director of the Meteorological Office

THE profession of meteorology is concerned, among other things, with a branch of technology t is based upon the application of physical prin- les to an ancient and universal art. However, s article is confined to weather forecasting as actised by the professional meteorologist. In itain everyone forecasts the weather every day, if y as a conversational gambit, and the mass of verbial sayings, signs, saints' days and the like nected with the weather show the antiquity of e practice of observation and deduction. This ditional form of weather prediction is based on e belief that the state of the atmosphere in a ited region at any given instant is uniquely ated to the weather afterwards experienced in the ne region. Provided that the period of the fore- st is kept short, this belief is largely justified, and the days of sail the seaman, by watching the sky d the barometer, could often make reliable fore- sts of coming storms. Much the same degree of eather wisdom' is shown by those who live in the untry, in particular by shepherds and others whose rk keeps them in the open for long periods.

Traditional weather lore has no conscious relation th physics. A few of the best-known signs and rtents can be explained in terms of physical eteorology; but proverbial sayings are often tangled with superstition, and the majority, on se examination, have proved to be unreliable ides. This applies without exception to proverbs at attempt to forecast for long periods ahead. us the weather on St. Swithin's Day (July 15) ars no unique relation to rainfall during the next rty days, and I know of no popular belief that will lp me to predict the nature of, say, the coming nter with any degree of assurance.

Scientific weather forecasting is the child of the ctric telegraph. We can fix its date of birth in itain with fair precision, for in 1859 the British sociation, meeting in Aberdeen under the presi- ncy of Prince Albert, decided to recommend that e Board of Trade should instruct its newly formed eteorological Department to make use of telegraphy warn ports of approaching storms. To-day we uld not regard this as genuine forecasting, but ther as timely reporting. However, FitzRoy, the st director of the Meteorological Office, encouraged Le Verrier of France, soon began to include prog- stications in his warnings, and in 1861 he intro- ced the word 'forecast'. It is appropriate here repeat FitzRoy's words concerning forecasts: rophecies and predictions they are not': the term recast is strictly applicable to such an *opinion* as the result of a scientific combination and calcu- tion . . .". Soon after taking up my present post, was moved to write a letter to *The Times* in much e same vein, reminding the readers of that news- per that "the meteorologist is to be regarded more an adviser than as a prophet".

FitzRoy's experiment—for it was scarcely more an that—did not find universal approval among men of science. This is scarcely to be wondered at, because for many years the whole matter of foretelling weather had been bedevilled by the almanac makers. After FitzRoy's death in 1865 the Royal Society advised the Board of Trade to discontinue the publication of forecasts, but that "an endeavour should be made to improve the storm warnings, to define the principles on which they are issued and to test these principles by accurate observations". In other words, the investigation was to continue, but in private. This happy state of affairs (happy, that is, for the meteorologist) did not go on for very long. The public demand for forecasts, supported by the British Association, became so strong that the next ten years saw the re-introduction of the public statements of impending weather. Such forecasts have continued until the present day.

Early in the latter half of the nineteenth century (it is difficult to fix the date with greater precision), the Dutch meteorologist, Buys Ballot, recognized the relation between wind and the horizontal distribution of pressure. Buys Ballot's Law, as it is now called, states that in the northern hemisphere an observer with his back to the wind has low pressure on his left hand. (The rule is reversed in the southern hemisphere.) This directed attention to the use of isobaric charts, and it soon became evident that such charts, drawn for pressures reduced to mean sea-level, exhibited certain well-defined patterns that we now call depressions, anticyclones, troughs and ridges.

From the latter half of the nineteenth century until to-day, professional meteorology has been largely preoccupied with the study of the anatomy, life-history and movements of these patterns in the pressure field. The weather forecast is largely based upon the observed behaviour of the atmosphere in the vicinity of such disturbances, but this, of course, is not the whole story. Following Dr. R. C. Sutcliffe, we may consider that the pressure field as a whole comprises the following systems:

| Scale | Example |
|---|---|
| (*a*) Micrometeorological | Cloud elements; turbulence near a boundary. |
| (*b*) Sub-synoptic | Local showers, thunderstorms, local winds. |
| (*c*) Small synoptic | Small depressions and anticyclones, tropical tornadoes. |
| (*d*) Large synoptic | Semi-permanent continental anticyclones; long waves. |
| (*e*) General circulation of the atmosphere | |

The practice of operational forecasting involves only those features of the synoptic chart that are included in (*c*) and (*d*). In general, disturbances of the pressure field of scales (*a*) and (*b*) cannot be 'seen' on the chart; the resolving power of the meteorological network, even in a highly developed country like Britain, with many airfields, is far too low to allow more than a small fraction of all the showers and minor storms to be recorded. The disturbances that are indicated on the forecaster's chart have something of the character of external waves in that the shape of the stream-lines of the motion is not very different at different levels and the change of wind with height is approximately the same along all the verticals within a restricted region. It is thus possible to approximate to a typical atmospheric disturbance of the synoptic scale by a two-dimensional model, and much of the early work on dynamical meteorology was concerned with such models. The outstanding feature of such disturbances, however, is their slow translational motion. The typical depression of these latitudes moves across the country at a speed between 20 and 30 m.p.h., and it is important to recognize that other disturbances, such as sound waves and gravity waves, move far too rapidly and are of too small an amplitude to have any appreciable effect on weather.

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[*] Substance of a Friday Evening Discourse given at the Royal stitution, London, on November 4.

We can get an idea of how the meteorologist of to-day works by considering two of the daily publications of the Meteorological Office. The first is the *Daily Weather Report* containing, on its inner pages, the familiar isobaric charts for the northern hemisphere and, on a larger scale, for the north-western corner of Europe. The pressure field depicted is that for a hypothetical mean sea-level surface—which may or may not coincide with the real surface of the globe. All observations, whether on high or low land, have been reduced by a mathematical formula to 'zero height'. This type of chart is too well known to need further description. The second publication, the *Daily Aerological Record*, is not so familiar. The inner pages of this publication contain two sets of maps, namely, contour charts of the 700-, 500- and 300-millibar pressure-levels and thickness charts for the strata between the 1,000-, 700-, 500- and 300-millibar pressure-levels. These terms need some explanation. A contour chart shows the height, in feet, of a surface of constant pressure above mean sea-level. This type of chart has largely replaced the constant-height chart for upper-air work for a variety of technical reasons that need not concern us here. The thickness chart shows the relative topography of the constant-pressure surfaces, and, by inverting the familiar barometric-height formula for an isothermal atmosphere, it is easily seen that the difference in height between two isobaric surfaces (that is, thickness) is proportional to the mean temperature of the stratum of air contained between them. In other words, thickness lines are isotherms of mean temperature, and instead of the customary 'lows' and 'highs' of pressure on a constant-height surface we now have 'cold' and 'warm' centres.

These considerations have important repercussions on the forecasting of winds at great heights, that is, for modern aviation forecasts. It was early realized in meteorology that the simplest possible relation between the pressure distribution and the wind is that given by the so-called geostrophic balance. Left to itself, any fluid tends to move from regions of high to regions of low pressure, but in non-equatorial latitudes the effect of the earth's rotation on the atmosphere is to be reckoned with as well. As a result, winds deviate and blow around centres of low and high pressure in the senses indicated by Buys Ballot's Law. If it be further assumed that the wind strength is automatically adjusted to achieve a balance between the pressure and deviational forces, the resulting motion is along the isobars. This motion, known as the geostrophic wind, is a good approximation to the actual wind at about 2,000 ft. above a level surface. The geostrophic wind can be found very easily, by means of a transparent scale, from the contour lines of any isobaric surface. The vector difference between the geostrophic winds on any two surfaces is called the thermal wind. The name is derived from the fact that this wind can be estima graphically, like the geostrophic wind, but now fr the thickness lines, or isotherms, with the therı wind blowing cyclonically around a 'cold' centre a anticyclonically around a 'warm' centre. One of most important facts about such centres is that tl play a large part in 'steering' the depressions a anticyclones.

Thus modern forecasting has a pronounced thr dimensional aspect. The information necessary the construction of the upper-air charts is obtair mainly by the radio sonde or its latest developme the radar sonde. In the radio sonde, pressure, te perature and humidity are transmitted back to ea as musical notes. Measurement of the pitch of th notes gives the value in its proper units of the ent being considered.

What is the future of forecasting ? Has there be any marked improvement in the accuracy of t published forecast in, say, the past twenty or thir years ? Neither of these questions is easily answer The phrase 'accuracy of forecasts' conceals one of t outstanding difficulties of meteorology, namely, th of evaluating the degree of success attained in objective fashion. The present situation is perha best summed up by saying that the basic questi for the ordinary person, "Will it rain to-morrow cannot be answered with markedly greater precisi to-day than it could twenty years ago. On the oth hand, the meteorologist now can answer ma questions, especially those relating to high-altitu flights, which he could scarcely have contemplat in the early 'thirties. There are three great proble confronting the forecaster : how to improve the fo cast of the general situation, that is, of the mov ments of disturbances that produce the da fluctuations of weather over the British Isles ; h to improve local forecasting, that is, forecasting f restricted regions for the next six, twelve or twent four hours ; and how to produce reliable long-ran forecasts, that is, forecasts of the general charact of the weather in, say, the coming month. There a of course, many other problems of comparab importance, but I will restrict my attention to thes

The problem of forecasting the broad features the pressure distribution over the British Isles a the surrounding seas for a period of twenty-four hou amounts to what is called professionally the produ tion of a 'prebaratic', or chart showing the distributi of pressure at the end of the prescribed period. present this is done by extrapolation. The forecast deduces the likely movements of the main distur ances by a combination of experience and physic reasoning. The process, naturally, is highly su jective and liable to be badly in error at times. this sense weather forecasting might be described more of a craft than a profession, since much of th skill is acquired by experience with older hands wh in the course of years, have developed a 'nose' f coming changes and often include a good deal intuition in their prognostications. Progress in th craft is now slow, if it exists at all. During rece years, however, the situation has undergone a radic change. It has long been a dream of meteorologis that some day it will be possible for their science approach the precision and infallibility of spheric astronomy; but the tremendous complexity of th meteorological problem and the relative paucity data have made a "Nautical Almanac" of the weath seem more improbable than interplanetary travel. notable attempt to produce a system of mathematic ecasting was made by the late Dr. L. F. Richardson his book "Weather Forecasting by Numerical ocess", published in 1922. The attempt was rtive in that the one example worked out by hardson (using inadequate data) was badly in or; but the principles used were novel and largely rect, and thus the seeds were sown. The develop- nt of the high-speed electronic computer in the ars following the Second World War, together with better understanding of the difficulties of the blem, have now made it possible to contemplate introduction of purely mathematical methods o operational forecasting. This has already been ne in the United States and in Sweden.

It is impossible, in this article, to go into the highly nplicated mathematics in any detail. Briefly, the thod is as follows. At any zero of time we may sider that the pressure and motion fields are own, approximately, for a series of levels over a le area of the northern hemisphere. The sub- uent changes in these fields are governed by the own laws of physics; but it is impossible to proceed ng the full exact equations, because they are too mplicated and also because there are insufficient ta and knowledge available to evaluate all the ms. Instead, certain simplified forms of the uations of motion are used to predict the changes the pressure patterns during the next twenty-four forty-eight hours. The mathematician, starting m a known distribution of pressure, uses the thod of step-by-step integration to produce the al pattern. Even with the very simple models ed, the work involves many millions of mathe- tical operations and could not be contemplated as realistic exercise without electronic aids. Modern chines, however, can complete the solution in less an one hour, and the total time taken to produce forecast chart is perhaps three or four hours.

In Great Britain the study is regarded as still in e research stage, and as yet no attempt has been ade to bring machines into operational use. The ults of trials with past charts are encouraging, and is remarkable that simple models have done so ll. The consensus of opinion, in Britain and else- here, seems to be that numerical forecasting offers e brightest hope seen for many years of sub- ntially improving routine weather forecasts. It is ssible that in the next decade or two the develop- ent of the method may result in the near elimination 'major errors' in the forecast of the movements of ge-scale disturbances. If this optimistic prophecy realized, scientific weather forecasting will have ade its greatest advance since its inception nearly hundred years ago.

It is important to realize that this approach, at esent, is restricted to prognostication of the pressure stribution with an indication of the broad features the vertical motion. The weather still has to be duced from the forecast chart by the human being ing time-honoured methods, that is, mainly by a udy of the geometry of the forecast pressure field. is is no easy task. Further, such studies relate ly to the macroscopic features of the pressure and otion fields and therefore concern only the general uation. Forecasts of local weather, where these volve prognosis of the fine structure of the field, are tside the scope of the mathematical study. Yet, early, it is very desirable to be able to time fairly curately the approach of a rain belt or a large understorm for a densely populated area like eater London.

It seems that the main hope for any improvement here lies, not in increasing the complexity of the synoptic chart, but in quick, accurate and frequent reporting. For this the meteorologist must be able to scan the atmosphere in his vicinity as well as to consult his chart, and here again he can now call on electronic aids. Within the past few months specially designed radar equipment has been installed on the roof of Victory House, Kingsway, London, for this purpose. The equipment works by the reflexion of 3-cm. waves from rain-drops, hailstones, snowflakes and particles of ice—the normal constituents of rain-producing clouds. An approaching storm of sufficient intensity can thus be seen as an echoing area on the cathode-ray tube, sometimes as much as a hundred and fifty miles away. But the radar method is selective in that it cannot 'see', for example, fog and mist. Aids such as this radar equipment, especially if suitably multiplied and coupled with a detailed study of the weather peculiarities of a restricted region, could lead to a much-improved service to the public.

Thus the 'further outlook' for short-range weather forecasting is not unpromising, and a judicious blend of the mathematical approach, with the continuing detailed study of the anatomy of weather systems, can be expected to yield good results in the not too distant future. But it is otherwise with the problem of long-range forecasting. Present methods of forecasting for twenty-four hours ahead have been extended to four-day periods, mainly by an intensive study of conditions in the upper layers of the atmosphere; but the degree of reliability decreases rapidly with the length of the period. In general, in temperate latitudes, there is usually no unique relation between the synoptic situation at any given time and that five days or more later. This illustrates what is perhaps the major difficulty in forecasting weather. Influences that were initially below the threshold of observation can grow and become dominant in a period as short as a few days, so that new initial conditions have to be introduced at frequent intervals. In this sense the problem of weather seems to be indeterminate, and a limit is imposed on the applicability of present methods of numerical forecasting which is unlikely to be removed by refinements in the mathematics. Even the most elaborate model is unlikely to produce trustworthy results from a single situation more than seventy-two hours ahead (except in certain highly stable situations, such as a well-developed summer anticyclone), and on many occasions the maximum period of validity may well be no more than forty-eight hours.

Despite many patient researches, particularly in Germany, there does not seem to be at present any real basis for reliable forecasts for periods of a month or more. Even less reliable are forecasts of the general nature of seasons, for example, whether the coming winter will be mild or severe. There is no well-defined rhythm in atmospheric processes (except for the cycle of the seasons) on which such forecasts can be founded. On the other hand, there are many tantalizing clues that there may be subsidiary rhythms, and this, no doubt, accounts for much of the assiduity with which investigations into long-range forecasting have been pursued. There is, for example, evidence to support a belief in the reality of singularities—periods of characteristic weather (such as dry, rainy or stormy)—that tend to occur about the same date in most years, but these are by no means infallible guides. They indicate, at the most, that not every variety of weather is equally probable on any given day in the year; but as yet there is no criterion for their appearance or non-appearance in any given year. Research into long-range forecasting has developed chiefly on two lines: the purely statistical approach, and the dynamical method. In the statistical approach, little or no attempt is made to assign physical causes, and the investigator usually confines his attention to a search for significant patterns or repetitions in the weather records. Harmonic analyses of temperature, for example, have been made for very long intervals; but the periods which emerge as 'significant' have not proved sufficiently persistent or of sufficiently large amplitude to form a basis for worth-while prediction. Nor is there any evidence to connect abnormalities in terrestrial weather with astronomical phenomena such as sunspots. The dynamical method has b developed mainly in the United States, wh monthly forecasts of departures from climatolog means are produced from a study of the lar pressure systems over the northern hemisphere. far the success obtained is marginal.

Progress in weather forecasting is like climbin peak in the Himalayas. It is not difficult to obt a moderate degree of accuracy, but the final stag that of reaching a high consistent level—is like c quering the last thousand feet on some hithe unclimbed peak. There is no easy way up, and p gress must be, at times, painfully slow. It is not e established beyond doubt that progress is certa but meteorologists have some reason, at least, believe that one day the goal will be in sight.

# THE LAST VOYAGE OF JOHN CABOT AND THE ROCK AT GRATES COVE*

By PROF. ARTHUR DAVIES

University of Exeter

IN 1497 John Cabot sailed from Bristol and discovered about three hundred leagues of the coastal regions and waters of North America. On his return he made a map of his discoveries, and the Spanish Ambassador in London sent a copy to Spain. From this the world map of Juan de la Cosa[1], drawn in 1500, was able to show an east–west coast of sea and land "discovered by the English" with English flags. It can be concluded that Cabot had discovered the Saint Lawrence region and that he had coasted back along south Newfoundland. He was awarded an annual pension of £20 by Henry VII.

In May 1498 John Cabot left Bristol in a fleet of five ships, provisioned for a year, which suggests they did not expect to be back until the spring of 1499. One ship put back to Bristol and reported that Cabot had sailed around the south of Ireland and set course north-west. No English documents record the route or discoveries made in this voyage of Cabot in 1498. His pension, due half-yearly, was paid to his wife on his account at Michaelmas 1498 and on March 25, 1499, but was not paid again. It would seem that he was assumed to be alive until March 25, 1499, but that news of his death was brought back to Bristol soon afterwards. John Cabot never again appeared in English records, and there is no trace of his death or burial in England. In 1939 Denys Hay[2] reported that in a manuscript of Polydore Vergil of about 1512, entitled "Anglica Historia", there is a reference to the death of John Cabot at sea. It reads as follows: "King Henry at the request of one John Cabot, a Venetian by birth and a most skilful mariner, ordered to be prepared one ship, complete with crew and weapons; this he handed over to the same John to go and search for those unknown islands. John set out in this same year and sailed first to Ireland. Then he set sail toward the west. In the end he is believed to have discovered no land [since he did not return, he was not credited with discovery of lands] save in the depth of the ocean, into which he is thought to have gone down together with his ship, being seized by the ocean itself, for after that voy he was never seen again".

Sebastian Cabot, the second son of John Cab transferred to Spanish service in 1512. By 1515 was describing an important voyage of discov which he claimed to have made for Henry VII England. By using the clearest indications from various versions of Sebastian, his voyage can described as follows. He set course around the so of Ireland and then north-west and so reached arctic ice sheet to the east of Greenland. Turn south-west, he rounded the south of Greenland a sailed on westward for about ten degrees of longitu between 61° and 64° N., in what is now Davis Str He met land and kept south and west of it in wl is now Hudson Strait. Here the crews threaten mutiny because of the cold and storms, and so June 11 he turned south and kept along Labrad east Newfoundland, Nova Scotia and New Engla In the latitude of about 38° N. he ended his d coveries and turned back to Europe. Sebast declared that at his farthest west, in Hudson Str at 62° N., he was as far west as Cuba and that t sea opened southward (probably Ungava Bay).

The geographical details of this voyage describ by Sebastian are so near to truth that they co not possibly have been invented; it is certain th such a voyage of discovery had been made. But is very unlikely that Sebastian Cabot had led such voyage. In one account he claimed to have ma this voyage in 1494, when he was only twelve ye of age, in another 1496, in others 1498 and, implication, in 1508–9. He was twenty-six years age in 1508, and this is the only possible acceptal date for him to have been given command of such voyage. But he took care not to mention his fathe voyages at all, and there is no hint in English reco of any such voyage with Sebastian aboard, still l that he was in command. In 1521 he was in Londo and Cardinal Wolsey urged the London merchants support a venture under Sebastian Cabot in sear of a north-west passage. They replied, without co tradiction from the Cardinal: "We think it were t a venture to joperd V shippes with men and ds unto the said Iland upon the singular trust of man, callyd as we understand, Sebastyan, whiche astyan, as we here say, was never in that land self, all if he makes reporte of many things as he heard his father and other men speke in times t”.

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* Paper read at Bristol before Section E (Geography) of the British Association on September 6.

The majority of scholars have concluded that bastian lied, and that he claimed credit for the coveries made in the 1498 voyage of John Cabot. 1929 J. A. Williamson[2], a leading English authority the Cabots, accepted the claim by Sebastian that had made such a voyage of discovery, dating it 8–9. But the evidence of the early Portuguese and anish maps of America proves conclusively that such oyage of discovery had taken place before 1500, en Sebastian was less than eighteen years of age l could not conceivably have been in command.

The Portuguese map of Cantino, drawn in 1502, ows Greenland and the Labrador–Newfoundland gion as two utterly distinct and separate lands, ich had been discovered for King Manoel of rtugal. In 1500 Gaspar Corte Real discovered eenland, and in 1501 he coasted Labrador and east wfoundland as far west as Saint Mary's Bay. This yage did not pass westward into the Saint Lawrence gion, nor did it make any discoveries of land in va Scotia and New England. Moreover, it took ly a few months, May–October 11, 1501. At some ce, probably in east Newfoundland, fifty Indian isoners were taken[4], one of them being in possession a broken gilt sword of Italian origin (which points John Cabot), while an Indian boy was wearing ver earrings of Venetian origin (which points to ncius, the young son of John Cabot, about fourteen ars of age). The only voyage in these waters evious to that of Corte Real was the 1498 voyage John Cabot. These relics are mute witnesses that hn Cabot and Sancius either reached shore alive or at their bodies were washed ashore. Indian custom uld ensure that an Indian boy wore the earrings ly if they were found on the boy Sancius; otherse they would have been worn by a man.

All the major Portuguese maps of the period show eenland and Labrador–Newfoundland as two quite parate land masses, much to the east of their true sition to ensure they were within the Portuguese here as defined by the Treaty of Tordesillas. This s the official Portuguese concept of the lands of north-west Atlantic, based on the voyages of rte Real. They include the Caveri (Canerio) map, Hamy–King map, the anonymous Portuguese p, all of 1502, the Reinel–Pilestrina map of 1503, Waldseemuller map of 1507, and others. The me Terra Corte Real is given on most of them to brador–Newfoundland, and on some Greenland is med Terra Labrador, after a squire of the Azores o first reported its discovery to Henry VII of gland.

The map of the north-west Atlantic by Pedro inel is utterly different from these other Portuguese ps. Reinel, the greatest of the Portuguese cartoaphers, was a free lance and not employed by the own. He drew maps from any sources available to n, and this is one which shows virtually continuous ntinental land from east Greenland to New Engd. The unusual outlines of Greenland and the gion to the west of it are to be explained as the tting of the ship's track rather than the coasts, error probably by Reinel. It was originally dated 1499 by Schmelling; but the map is now assigned to 1502, prior to the other Portuguese maps, by Fontoura da Costa[5] and Armando Cortesao[6], the leading authorities on these maps. It is a Portuguese map with Portuguese names, and its latitudes are nearly correct throughout. It shows nearly continuous continental land from east of Greenland westward by way of Davis Strait, Hudson Strait, Labrador, Newfoundland to New England, ending at about 38° N. The two flags, of Portugal and Spain, indicate the dividing-line of the meridian of Tordesillas passing through west Newfoundland, utterly different from the official Portuguese maps based on the Corte Real voyages. This Reinel map of 1502 corresponds exactly with the discoveries claimed by Sebastian Cabot, thus proving that the voyage which made those discoveries had been completed before 1502. It rules out any possibility that Sebastian could have led it, for he was then less than twenty years of age.

But the map of Juan de la Cosa, drawn in 1500, also shows a continuous continental land mass extending from “the English coasts with flags” northward by way of Labrador and swinging north-east to include Greenland. The coasts are distorted and not comparable in detail with those of the 1502 Reinel map; but the cosmographical concept is identical and the main coastal trends similar. It shows that the voyage which revealed the North American lands from Greenland to New England preceded the Cosa map of 1500, and that it must have been the voyage of John Cabot in 1498. Cosa got the outlines of the 1497 Cabot voyage from the Spanish Ambassador in London. The general outline of the 1498–99 Cabot voyage, brought back by the surviving ship to Henry VII, may well have been copied roughly by the Spanish ambassador and sent to Spain, as had been done in 1497.

The nomenclature of the 1502 Reinel map on the Labrador and Newfoundland coasts is particularly rich, and it reveals numerous associations with the voyage of John Cabot. At 59° N. are the island of fortune and the island of torment. André Thevet[7] stated: “in that place the pilot of King Henry of England thought to have found a strait to pass into the Pacific Ocean. But being in the latitude of 59 degrees north . . . he came to touch at the island of Caravelle where he almost lost his life because of the breakers, rocks and perils that are there. Passing beyond he entered the river of torment.” Evidently he escaped disaster by good fortune, and fortune might have come to be the name of the island.

Then come C. domarco, san johan and san pedro, which are the Cape of Saint Mark and the Islands of Saint John and of Saint Peter. In one of the accounts of Ramusio, it was stated that Sebastian Cabot turned back on June 11, owing to threat of mutiny. The name Saint John is an indication that the island was found on, or near, the feast day of Saint John in the Roman Catholic Calendar of Saints. This was June 24, and Saint Peter was June 29, which dates correspond very well with a voyage which turned back at 62° N. in Hudson Strait on June 11. The feast of Saint Mark is April 25; this name occurs twice on this map, which indicates it was not given by reason of its dates but, as was often done, for personal reasons. John Cabot was a citizen of Venice and his patron saint was Saint Mark. When he first discovered land in 1497, he raised the banner of Saint George for England and of Saint Mark for Venice.

Y dos aves is Portuguese for island of birds; C. dos gamas is cape of deer; boaventura means good luck. Y. do frey luis at 51° N. is the island of brother Lewis or Luis. To-day it is Lewis Island, the English name, not the Portuguese. Most scholars have assumed this indicates the presence of a friar on board, but this is very improbable. Priests never went on dangerous voyages of exploration, only on later voyages of colonization and settlement. Columbus and Vespucci had no priests on their voyages of exploration. The eldest son of John Cabot was called Lewis, and he does not seem to have survived this voyage. The island of brother Lewis may have been named after him.

Baya de Santa Cyria indicates August 8. Y. dos bacalhaos is island of cod fish. Sebastian Cabot told Peter Martyr that he had given this name to east Newfoundland because of the plentiful supply of cod fish found there; but Martyr noted that there were many Spaniards who denied that Sebastian Cabot had sailed so far west and discovered this land. Baya do concepcam indicates the feast of the Conception on December 8, which points to a very long delay in this region. The next name, C. da espera, gives the explanation of this long delay, for it means the cape of waiting. To English ears espera sounds like spear, and Cape Spear occurs on modern maps just south of Saint John. It is possible that John Cabot took only two ships on this westward exploration, the other three ships which sailed out in company from Bristol being bound for Iceland. Thus there would be one consort ship, and it is probable that this ship set up a look-out post at C. da espera and then spent months searching the coasts and rivers to the south and then to the north for signs of survivors. This was the duty of a consort ship, and faithfully they pressed their fruitless search month after month. R. de sam francisco to the south is October 4, while baya do concepcam to the north is December 8. The tragedy would seem to have occurred as follows. After fishing for cod fish near the island of Bacalhaos (the modern Baccalieu island), they turned south to cross Conception Bay. Possibly during hours of darkness the ship of John Cabot "went down in the depth of the ocean being seized by the ocean itself". The description almost implies that it was not wrecked on a coast nor sunk by tempest. "Being seized by the ocean itself" suggests that the consort ship was at a loss to account for the disappearance of the Cabot ship. It is possible that the ship carrying John Cabot struck an iceberg during darkness not far from Baccalieu Island, at the north end of Conception Bay. Near by is Grates Point, and just west of it is Grates Cove. It may be that Cabot, his young son Sancius and some of the crew succeeded in reaching Grates Cove in the ship's boat. Cabot and Sancius certainly got ashore, alive or dead, for the broken Italian gilt sword points to Cabot himself and the Venetian silver earrings to the boy Sancius.

The consort ship must have missed them next day but, assuming they would link up, carried south as far as Cape Spear, when it became apparent something was seriously wrong. Thereafter the crew of the consort ship set up a look-out at this 'cape of waiting' and searched the coasts to the south, and then finally in December, as a last resort, they retraced their course northward and searched Conception Bay, naming it on December 8 after three months of vigil. They may have discovered wreckage of the ship, but most probably gave up the search in December, finding no trace of Cabot. The date, December 8, points clearly to the Cabot voyage of
1498, which did not return to Bristol until a
March 25, 1499. The Corte Real voyages were b
in Lisbon by early October on each occasion.

Resuming the voyage, the consort ship roun
C. Rase, which means 'flat cape'. English ears no
it as Cape Race, its modern name. The ship cros
the Saint Lawrence to Nova Scotia, and thereaf
coasted to New England in mid-winter. The Isla
of Saint Johan, off Nova Scotia, indicates the fe
of Saint John of Ravenna on January 12. Af
reaching 38° N. the consort ship turned back
England, where its Portuguese pilot, Juan Fernand
the labrador or squire of Terceira in the Azo
reported the discovery of Greenland, etc., to Ki
Henry of England and the loss of John Cabot w
the King's ship. This is noted from the account
Alonso de Santa Cruz, a friend of Sebastian Cabot
Spain, writing in 1541. In his work, "The Voya
of the Cabots" (1929), J. A. Williamson quotes
following passage of Alonso de Santa Cruz: "T
region of which we now wish to treat is commo
called the land of the Labrador (Greenland). .
As for the western side toward the land of
Bacalhaos it is said that two Portuguese brothe
named the Corte Reals, . . . asserted that the ma
land, of which they reached the extreme end,
separated from that island of the Labrador by a ve
large and wide sea channel, of which the pilot Anto
Gaboto also had information. It was called the isla
of the Labrador because a Labrador of the Azo
gave notice and information about it to the King
England, when he sent in search of it Antonio Gabo
the English pilot and father of Sebastian Gabo
. . . The land named the Bacalhaos, where the Co
Reals went to colonise, was first discovered by
pilot Antonio Gaboto, the Englishman, by comma
of the King of England". It may be noted, in passi
that Williamson argues that Santa Cruz was mistak
and knew little about the matter. But Santa C
had accompanied Sebastian Cabot on his voyage
the Plate River in 1526 and had close connexic
thereafter in Spain with him. It is probable th
Sebastian Cabot was the source of this account
Santa Cruz, belatedly giving credit to his father
the discovery of the Bacalhaos before the Corte Re
went there.

These documents and maps show that the 14
Cabot voyage discovered the continent of Nor
America from Greenland to Delaware Bay in 149
99. When Cabot went down with his ship,
Portuguese pilot, Juan Fernandez, completed
voyage and reported back to Henry of Englan
This report found its way through the Spani
Ambassador in London to the 1500 map of Juan
la Cosa in Spain. Fernandez's own chart of the voya
formed the source of the 1502 Reinel map of
north-west Atlantic. It is the only map record a
the only surviving document of the last voyage
John Cabot. It serves as a complete and accur
record of that voyage and its proud achievement
discovery in the New World. Since Fernandez he
his lands in Terceira under the Corte Reals, captai
donatory of the island, it is almost certain that
passed on information of the Cabot discoveries
them. The Corte Real voyages of 1500 and 15
were, therefore, the outcome of the Cabot voyag

An important piece of evidence in this reco
struction of Cabot's last days is the large rock
Grates Cove, near Grates Point, north of the hea
land which terminates Conception Bay and practi
ally opposite Baccalieu Island. This rock, which w

t described in 1822 by William Epps Cormack as
large block of rock which stands on the shore",
rs an inscription, still partly discernible, in which
words Jo Caboto can be plainly traced. Parts of
er names are legible, and among these are Sancius
l Sainmalia. Leo F. English, curator of the
seum at St. Johns, Newfoundland, has recently
nmented on this rock[8]; he quotes Archbishop
wley for the statement that Grates Cove comes
m the Italian gratia, thanks be to God. No
glish names can be deciphered.

n the supposition that John Cabot and Sancius
h some of the crew got ashore at Grates Cove, it
uld seem that, knowing the consort ship would
rch the coasts for them, they inscribed these names
the rock at Grates Cove. No one by the name of
nmalia is known to be connected with the expedi-
n. It may be that it is the illegible remnant of
nta Maria save us" or some such expression. It
not credible that such an inscription could be
thing but genuine, for no forger before 1822,
wever learned, knew of the Reinel 1502 map, which
s first discovered in 1844, and not until to-
y has anyone reconstructed the 1498 voyage of
n Cabot and suggested that his ship went down
the vicinity of Grates Cove. One can only assume that Cabot and his party, after inscribing the stone, were overcome and killed by the Beothuk Indians. The searchers from the consort ship never went north of Baccalieu Island and never saw the inscription on the rock. Had they done so, it is possible they might have saved John Cabot and his men, stranded on this wild coast to end their days.

The rock at Grates Cove, the broken gilt sword of Italian origin and the silver earrings of Venetian origin are relics of the disaster which overtook John Cabot. With the aid of Portuguese maps of America they help to reconstruct in detail the fortunes and achievements of the 1498–99 voyage, one of the greatest triumphs over hardship and danger that exists in the annals of American discovery.

[1] Ganong, W. F., "Crucial Maps", *Trans. Roy. Soc. Canada*, Sect. 2, 135 (1929).

[2] Hay, D., *English Historical Rev.*, 54, 246 (1939); *Camden Series*, 74, 116 and 117 (1950).

[3] Williamson, J. A., "The Voyages of the Cabots" (London, 1929).

[4] Williamson, J. A., *op. cit.*, 40.

[5] Fontoura da Costa, A., "A Marinharia Dos Descobrimentos" (2nd ed.), 206 (Lisbon, 1939).

[6] Cortesao, Armando, "Cartografia e Cartografos Portugueses", 260 (Lisbon, 1935).

[7] Thevet, André, quoted by J. A. Williamson in "The Voyages of the Cabots", 115.

[8] English, Leo F., "Historic Newfoundland", 14 (St. Johns, Newfoundland, 1955).

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# LABORATORY DESIGN

## SURVEY OF SPACE AND SERVICES REQUIREMENTS IN TWO AGRICULTURAL RESEARCH LABORATORIES

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N 1954, at the suggestion of the Agricultural
Research Council, the Division for Architectural
idies of the Nuffield Foundation began an investi-
ion into the design of laboratories. Work is at
sent in progress on several aspects of laboratory
ign, including the arrangement of rooms for con-
nient circulation, the layout of local and central
res, etc. The problems of laboratory lighting and
tilation, the economics of service installations and
performance of various materials and finishes are
subject of studies being conducted jointly with
Building Research Station. This article describes
ilot survey, made last year, which was designed
throw light on the provision of space and services
meet the needs of scientific workers in the labor-
ries of the Agricultural Research Service. The
vey is being followed by a main one, at present
progress, covering all the laboratories of the
ricultural Research Council and two or three
oratories operated by other authorities. Both
veys are concerned with the design of the common
e of laboratory, where work is done at benches;
y do not cover rooms designed for special purposes,
h as constant-temperature rooms, or the sort of
ommodation needed for large-scale work such as
ineering research. The results of these surveys
d the other studies at present in progress will be
ced before a panel of scientists for critical con-
eration.

When a laboratory is planned, decisions are required as to the provision of space and the supply of gas, hot and cold water, electricity, suction, compressed air, etc., for each worker. Successful design will depend on giving sufficient facilities without extravagance. Some authorities have established standards for space—generally expressed in floor area per worker—but these standards seemed to be arbitrary and to vary without apparent reason. Attempts have been made to throw light on these problems by measuring the floor area allotted in existing laboratories to scientific workers[1]; but this approach takes no account of the fact that the space provided may be too little or too great. Provision of services also varies considerably, and authorities differ widely on what they consider necessary.

It was therefore decided to carry out a survey of the use actually made of space and services by scientists working in reasonably well-provided laboratories; the pilot survey was undertaken to develop practical methods of collecting information and was carried out during April–June 1954 in two establishments—Rothamsted Experimental Station and the National Institute for Research in Dairying at Shinfield, near Reading. These stations were chosen because they cover a wide range of disciplines, and are reasonably well provided with space and services. The results obtained should not be taken as necessarily representative of institutions of the Agricultural Research Council, or of the needs of scientists throughout the year; but they show the sort of information which can be obtained by the method employed. The main survey, at present in progress, covers a wider range of institutions during a whole year.

The method adopted in the pilot survey was to observe selected individuals at work in the laboratory for a period of one hour each. The individuals, 232 in number, were selected from staff lists supplied by the stations and were grouped together according to grade—scientific officers, experimental officers, or assistants. In the pilot survey the total numbers were too small for significant differences to be distinguished in the needs of the several scientific disciplines. In the main survey the data should be sufficient to bring out these differences, if they occur.

In studies of this sort the presence of an observer may affect the activities of the person observed: to minimize this effect, visits were made in random order, and no individual knew in advance that he was going to be observed. Analysis of the data showed that there was no appreciable change in the pattern of work during the period of the study, and it therefore seems likely that the data collected were not greatly affected by the presence of the observer. Continuous observation for a period of an hour was of value in the pilot survey, as it enabled the observers to see scientific work as a process, and to notice points of general importance in the interpretation of the results. It was found that many of the observations repeated at short intervals during the hour were highly correlated, and accordingly the main survey has been designed to employ the 'snap-round' technique, so that observations on each individual are made at widely separated times.

## Bench-Length

The bench-length in use during the period of observation was recorded; where scientists had in use simultaneously two or more lengths of bench in different parts of the laboratory, all such lengths were added together.

Data from the pilot survey were analysed to show the proportion of time that workers in each of the three groups studied used particular lengths of bench. Differences in the lengths used by scientific and experimental officers were small; it was found for these grades that about 12 ft. of benching satisfied one man's requirements for 97 per cent of the time. The data also can be used to show what saving in space arises where a number of men work in the same laboratory; for example, three men working independently in the same laboratory would be satisfied for 97 per cent of the time by 23 ft. run of bench. Assistants were found to need rather more bench-length than scientific and experimental officers; while this result might be expected, it is worth noting that most standard scales of provision allow less space for assistants than for scientists. In practice, small teams often work together. Table 1 shows the bench-length that would be needed to satisfy the needs of a number of teams for varying percentages of time. A finding of some interest was that for 57 per cent of a scientist's time and 33 per cent of an assistant's time, no bench was in use at all.

A somewhat similar analysis can be made for the space occupied by sinks and draining boards, the main difference being that, though these are essential, they are very seldom used—only 1, 2½ and 4 per cent of the time for scientific officers, experimental officers and assistants, respectively. More inform-tion is needed; but the indications are that ab a 5 ft. length of draining board is sufficient fo scientist, and up to 8 ft. is required for an assista These figures would remain about the same for sm working-groups, since sinks for washing up are rar used simultaneously by several people.

Table 1. Bench-Length required for Various Groups o Scientists and Assistants

| Number of scientists | Number of assistants | Proportion of time that the bench-length will satisfy the group's requirements 95% | 96% | 97% | 98% | 99% |
|---|---|---|---|---|---|---|
| | | ft. | ft. | ft. | ft. | ft. |
| 1 | 0 | 10·4 | 11·0 | 11·6 | 12·4 | 13·7 |
| | 1 | 18·0 | 18·6 | 19·5 | 20·6 | 22·3 |
| | 2 | 25·1 | 25·9 | 26·9 | 28·2 | 30·3 |
| | 3 | 31·7 | 32·8 | 33·9 | 35·4 | 37·8 |
| 2 | 0 | 15·9 | 16·6 | 17·5 | 18·8 | 20·6 |
| | 1 | 22·9 | 23·8 | 25·8 | 26·2 | 28·4 |
| | 2 | 29·7 | 30·7 | 31·8 | 33·4 | 35·8 |
| 3 | 0 | 20·8 | 21·7 | 22·8 | 24·2 | 26·4 |
| | 1 | 27·5 | 28·5 | 29·7 | 31·3 | 33·8 |
| 4 | 0 | 25·4 | 26·4 | 27·6 | 29·3 | 31·8 |

## Provision of Services

Another aspect of laboratory design on which t survey material has some bearing is the provision various services to the bench. For example, da taken from the pilot survey show the average made of cold-water taps. From this the probabil distribution of the number of taps in use at a moment can be found. If a man were provid with four taps, then on certain reasonable assum tions it can be shown that he would use no water 92·2 per cent of the time, one tap being in use 7·5 per cent, two taps for 0·2 per cent and three four taps for a negligible proportion of the tim Service pipes and drains adequate to deal with t taps full on at any moment would in general entirely satisfactory. The main point to be ma here is that this is the kind of information requi on which to base standard methods of calculati leading to an efficiently designed service installati Similar data were obtained for hot water and d tilled water. Drainage calculations should take i account all forms of waste water. Data were a obtained for coal gas supplies, and similar calcu tions show the provision necessary to meet a required proportion of total requirements.

Another service of great importance is elect supply. One way of studying the material is to c sider the number of electric points in use at a instant, as with taps for gas or water. It is like on general grounds, that such an approach wo be very inexact for electricity supplies, as the curr used is often very much less than the maxim rating of the socket or fuse. An alternative appro is to consider the variation in the actual amount current used by an individual. Thus it was fou that although scientists used on average 0·60 am a.c. at the usual 230-volt level, 4 amp. would needed to cover the requirements for 98 per cent the time. The needs of a group of workers could a be calculated as was done for bench-length.

## Requirements for Illumination

Information was also collected, using the Illumi ating Engineering Society's code values[4], on size detail and contrast occurring in the work done the scientists. The results are given in Table 2.

ble 2. PERCENTAGE OF TIME THAT VARIOUS COMBINATIONS OF TAIL AND CONTRAST OCCURRED IN THE WORK OF SCIENTISTS IN LABORATORIES (EXCLUDING READING AND WRITING)

| Size of detail | Contrast | Scientific officers | Experimental officers | Assistants | Scientific officers and experimental officers together |
|---|---|---|---|---|---|
| licroscopy | — | 5·0 | 7·3 | 2·5 | 5·6 |
| linute | Good | 3·0 | 0·0 | 0·3 | 2·3 |
| linute | Average | 2·4 | 0·0 | 0·2 | 1·8 |
| linute | Poor | 2·9 | 4·2 | 1·1 | 3·3 |
| mall | Good | 3·4 | 3·4 | 1·7 | 3·4 |
| mall | Average | 21·8 | 23·7 | 22·5 | 22·3 |
| mall | Poor | 11·2 | 12·1 | 21·2 | 11·4 |
| rdinary | Good | 2·2 | 0·0 | 0·0 | 1·6 |
| rdinary | Average | 0·1 | 1·9 | 0·2 | 0·6 |
| rdinary | Poor | 1·2 | 1·1 | 2·9 | 1·2 |
| ark room | | 0·1 | 0·0 | 0·3 | 0·1 |
| eneral activities | | 46·6 | 46·3 | 47·2 | 46·5 |
| | | 99·9 | 100·0 | 100·1 | 100·1 |

Such data will help in specifying the artificial umination needed, and can also be used to assist design for natural daylight. The daylight anticipated at any point in a proposed laboratory can be calculated from drawings by techniques already established, and compared with the requirements for scientific work. (To assist such comparisons, a study of reflexion factors in typical laboratories is needed, and this is at present in progress at the Building Research Station.)

## Time Spent Reading and Writing

Time spent in reading and writing has an influence on laboratory design: it affects decisions as to whether separate office space is necessary for some scientists, and whether laboratories should be designed with space for desks as well as benching. The percentages of the time spent reading and writing while in the laboratory were found in the pilot survey to be 33·8, 30·2 and 7·6 per cent respectively for scientific officers, experimental officers and assistants.

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[1] "Report on Space Requirements for Scientific Research Laboratories". By J. Lorne Gray. (Tech. Rep. No. 3. Div. Building Res., Nat. Res. Council Canada, Ottawa; January 1949.)

[2] I.E.S. Code for the Lighting of Building Interiors. (London: Illuminating Engineering Society, 1949.)

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# THE CHEMISTRY OF INSULIN

N the *Biochemical Journal* of August 1955 (Volume 60, No. 4) is a communication (pp. 541–556) titled "The Disulphide Bonds of Insulin", by P. Ryle, F. Sanger, L. F. Smith and Ruth Kitai, wards the end of which appears the statement: he results are summarized in Table 10, which gives e complete structure of insulin". The insulin ferred to is from ox pancreas, and in the following per ("The Structure of Pig and Sheep Insulins", H. Brown, F. Sanger and Ruth Kitai, pp. 556–5) the small differences in structure between pig, eep and ox insulins are elucidated.

Dr. Sanger has thus brought to completion the searches which he initiated in 1945 with a paper "The Free Amino Groups of Insulin"[1]. In this st communication he described the use of dinitro-iorobenzene for the identification and estimation of e free amino-groups of proteins and peptides, a ethod which depended upon the fact that dinitro-iorobenzene reacts rapidly with the free amino-oups of proteins under very mild conditions. ydrolysis of the dinitrophenyl derivative of the otein thus formed yielded coloured derivatives, adily separable by chromatography, of those nino-acids which had reacted with the dinitro-iorobenzene. With this new and powerful tool, nger was able to show that if the molecular weight the sub-unit of insulin was assumed to be 12,000, ere were six free amino-groups present, two of ese on glycine residues, two on phenylalanine sidues and two on the epsilon amino-groups of sine.

At the time that Sanger began this work, the nino-acid composition of insulin was known with a asonable degree of certainty, largely as the result the careful analyses of Chibnall and his colleagues; d, on the basis of crystallographic measurements d of findings with the ultracentrifuge, the molecular eight of insulin was believed to be either 36,000 or ,000, with perhaps a sub-unit of 12,000. Later, easurements of osmotic pressure suggested a figure 48,000[2]. The task that faced one who wished to determine the complete structure of a protein of this molecular weight would have caused many a lesser man to quail; but fortunately Sanger was not deterred by the immensity of the task. The next important step was the demonstration that oxidation of insulin with performic acid, to break disulphide bonds, led to two separable fractions, the *A* or glycyl chain, and the *B* or phenylalanyl chain[3]. By partial hydrolysis of the two fractions with acid or enzymes[4], and the application of the dinitrofluorobenzene method to the separated peptides which had thus been formed, Sanger and his colleagues were able to elucidate the sequence of the amino-acids in the *A* and *B* chains. Ultimately they demonstrated that their results were compatible with the view that the insulin molecule is built up of two chains, joined by two disulphide linkages, and that the sequence of amino-acids in these chains was, for ox insulin, unique and completely determined. The position of a third disulphide linkage was, at that stage, still obscure. In the meantime the results of others[5] had shown that the molecular weight of insulin was in fact about 6,000, although aggregates could easily be formed. Thus the structure which Sanger had studied was indeed that of the molecule.

The identification of those dicarboxylic amino-acids which possessed an amide grouping[6] involved hydrolysis under very carefully controlled conditions. Finally, the publication to which we have already referred, in the August issue of the *Biochemical Journal*, described the determination of the position of the disulphide bonds by the subjection of insulin to partial hydrolysis, by chymotrypsin and under other conditions in which the disulphide bonds were stable. The cystine-containing peptides in the hydrolysate were separated and their structures determined by the methods previously developed. The structures of the cystine peptides which thus emerged permitted only one solution to the problem of the distribution of the disulphide bonds in insulin, and the conclusion was drawn that in one chain a disulphide linkage spanned six amino-acid residues in a manner similar to that deduced by du Vigneaud and his colleagues for oxytocin and vasopressin[7].

As *The Times* said on September 5 of Dr. Sanger's work, "It has not only involved an immense amount of painstaking manipulative operations at the laboratory bench, but, what tends to be over-looked, it rests just as essentially on hard logical thinking, in planning the attack and interpreting its results". Nobody who has read Dr. Sanger's papers will dissociate himself from this view. At each step in the development of the work the methods necessary for the solution of the particular problem have been invented, critically surveyed and effectively applied to the problem in hand. The elucidation of the manner in which the multitude of the smaller peptides which were obtained as the result of partial hydrolysis could be fitted together to yield unique structures for the *A* and *B* chains was itself a masterly achievement. The fact that at each stage the results could be interpreted in only a unique fashion demonstrated the validity of the methods used in a manner that was completely convincing. No investigator in this field has disagreed with the results of Sanger's investigations, and now that we know the structure of insulin to be what he finds so far as the chemistry of the problem is concerned, it is for the crystallographers to tell us exactly how in space the structure deduced by Dr. Sanger is to be distributed. There is also the question of the forces involved in the aggregation of the unit molecules. These matters a the subjects of active investigation at the present tim

In his now classical elucidation of the structur of the octapeptides, oxytocin and vasopressin, Vigneaud based much of his method upon th evolved by Sanger. In the development of his studi du Vigneaud was able to go further than is n possible with a structure like insulin, and succeed in effecting a complete chemical synthesis of ox tocin and vasopressin, an achievement which h earned him this year's Nobel Prize for Chemist Sanger's work has indeed opened up the possibili that insulin itself may ultimately be complete synthesized in the laboratory, although this cann occur for some time yet.

Sanger's methods and example have set in moti a large force of endeavour in the investigation protein structure, the limits of which have yet to visualized. What is now happening perhaps w illustrates the old saying "imitation is the sincere form of flattery".

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[1] *Biochem. J.*, **39**, 507 (1945).

[2] Gutfreund, H., *Biochem. J.*, **42**, 156 (1948).

[3] *Biochem. J.*, **44**, 126 (1949).

[4] *Biochem. J.*, **45**, 563 (1949); **49**, 463, 481 (1951); **53**, 353 (1953)

[5] Fredericq, E., and Neurath, H., *J. Amer. Chem. Soc.*, **72**, 2684 (195 Harfenist, E. J., and Craig, L. C., *J. Amer. Chem. Soc.*, **74**, 3 (1952).

[6] *Biochem. J.*, **60**, 509 (1955).

[7] *J. Biol. Chem.*, **205**, 949 (1953); *J. Amer. Chem. Soc.*, **75**, 4880 (195

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# NEWS and VIEWS

## Chemical Microbiology at Oxford:

### Prof. D. D. Woods, F.R.S.

The promotion of Dr. D. D. Woods to the new Iveagh professorship of chemical microbiology in Oxford will be warmly welcomed by those who are aware of his distinction in his field. Prof. Woods received his early training in Cambridge, where he worked under the inspiring guidance of the late Dr. Marjorie Stephenson. In 1939 he joined the Medical Research Council Unit for Bacterial Chemistry under Dr. (now Sir) Paul Fildes; he went to Oxford in 1945 and was appointed reader in microbiology in 1946. Among his many contributions is the discovery in 1940, while collaborating with Sir Paul Fildes, of the mechanism of action of sulphonamide drugs; he established the competition between sulphonamides and *p*-aminobenzoic acid, a normal cell constituent which had not been recognized before as such. From 1940 until the end of the War his academic research was interrupted by service with a Ministry of Supply research team (led by Sir Paul Fildes) to study defence against biological warfare. At Oxford he has built up a flourishing school of chemical microbiology. He is at present interested mainly in the synthesis of vitamins and amino-acids by micro-organisms.

The institution of the new professorship has been made possible by a generous endowment from Arthur Guinness, Son and Co., Ltd. This firm has already provided three Guinness research fellowships at Oxford which enable senior research workers to carry out full-time research on the biochemistry of micro-organisms. The many benefactions to scientific research made by Lord Iveagh (who is head of the house of Guinness) were referred to in *Nature* of June 4, p. 975, on the occasion of his appointment to the Order of the Garter.

## Botany at St. Andrews:

### Dr. J. H. Burne

Dr. J. H. Burnett, lecturer in the University Liverpool, has been appointed to the newly create chair of botany at the University of St. Andrew Dr. Burnett entered the University of Oxford 1940 as a Postmaster scholar of Merton and, aft taking the shortened degree course, was commission in the Navy. During his service, which was main in the Mediterranean, he commanded a landing-cra and was both wounded and mentioned in dispatche On returning to Oxford, he took Schools agai obtaining a first class, and was elected to a Christoph Welch scholarship. He became a University demo strator in botany in 1949 and was for a time actu curator of the Fielding Herbarium. In January 19 he moved to the University of Liverpool as lectur in botany. Dr. Burnett's interests lie mainly in th application of the broader genetical principles biological problems. Since 1953, his work on fung genetics has been supported by a grant from th Nuffield Foundation. His early studies were on th physiology of the mating process in *Mucor*; but mo recently he has been interested in the matin mechanisms of the Basidiomycetes and, in particula the problem of estimating the population size b using mating alleles as markers. In Liverpool h played an active part in the running of a geneti discussion group among the medical staff of th hospitals.

## Nematology at Rothamsted Experimental Statio

### Mr. F. G. W. Jon

Mr. F. G. W. Jones, lecturer in agricultur zoology in the School of Agriculture, Cambridge, ha been appointed head of the Nematology Departme of Rothamsted, and will take up his new duties January. Educated at Queen Mary's Gramm hool, Walsall, and Jesus College, Cambridge, he ad botany, zoology and chemistry for Part I of the tural Sciences Tripos, and zoology (specializing in tomology and experimental zoology) for Part II. e graduated B.A. in 1936 and M.A. in 1941. In 37 he was attached to the old Agricultural Advisory rvice at the School of Agriculture at Cambridge, ad on the discontinuation of the Service he was pointed successively University demonstrator (1946) ad University lecturer (1947). In these roles and as rector of studies in agriculture at Jesus College he as been closely concerned with undergraduate and stgraduate education. His research work has been iefly on plant nematodes. As adviser to the Com- ittee for Sugar Beet Research and Education since 46, he has attracted to his side an active research am for working on sugar beet pests, principally the gar beet eelworm, *Heterodera schachtii*. The use of icroplots', each a few square feet in area, has cilitated adequate mixing and sampling of field ils and has yielded valuable data on changes in e population of beet eelworm under various gronomic conditions. Other lines of work have alt with the host ranges of this and other eelworms, ad the effects of different levels of soil moisture on e hatching and migration through the soil of *eterodera* larvæ.

## ycology and Bacteriology at the Weizmann Institute of Science, Rehovoth :

### Dr. Esther Hellinger

Dr. Esther Hellinger, who is retiring from her st as chief mycologist and bacteriologist at the aniel Sieff Research Institute, now part of the 'eizmann Institute of Science, Rehovoth, is one of e band of enthusiastic scientists who have done so uch for plant pathology and industrial mycology in rael. Her investigations have covered a wide field id have all been concerned with problems of prac- cal importance. Her first task was examining perimental shipments of grapes to Britain, every cility for this work being given in London by the te Sir Edwin Butler at the Imperial Bureau of ycology (now Commonwealth Mycological Institute). 1926 she went to Palestine again and worked under r. I. Reichert at the Agricultural Experiment ation, Tel Aviv, on a number of local plant diseases. uring 1928–31 she undertook the investigation of e wastage of citrus and other fruits then causing much concern to exporters, a project financed intly by the Empire Marketing Board and the lestine Government. Her association with Dr. eichert continued in 1932, and a number of joint pers were published by them chiefly on citrus and nana storage diseases. Late in 1932 Dr. Weizmann vited her to join his staff at the Daniel Sieff Research stitute as chief mycologist and bacteriologist, and e then turned her attention to studies on fermenta- on processes and the retting of flax. Dr. Hellinger's ntribution to science is considerable both in antity and quality, and it is to be hoped she will ng enjoy her well-earned retirement.

## ew Polarographic Laboratory of the Cambridge Instrument Co., Ltd.

The Cambridge Instrument Co., Ltd., has recently ilt a small extension to its research department, ich is to be used exclusively for work in polaro- phic problems and techniques, and on November Prof. J. Heyrovský, of Prague, formally opened e building. The Cambridge Instrument Co., Ltd., is a pioneer among makers of polarographs in Great Britain, the earliest instruments being sent out just before the Second World War, and Dr. G. Jessop, of the Company's research department, has done a large amount of work on the development of polarographic instruments and techniques. During recent years the volume of original and outside consultant work has so increased that the new polarographic research laboratory has become necessary. The laboratory will be in the charge of Mr. W. J. Parker, and its specialized services will be available for advice and help to firms and to research workers interested in this subject.

## Institution of British Agricultural Engineers

The Institution of British Agricultural Engineers has moved into new premises at 6 Buckingham Gate, London, S.W.1, and all future sessions of the London open meetings of the Institution will be held there.

A new local centre of the Institution has been inaugurated, covering the counties of Monmouthshire, Gloucestershire, Herefordshire, Wiltshire, Somersetshire and Dorsetshire (east of Bridgwater to Dorchester). It will be known as the Western Centre, and its meeting places will be in Bristol and Chippenham.

## Unclassified Reports on Atomic Energy

Unclassified reports on atomic energy have hitherto been made available to the public by the United Kingdom Atomic Energy Authority at the Science Museum Library in London and the Sheffield Central Library. To provide for the increasing demand for such documents, particularly from industry, they will now also be sent to the following libraries: Central Library, Birmingham; Mitchell Library, Glasgow; Central Library, Liverpool; Central Library, Manchester; Central Library, Newcastle. Documents deposited in these libraries are freely available to the public, and the libraries have agreed to supply photostat copies at their usual rates on request. The documents are also sent to the copyright libraries and to the Patent Office Library, and some are on sale through H.M. Stationery Office. A monthly list of Authority documents available to the public in depository libraries (including those on sale through H.M.S.O.) is to be issued from the Atomic Energy Research Establishment at Harwell on behalf of all Authority establishments. This list will also include papers published in the scientific and technical press, and an indication of whether reprints of these papers are available. Requests to be put on the mailing list should be sent to the Librarian, Atomic Energy Research Establishment.

## Digital Computers of the United States National Bureau of Standards

Since 1946, the United States National Bureau of Standards has been actively engaged in the general field of electronic digital computers, largely for other agencies of the United States Government. The computer programme has been conducted jointly by the Electronics and the Applied Mathematics Divisions of the Bureau: the Electronics Division in Washington, D.C., has been concerned with the development and construction of the two computers (SEAC and DYSEAC), components research and development, and various technical and advisory services; and the Applied Mathematics Division has conducted research on numerical analysis of importance in the solution of problems by computers and the design and construction of the computer (SWAC) at the Bureau's Institute of Numerical Analysis at Los Angeles. Circular No. 551 of the National Bureau of Standards (pp. 146. Washington, D.C.: Government Printing Office, 1955; 2 dollars) is a bound book in which the more important engineering aspects of the Bureau's electronic computer programme are presented. It is based largely on the experience gained in relation to SEAC (National Bureau of Standards eastern automatic computer) and DYSEAC (second SEAC). The contents of the circular consist of eight articles, in addition to an introduction by S. N. Alexander, who gives a brief résumé of the historical development of the programme. The topics discussed in the articles include dynamic circuitry techniques, design of systems, high-speed memory development, input-output devices, construction and maintenance, in addition to a review of three years of operational experience on SEAC.

Both SEAC and DYSEAC are high-speed, automatically sequenced, electronic digital computers, in which extensive use is made of germanium diodes for switching and gating. They have mercury delay-line internal memories, and SEAC has an additional electrostatic memory. Since September 1950, SEAC has been in almost continuous daily use, but interspersed with its productive computational operation there have been periods during which research and development have been conducted on it. The new constructional techniques that have resulted from the experience with this computer have been incorporated into DYSEAC, and this latter represents a considerable advance in the computer art, though it was designed to serve as an experimental nucleus for more complex data-processing networks.

## The Shape of the Earth

THE different methods for determining the Earth's ellipticity $c$ are discussed by G. Tiercy in No. 50, Series *A*, of "Publications de l'Observatoire de Genève" (Fasc. 1 of Vol. 6). The four main methods are: the geodesic method by measuring the length of 1° of the arc of a meridian; the determination of gravity at various latitudes; the precessional method; and the perturbations observed in the motion of the Moon. While the geodesic value 1/297, adopted in 1911 by the International Conference of Astronomical Ephemerides, is adhered to, nevertheless there exists some uncertainty regarding its accuracy, for the value of 1/294, obtained from the results of the lunar dynamics, still presents a difficulty in accepting a unique and definitive value of $c$. Reference is made to Bulletin No. 78 of the United States National Research Council, published in 1931, which contains a memoir by W. D. Lambert, who expressed the opinion that the dynamic solution could be made to approximate to the geodesic solution if one or the other of three possibilities was accepted: changes in the values of the secular variations deduced from observations; changes in the data for the Earth's figure; and contingent corrections in the very complex mathematical theory of the problem. Tiercy then proceeds to consider another possibility, which may be briefly summarized as follows. In 1932 Wavre dealt with the problem of the oblateness of the Earth, retaining terms of the order of $\omega^4$, $\omega$ being the angular velocity, and obtained for the terrestrial meridian a slightly flattened curve with reference to an ellipse with the same poles and the same equatorial radius. The theoretical value of the flattening obtained by Wavre was $c = (a - b)/a \doteqdot 1/295$, a
the small portion $\Delta$ intercepted by the radius betwe
the two curves is derived from $\Delta = \frac{1}{4} kb\omega^4 \sin^2$
where $k$ is a constant and $\varphi'$ the geocentric latitu
From this it was found that $\Delta = 310$ metres. Wi
the aid of two diagrams, Tiercy shows that Wavr
investigations practically eliminate the discrepan
which was obtained for $c$, by the following co
promise. Taking the surface of the Earth to confor
to the international ellipsoid ($c = 1/297$) but flatten
in accordance with the formula given above, t
flattened globe would behave very closely, from t
point of view of lunar dynamics, as an ellipsoid
which $c = 1/295$. Admitting that it is only a co
promise, it is suggested that it can last until a mo
ingenious interpretation will produce reconciliati
of the different results.

## Year Book for 1955 of the Library Association

A FEATURE of the Year Book, 1955, of the Libra
Association (pp. 193; from the Association, Londo
21s.; 15s. to members) continues to be the us
graded list of text-books and works of referenc
which has a value far from confined to those pr
paring for the examinations of the Association, t
regulations and syllabus for which are also give
The entries under science and technology are w
chosen and balanced, and the scientific worker hi
self might well turn to these lists for references
books on general science, including the history
science, natural history and biological sciences. F
the science teacher they should be particularly usef

## American Association for the Advancement Science: Meeting in Atlanta

THE 122nd meeting of the American Associati
for the Advancement of Science will be held
Atlanta, Georgia, during December 26–31. Sixte
sections of the Association and approximately sixt
five affiliated and associated societies will meet co
currently in Atlanta. The programme includes
joint meeting of the Association with the Oak Rid
Institute of Nuclear Studies, at which twenty-tw
papers on "Atomic Energy and Agriculture" will
given, and three symposia on, respectively, the ne
psychiatric drugs, the treatment of alcoholism, a
recent concepts in clinical chemistry. Dr. James
Killian, jun., president of the Massachusetts Institu
of Technology, will give the Sigma Xi Lecture, a
Mr. Newman Bumsted, assistant chief of cart
graphic staff, the National Geographic Societ
Lecture, his subject being "Atlantic's Farthe
Shores". Further information about the meeting c
be obtained from the Director of Public Informati
of the Association, Dr. Sidney S. Negus, Medic
College of Virginia, Richmond, Virginia.

## Soviet Science To-day: Symposium in London

A SYMPOSIUM on "Soviet Science To-day", arrange
by the Society for Cultural Relations with th
U.S.S.R., will be held on November 29 at 7 p.m.
the Caxton Hall, Victoria Street, London, S.W.
The symposium will take the form of a question-an
answer meeting, and questions should be submitte
in advance. Three aspects of current developmen
in the U.S.S.R. will be considered by the following
Academician N. V. Tsitsin, director of the Permane
Agricultural Exhibition, Moscow (on agriculture)
Prof. C. F. Powell, professor of physics in th
University of Bristol (on atomic energy); and D
S. Lilley, of the Department of Extra-Mural Studi

iversity of Birmingham (on automation). In dition, Mr. J. Allan Cash, a photographic journalist, ll show slides of a number of photographs which he ok last August in the U.S.S.R. Prof. Powell and . Lilley have also visited the U.S.S.R. during gust and September of this year. Admission kets to the symposium (price 2*s*.) and further formation can be obtained from the Society for ltural Relations with the U.S.S.R., 14 Kensington uare, London, W.8.

## ineralogical Society

The following have been elected officers for 1955– of the Mineralogical Society: *President*, Prof. L. awkes; *Vice-Presidents*, Dr. F. A. Bannister and r. F. Dixey; *Treasurer*, Prof. J. H. Taylor; *General cretary*, Dr. G. F. Claringbull; *Foreign Secretary* d also *Editor of the Journal*, Dr. L. J. Spencer.

With the issue of No. 231 (December 1955) of the *ineralogical Magazine*, Dr. L. J. Spencer will retire om the editorship, having completed fifty-five years . this honorary office, to which he has devoted his hole time since he retired in 1935 from his post as eeper of minerals in the British Museum (Natural istory). The work involved is now so onerous that e Council of the Society has decided to appoint two litors, one of the *Magazine* and one of the *Abstracts*; e new editors will be Dr. M. H. Hey and Dr. . F. M. Henry, respectively. The Society has cently moved its offices from Burlington House, nd its new address is now 41 Queen's Gate, South ensington, London, S.W.7.

## he Night Sky in December

New moon occurs on Dec. 14d. 07h. 07m., U.T., nd full moon on Dec. 29d. 03h. 44m. The following njunctions with the Moon take place: Dec. 5d. 5h., Jupiter 6° N.; Dec. 10d. 18h., Mars 4° N.; ec. 12d. 07h., Saturn 4° N.; Dec. 16d. 20h., Venus ° S. Mercury, in superior conjunction on December , is unfavourably placed for observation during the onth. Venus sets at 17h. 10m., 17h. 35m. and 18h. 5m. on December 1, 15 and 31, respectively, and is isible for some time after sunset; but owing to its rge southern declination it does not attain a great ltitude. Its stellar magnitude varies from −3·3 to -3·4, the visible portion of its illuminated disk ecreasing from 0·923 to 0·870; its enhanced rightness is due to its distance from the Earth ecreasing from 142 to 129 million miles. Mars rises bout 4h. 15m. during December; it moves from a osition near κ Virginis early in the month to about idway between α and γ Librae towards the end of e month, its stellar magnitude varying from 1·9 to ·8 and its distance from the Earth between 215 and 95 million miles. Jupiter rises at 22h. 35m., 21h. 0m. and 20h. 40m. on December 1, 15 and 31, spectively, and remains fairly close to α Leonis, its otion being westward until December 18, after hich it is eastward. Its stellar magnitude varies om −1·8 to −1·9 owing to its distance from the arth decreasing from 478 to 437 million miles. aturn rises at 6h. 30m., 5h. 50m. and 4h. 50m. on ecember 1, 15 and 31, respectively. Its eastward otion from near γ Librae towards Scorpius can be bserved, its stellar magnitude varying from 0·7 to ·8; owing to its southern declination, it will not ttain an elevation of 22° during the month in the titude of Greenwich and is not very well placed r observation. Occultations of stars brighter than agnitude 6 are as follows, observations being made at Greenwich: Dec. 3d. 04h. 02·8m., 5 Cnc. (*R*); Dec. 4d. 02h. 48·7m., α Cnc. (*D*); Dec. 4d. 03h. 49·8m., α Cnc. (*R*); Dec. 7d. 02h. 20·2m., ε Leo (*R*); Dec. 26d. 02h. 28·3m., δ Ari. (*D*); Dec. 27d. 03h. 56·3m., 51 Tau. (*D*); Dec. 27d. 04h. 18·4m., 56 Tau. (*D*); Dec. 28d. 01h. 58·0m., η Tau. (*D*); Dec. 30d. 06h. 40·7m., *f* Gem. (*R*). *R* and *D* refer to reappearance and disappearance, respectively. The Geminid meteors attain a maximum during December 11–13, the radiant being close to α Geminorum. An annular eclipse of the Sun, invisible at Greenwich. takes place on December 14, and will be visible in the Sudan, the Indian Ocean, Thailand and part of China, the partial phase being visible generally over Africa and Asia.

## Announcements

Dr. Otto Maass, principal research officer in the Division of Pure Chemistry of the National Research Council of Canada, and formerly Macdonald professor of physical chemistry and head of the Department of Chemistry of McGill University, has been elected an honorary member of the Chemists' Club of New York. Honorary membership is restricted to about a dozen chemists, and Dr. Maass is the only Canadian so honoured. His scientific work has been mainly concerned with the chemistry and technology of paper.

The National Science Foundation, Washington 25, D.C., has appointed Dr. James M. Mitchell as associate director of the Foundation and Dr. John T. Wilson as assistant director for biological and medical sciences. Dr. Mitchell, a past president of the American Society for Public Administration, was formerly assistant to the director of the Foundation, and Dr. Wilson was formerly programme director for psychobiology.

Prof. J. R. Whitehead, associate professor of physics in McGill University, has been appointed head of the new research laboratories in Montreal of the RCA Victor Co., Ltd. Associated with him will be Dr. Sydney Wagner, also formerly of McGill University, and a number of other physicists, and their work will be in the field of pure physics and electronics research, not necessarily connected with the Company's projects or developments. Prof. Whitehead is British by birth, being a graduate of the University of Manchester and Cambridge, and during 1939–51 he was on the staff of the Telecommunications Research Establishment, working on radar.

Mr. W. F. Grimes, director of the London Museum. has been appointed director of the Institute of Archæology and professor of archæology in the University of London. Dr. E. O'F. Walsh, senior lecturer in the Department of Physiology, the Royal Free Hospital School of Medicine, London, has been appointed to the University readership in biochemistry tenable at that School.

A symposium on the various chemical, biochemical, physiological and medical aspects of heparin, organized by the Società Lombarda di Scienze Mediche e Biologiche, will be held on December 19 in Milan at the Museo della Scienza e della Tecnica, 17 Via S. Vittore. For non-members of the Società Lombarda a registration fee of 1,000 lire will be charged, which will entitle them to a copy of the proceedings. Further information can be obtained from Prof. Walter Montorsi, Pad. Monteggia, Via F. Sforza 35, Milan.

# SOUTH-EAST ESSEX TECHNICAL COLLEGE, DAGENHAM

## EXTENSIONS TO THE SCIENCE DEPARTMENTS

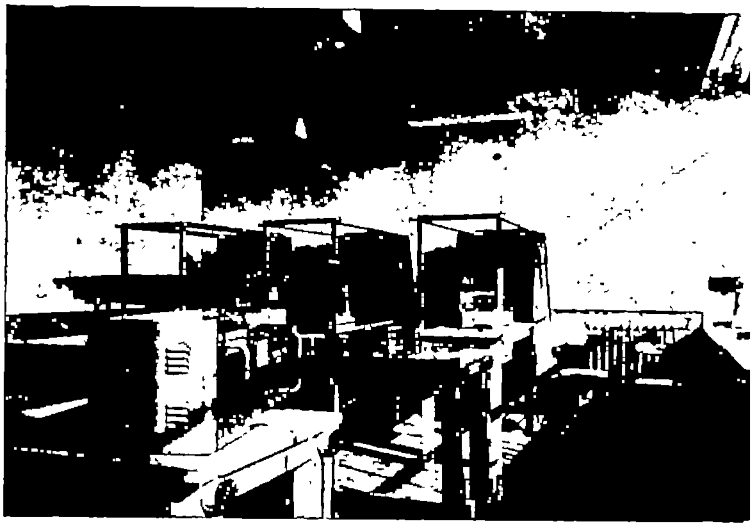

Fig. 2. Advanced Optics Laboratory

It had been apparent for several years that the accommodation for the Science Departments of the South-East Essex Technical College at Dagenham was inadequate. The College was opened in 1936 and at that time there was one Science Department which operated mainly on the ground floor of the now enlarged Science Block. Since that time, the provision of laboratories for the College has remained practically the same, although the demands on this section have developed considerably. One measure of the growth is reflected in the fact that within the past ten years it has been necessary for purposes of organization to split the original Science Department into a Department of Chemistry and Biology and a Department of Physics and Mathematics, and the number of full-time staff has been more than doubled to meet the increased demands. The total number of students attending the College on a full-time or part-time basis is now approximately 8,500, and of these approximately 900 are enrolled in the Science Departments.

The deficiency in accommodation became increasingly noticeable immediately after the Second World War, and early steps were taken to plan extensions to the existing block by which two upper floors would have been added, together with extensions outward to the east and west. This block would have included provision, not only for science and engineering, but also for art, architecture and domestic science. The scheme was approved by the Ministry of Education in 1950, but shortly afterwards, as part of a gener policy of national economy, approval was withdraw however, the Ministry finally gave approval to t present amended scheme. The effect of this has been exclude the extensions outwards to the east and we and to limit the extensions to two new floors abo the original block. In spite of these reductions, t new extensions have resulted in a substantial additio to the accommodation for the two Science Depar ments, with some classroom accommodation for t Engineering Department.

In planning the accommodation and equipmen consideration has been given not only to the nee of existing courses, including degree courses, but al with reference to new types courses in applied science to me the changing needs of industry. T give only one example, a phot graphic section has been include and this will provide courses prin arily to meet the requirements industry, where this technique is increasing importance. It is vital necessary that the departments the College should be abreast modern developments in all the su jects taught and, indeed, in a pos tion to point the way to new a vances in the future. The researc laboratories will enable postgrad ate students to be trained in th methods of research and to wor for higher degrees.

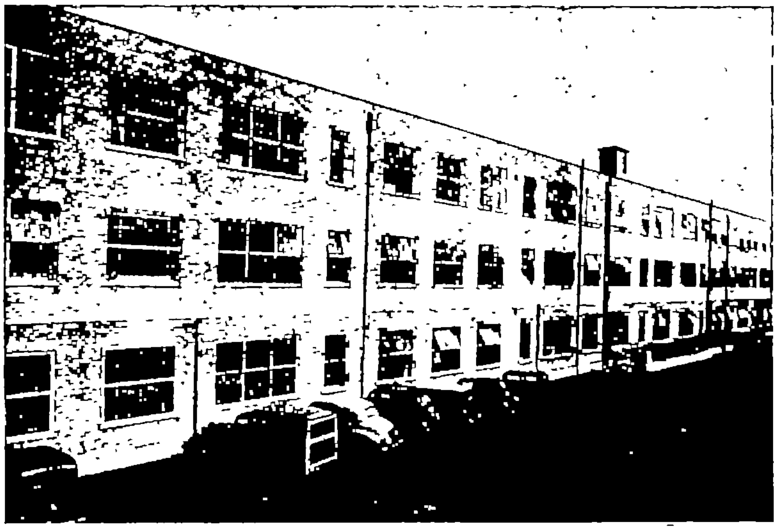

Fig. 1. Science Block extensions ; from the west end

The new accommodation include two chemistry research laboratorie two physics research laboratorie advanced chemistry lecture roo large lecture theatre and labor ies for general chemistry, physical chemistry, radio d television servicing, advanced radio and applied oustics, X-ray and high-vacuum work; general ysics, heat, sound and optics, magnetism and ctricity, advanced optics and photography. Pro- sion has also been made for three engineering awing offices and three engineering classrooms, and physics workshop.

The new laboratories have been well equipped and is only possible to mention a few items; for ample, a high-frequency motor alternator set, ilger standard polarimeter, 'Speedivac' high-vacuum mp, vacuum coating unit, X-ray diffraction equip- ent, measuring microscopes, single-crystal gonio- eter, Brown electronic potentiometer, Brunsviga lculating machines, various special cameras and otographic equipment, equipment for physics rkshop, spectroscopic chemical analysis, radio and levision servicing, audio-radio and high-frequency easurements, electronic measurements, etc.

The Science Departments provide both full-time d part-time courses for B.Sc. special chemistry and ecial physics, and for the general degree of the niversity of London, associateship of the Royal stitute of Chemistry, and graduateship of the stitute of Physics. Part-time day and evening urses are provided for Ordinary and Higher ational Certificates in chemistry, applied physics d engineering, and City and Guilds of London stitute courses in telecommunications, radio engin- ring, radio and television servicing, photography, emical plant operation and metallurgy. Courses ve been offered at various times in nuclear physics, gh-vacuum technique, electronic measurements, lve technology, advanced mathematics for physi- sts, chemists and engineers, statistics, theory and actice of X-ray diffraction, theory and practice spectroscopic analysis, servo-mechanisms, glass- owing and plant technology.

It is proposed to offer a number of 'sandwich' urses suitable to the area served by the College, d these include applied physics, chemistry, radio d electronics, mechanical and production engin- ring, and electrical engineering.

The new extensions were opened on November 19 Mr. Geoffrey Marchand, who was until recently airman of the London Regional Advisory Council r Higher Technological Education, in the presence a representative gathering of the County of Essex d other professional and academic bodies inter- ted in the work of the College.

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# ASSOCIATION OF SCHOOL NATURAL HISTORY SOCIETIES

## ANNUAL EXHIBITION, 1955

THE seventh annual exhibition of the Association of School Natural History Societies was held the British Museum (Natural History), London, on tober 15. Once more, the main contribution was om member schools, which sent exhibits from widely parated areas. For example, Ackworth School sent a splay illustrating work done in Alderney, Channel lands, and in Ackworth, Yorks. From farther ield came the log-book of the Natural History Society Breeks Memorial School, Ootacamund, India; this cluded some beautifully executed water-colour intings of local avifauna. Living midwife toads and tadpoles (from Provence in France) were exhibited by Glyn Grammar School, Ewell, Surrey.

There were many collections on show, including an extensive comparative display by Bishop's Stortford College of aquatic larvæ from Bishop's Stortford and Flatford Mill, and an equally extensive collection of twenty-seven species of moss from the Lake District shown by University College School, Hampstead. Cranbrook School, the interests of which lay in the lower vascular plants, showed herbarium sheets of local ferns. A collection of dragonflies preserved by vacuum-desiccation to retain the natural colours was exhibited by Lord Wandsworth College, Long Sutton. This and several other entomological exhibits, such as those of Felsted School, Herts and Essex High School for Girls, Bishop's Stortford College and King's School, Canterbury, showed the painstaking care that is taken by these young naturalists to ensure that their specimens are preserved in optimum condition. The wild tropical silk moths exhibited by Tonbridge School were some of the most beautiful creatures on display that day. On the whole, there were more entomological exhibits this year—a fact noted with approval by several visitors.

It is a frequent criticism of the exhibitions that there are "too many graphs"; but nevertheless the compiling of detailed observations and the plotting of transects and quadrats are essential to serious ecological studies. Detailed charts showing the vegetation of East Coast localities were shown by Felsted School. In connexion with local angling interests, Oundle School had made a complete ecological survey of the Willow Brook, a tributary of the River Nene, which is to be stocked with trout. In another exhibit they traced the colonization of spoil heaps, from opencast mining, from bare earth to complete cover, over a period of thirty years. Dauntsey's School showed results obtained in studying the relative frequency of orchids on a Downland site, together with preliminary investigations to account for the observed frequencies. Less detailed, yet also worth while, were the line transects made by Brighton and Hove High School for Girls, which also exhibited a fine collection of local Basidiomycetes. Kimbolton School showed the results of botanical surveys made in the grounds of Kimbolton Castle and at a site on the River Kym. A hundred-yard transect clearly demonstrated the effect of shade upon the composition of the field layer-vegetation.

To many people, graphs and charts are dull, but in fairness it must be said that this year there was a noticeable improvement in the presentation of results: charts were clearly drawn and labelled; captions were short and to the point; and neatness abounded. Those who, in previous years, had produced results which were undoubtedly valuable but were tediously presented now attempted to enliven their charts with colour, bold lettering and other devices. Thus it has been demonstrated this year that members can not merely produce results and specimens, but they can also produce an exhibition. This point is well illustrated by the display put on by the William Grimshaw School, London. "Discovering Coldfall Wood" was a record of what had been found by pupils in an area of woodland. Where actual specimens could not be brought, their place was taken by photographs, models or paintings, so that a visual account of the wild-life of the wood was presented. Another project directed towards visual education was the film strip being produced by Orange Hill Girls' Grammar School, Edgware. This showed stages in the preparation of diagrams for a film strip illustrating the life-history of the honey bee.

The exhibition was supported by three guest exhibitors: the Amateur Entomological Society, the School Nature Study Union and the Universities Federation for Animal Welfare. During the afternoon a colour film, "Coral Wonderland", was shown, describing life in and around the Great Barrier Reef of Australia. A catalogue of exhibits was available, and an enlarged edition of this catalogue, giving an account of the exhibition and a complete list of members, can be obtained from the honorary general secretary of the Association, O. N. Bishop, Kimbolton House, Kimbolton, Huntingdonshire, price 10*d*. post paid.

The general improvement in quality of presentation, together with the maintenance of good scientific standards, are pleasing to note. Many of the exhibits were again on view in the Department of Zoology, University College, Leicester, on November 5, when the Association held its first provincial meeting. It is hoped thereby to encourage more Midland schools to take an active part in the work of the Association.

O. N. BISHOP

# DISSEMINATION OF SCIENTIFIC INFORMATION

A CONFERENCE on the Dissemination of Science, organized by Unesco, was held in Madrid during October 19–22. Twenty-five delegates, representing national associations for the advancement of science and associations of science writers, took part. The United States and most European countries were represented, including Belgium, France, Denmark, Spain, Italy, Western Germany, Switzerland, Greece, Netherlands, Poland, Sweden, Turkey and Great Britain.

A wide range of problems was discussed on an agenda drawn up by the Unesco Secretariat, which agenda was severely criticized by many of the delegates because it failed to embrace the fundamental difficulties of scientific popularization. Nevertheless, many interesting issues were covered, and the widely different practices of the various countries soon became obvious.

Many of the delegates commented on the inaccuracy of scientific contributions appearing in the lay press and on the prevalent tendency of editorial staffs to make unauthorized changes in scientific articles. This particular problem does not exist to any great extent in Great Britain, where almost all papers of repute have a professional scientific correspondent. The position in France, however, appears to be so unsatisfactory that the French Association of Science Writers has devised a scheme which enables newspaper editors to check information rapidly on the telephone. The Association has prepared a chart giving the name and telephone number of scientists prepared to answer questions on given subjects at short notice. The usefulness of such a service is great; but the Conference was at pains to point out that it should be regarded only as a temporary measure, and that the true solution lies in the recruitment by newspapers of adequately qualified scientific writers.

One of the documents prepared by the Drafti Committee under the chairmanship of Sir Ben Loc speiser, a British delegate, stressed the importance popularizing science and improving general scienti knowledge among certain special sections of t community, embracing on one hand children a their parents, and legislators and business men the other.

The future supply of scientists can undoubted be improved by awaking the children's interest science at an early age. Even those who do not ta up science will benefit from wider scientific kno ledge than the present generation. It is importa to interest parents also, for in many cases they w determine the career on which their children w embark. There was considerable discussion on t ways in which this group could be reached.

Mr. C. A. Reichen, of Lausanne, produced a numb of copies of an excellent illustrated children's mag zine, in which scientific matters were given conside able prominence. This magazine has the support a number of industrial firms. It was consider desirable that similar publications should be start elsewhere. The need for more scientific programm on radio and television for children was also discusse

Prof. E. B. Schieldrop, of Norway, spoke on t value of laboratory visits, which had proved pa ticularly successful in the University of Oslo. Sir B Lockspeiser strongly supported this point of vie and said that the most valuable feature of su visits was that children and parents were able to s how scientists worked.

Mr. Watson Davis, director of 'Science Servic an American non-profit-making organization devot to the popularization of science, told the Conferen about the scientific clubs which have become popul among young people in the United States. Fro time to time these clubs organize science fairs— effect conversaziones—in which all the exhibits a made and demonstrated by the members. The science fairs are well supported by local people.

It was considered that the best approach to t second group—those who control government industrial policy—can be made through scientif articles written by scientists and science writers an published in the special journals read by the membe of the group. A notable example of this techniq is the regular publication of articles, on science an its application in industry, in the *Financial Time* Such articles could help greatly in educating busine executives in the possibilities presented by t application of science.

Considerable interest was also shown in the pap prepared by Mr. M. Philips Price, M.P., on th Parliamentary and Scientific Committee. Th informal group, which was started in the 1930's, no has considerable influence both in the House Commons and House of Lords. It acts as a foc point where legislators may meet and discuss scientifi technical and related economic problems with me interested in research. In this way the influenti layman may be kept informed of the part whic science can play in public affairs.

The Conference agreed that such bodies play most important part in furthering knowledge o science and that they should be established in othe countries for legislators and possibly busines executives also.

A considerable amount of time was spent in some what futile discussion of science fiction and "th fight against false sciences". There was also muc rgument as to whether some form of international rganization for co-ordinating the work of national associations for the advancement of science and the ational associations of science writers should be set up. Finally, however, a recommendation was adopted to the effect that it was undesirable at the present moment to establish an international organization for these purposes, but that Unesco should consider the possibility of forming a consultative committee to further co-operation between the various national ssociations if this should prove necessary.

Although the Conference produced no definite or positive conclusions, it was nevertheless valuable in showing that the problems of popularizing science vary greatly from country to country, and in bringing people together with similar interests from many ountries.

T. A. MARGERISON

## ROYAL BOTANIC GARDENS, KEW

A REVIEW of all aspects of the work of the Royal Botanic Gardens, Kew, during 1954, is presented in the *Kew Bulletin*, No. 1, 1955. The past year has been one of sustained progress, but various problems of accommodation remain acute—for example, the Palm House, the Herbarium and library—and are receiving close attention. The main activities of the Gardens, however, are being maintained with unimpaired vigour. It is impossible o touch on more than a few of these in this short article, but some idea of the nature and volume of he problems handled may be indicated by some selected references. Thus, the specimens received for he Herbarium, excluding those prepared at Kew from living material, amounted to 55,994; some ,166 sheets were received on loan; 5,652 were sent on loan; 16,424 sheets were distributed as duplicates; and, in all, some 47,780 sheets were mounted excluding algae, lichens, fungi and bryophyta, and specimens received already mounted). No fewer than 4,077 botanists paid visits during 1954, many of these being from overseas, attending the Eighth International Botanical Congress at Paris. Here, too, reference may be made to the fact that 2,635 nquiries and plant consignments were dealt with during the year.

As in previous years, important activities were the dentification of economic plant products and the supplying of information on economic plants: for example, cinnamon, groundnuts, sesamum, raffia, balsa, senna, sansevieria, capers, opium poppy, aloes, patchouli, pepper, ginger, vanilla and cardamoms. In relation to the present high prices of tea and coffee, various inquiries as to the possibility of growing these crops in new areas received consideration.

For many years the Gardens have rendered an important service to scientific agriculture by maintaining the Quarantine House, the function of which is to prevent the spread of diseases and pests during the transference of economic plants from one part of the world to another. Thus, at the present time, varieties of cacao from the Imperial College of Tropical Agriculture, Trinidad, have occupied most of the available space during the year, these being the most promising of the Imperial College selections of Trinidad trees and some Amazonian forasteros originally collected on the Upper Amazon. Rooted cuttings from these plants have been suitably packed and sent by air to the West African Cacao Research Institute, Gold Coast, and to the Departments of Agriculture in Malaya, Ceylon and Fiji, and, with the exception of a consignment sent to Malaya, are reported to be growing successfully in their new environments. Material of *Theobroma* and the related genus *Herrania*, collected in Colombia in 1952 and sent to Kew via Trinidad, is now on its way to West Africa for the use of plant-breeders there. Various banana and cotton collections are also under surveillance in the Quarantine House.

A further service to countries of the British Commonwealth consists in obtaining plants of potential value. For example, young plants of ipecacuanha (*Cephaelis ipecacuanha* Rich.) have been sent to the Departments of Agriculture in Nigeria, British Honduras and Malaya for local trials.

Work of a rather different kind consists of research on the systematic anatomy of the Monocotyledons; notes on this important and extensive undertaking have appeared from time to time in these columns. Arrangements for the publication of this work in three volumes, of which the first will deal with the Gramineae, have now been made with the Clarendon Press, Oxford. A large number of routine inquiries, relating to miscellaneous botanical materials, including timbers, archæological specimens, and rubbed and powdered herbs, have been dealt with in the Jodrell Laboratory during the year. Among the more unusual samples were nylon bobbins examined on behalf of the Board of Customs and Excise, twigs of alleged apple trees, most of which proved to be plum suckers, submitted by the laboratory at New Scotland Yard, and unsatisfactory pick handles which were found not to have been made of the timber that had been specified.

The report also deals in some detail with the progress that has been made in the preparation of the several regional floras, and with other taxonomic studies, and the cultural work in the different sections of the Gardens is appropriately reviewed. A comprehensive list of publications and a staff list conclude this interesting and important publication.

## OPINIONS AND SOCIAL PRESSURE

WHAT is the effect of the opinions of others on our own? How strong is the urge towards social conformity? An American psychologist, Solomon E. Asch, has approached these questions by means of unusual experiments. These, and his findings, have been described in the November issue of *Scientific American*, which contains a number of other articles of outstanding interest as follows: "Trenches of the Pacific", by R. L. Fisher and R. Revelle; "Synthetic Diamonds", by P. W. Bridgman; "Radiation and Human Mutation", by H. J. Muller; " 'Empty' Space", by H. C. van de Hulst; "What makes Leaves Fall?", by W. P. Jacobs; "Etruscan Metallurgy", by A. N. Modora; "Too Many Deer", by A. S. Leopold[*].

Dr. Asch's investigations were guided by certain underlying assumptions, which to-day are common currency and account for much that is thought and said about the operations of propaganda and public opinion. The assumptions are that people submit uncritically and painlessly to external manipulations by suggestion or prestige, and that any given idea or value can be 'sold' or 'unsold' without reference to its merits. Asch has described his experiments as follows.

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[*] *Scientific American*, 193 (November 1955), 2 West 45th Street, New York. 50 cents.

A group of seven to nine young men, all college students, are assembled in a classroom for a "psychological experiment" in visual judgment. The experimenter informs them that they will be comparing the lengths of lines. He shows two large white cards. On one is a single vertical black line—the standard length of which is to be matched. On the other card are three vertical lines of various lengths. The subjects are to choose the one that is of the same length as the line on the other card. One of the three actually is of the same length; the other two are substantially different, the difference ranging from three-quarters of an inch to an inch and three-quarters.

The subjects announce their answers in the order in which they have been seated in the room, and on the first round every person chooses the same matching line. Then a second set of cards is exposed; again the group is unanimous. The members appear ready to endure politely another boring experiment. On the third trial there is an unexpected disturbance. One person near the end of the group disagrees with all the others in his selection of the matching line. He looks surprised, indeed incredulous, about the disagreement. On the following trial he disagrees again, while the others remain unanimous in their choice. The dissenter becomes more and more worried and hesitant as the disagreement continues in succeeding trials; he may pause before announcing his answer and speak in a low voice, or he may smile in an embarrassed way.

What the dissenter does not know is that all the other members of the group were instructed by the experimenter beforehand to give incorrect answers in unanimity at certain points. The single individual who is not a party to this pre-arrangement is the focal subject of the experiment. He is placed in a position in which, while he is actually giving the correct answers, he finds himself unexpectedly in a minority of one, opposed by a unanimous and arbitrary majority with respect to a clear and simple fact. Upon him are brought to bear two opposed forces: the evidence of his senses and the unanimous opinion of a group of his peers. Also, he must declare his judgments in public, before a majority which has also stated its position publicly.

The instructed majority occasionally reports correctly in order to reduce the possibility that the naïve subject will suspect collusion against him. There are eighteen trials in each series, and on twelve of these the majority responds erroneously.

How do people respond to group pressure in this situation? First, there are the statistical results of a series in which a total of 123 subjects from three institutions of higher learning were placed in the minority situation described above.

Of the 123 put to the test, a considerable percentage yielded to the majority. Whereas in ordinary circumstances individuals matching the lines will make mistakes less than 1 per cent of the time, under group pressure the minority subjects swung to acceptance of the misleading majority's wrong judgments in 36·8 per cent of the selections.

Individuals differed in response. At one extreme about one-quarter of the subjects were completely independent and never agreed with the erroneous judgments of the majority. At the other extreme, some individuals went with the majority nearly all the time. The performances of individuals in the experiment tend to be highly consistent. Those wh strike out on the path of independence do not, as a rule, succumb to the majority even over an extended series of trials, while those who choose the path of compliance are unable to free themselves as the ordeal is prolonged.

The reasons for the startling individual difference have not yet been investigated in detail. At this point only some tentative generalizations from talk with the subjects, each of whom was interviewed at the end of the experiment, can be reported. Among the independent individuals were many who held fast because of staunch confidence in their own judgment. The most significant fact about them was not absence of responsiveness to the majority but a capacity to recover from doubt and to re-establish their equilibrium.

Many of the individuals suspected that the majority were 'sheep' following the first responder, or that the majority were victims of an optical illusion; nevertheless, these suspicions failed to free them at the moment of decision. More disquieting were the reactions of subjects who construed their difference from the majority as a sign of some general deficiency in themselves, which at all costs they must hide.

Which aspect of the influence of a majority is more important—the size of the majority or its unanimity? The experiment was modified to examine this question. In one series the size of the opposition was varied from one to fifteen persons. The results showed a clear trend. When a subject was confronted with only a single individual who contradicted his answers, he was swayed little: he continued to answer independently and correctly in nearly all trials. When the opposition was increased to two, the pressure became substantial: minority subjects now accepted the wrong answer 13·6 per cent of the time. Under the pressure of a majority of three, the subjects' errors jumped to 31·8 per cent. But further increases in the size of the majority apparently did not increase the weight of the pressure substantially. Clearly the size of the opposition is important only up to a point.

Disturbance of the majority's unanimity had a striking effect. In this experiment the subject was given the support of a truthful partner—either another individual who did not know of the pre-arranged agreement among the rest of the group, or a person who was instructed to give correct answers throughout.

The presence of a supporting partner depleted the majority of much of its power. Its pressure on the dissenting individual was reduced to one-fourth. Most interesting were the reactions to the partner. Generally the feeling toward him was one of warmth and closeness; he was credited with inspiring confidence.

Was the partner's effect a consequence of his dissent, or was it related to his accuracy? There was now introduced into the experimental group a person who was instructed to dissent from the majority but also to disagree with the subject.

Again the results are clear. When a moderate dissenter is present, the effect of the majority on the subject decreases by approximately one-third, and extremes of yielding disappear. Moreover, most of the errors the subjects make are moderate. To this extent the subjects broke away from the majority even while bending to it.

On the other hand, when the dissenter always chose line that was more flagrantly different from the ndard, the results were of quite a different kind. e extremist dissenter produced a remarkable freeing the subjects; their errors dropped to only 9 per t. Furthermore, all the errors were of the moderate riety. It was concluded that dissent *per se* increased lependence and moderated the errors that occurred, d that the direction of dissent exerted consistent ects.

# SCIENTIFIC EXPLORATION OF THE BELGIAN AFRICAN NATIONAL PARK OF THE GARAMBA

By DR. TRACY PHILIPPS

TEN years before the Second World War, King Albert of the Belgians founded the Belgian rican National Parks and the National Parks stitute in Brussels for their scientific study; his ientific adviser was Dr. Victor van Straelen, who s until 1954 director of the Royal Institute of tural Sciences. Dr. van Straelen is president of e National Parks Institute, where he carries out th foresight and energy the founder's purpose, and whom the preliminary report of the Garamba pedition is dedicated by its members. Nominated the King of the Belgians as British member of e Institute, I have for my five-year term taken rt in the scientific administration of the Belgian rican National Parks; the continuing British embers are the Hon. Sir Evelyn Baring, Lord illiam Percy and Lord Willingdon.

The conservation of natural resources, including e recording of their inter-relation, is the more tic of the Institute's two main objectives. In the alm of the natural sciences, the Institute's more namic part is for the improving of natural know-lge of how to reconstitute Nature's ill-used or er-used forces, and how to re-deploy them by w methods towards "delivering mankind from e bondage of ignorance" of himself and his rroundings.

No organization offers better opportunity than the lgian African National Parks for uninhibited servation of natural surroundings, of what grows ere and of what lives there, inter-related and fluenced by the total environment. These reserves re most carefully chosen at the conjunction of eat zoological and botanical zones, and of the eeting places of three main atmospheric currents. tanically, the Garamba Reserve lies within Engler's danic province, which extends roughly from the negal River to the foot of the Ethiopian plateau. he Institute's programme aims at establishing a ientific inventory of the fauna and flora of the serves of which the Government has confided to it e administration. Thanks to the work already done this plan, it can be said that the areas occupied the Institute's four national parks between the dan and Rhodesia have become scientifically the st-known part of the African tropics. Only the ost careful and systematic exploration enabled these sults to be reached, and elements of remarkable terest to be placed at the disposal of organized science. Among the publications issued by the Brussels Institute during the past eight years there can be counted 1,334 new zoological species. These are headed by 561 Coleoptera. From the material collected by the Institute's scientific missions, sixty new botanical species have also been described.

Recently, an important exploration and inventory have been made in the National Park of the Garamba, which lies along the north-western section of the Congo–Nile Divide bordering the Nilotic Sudan. The Garamba is situated on the confines of two great bio-geographic areas, the Guinean and the Sudanic. This recent exploration has been working on a plan differing from its predecessors in the other park reserves. The latter were virtually confined to the collection of zoological and botanical specimens. The Garamba expedition's programme set out to determine all the characteristics of the biological environment, including climate and soil, and then to study the distribution of animals and plants in relation to these conditions. The insect collection alone of the expedition amounts to some 1,500,000 specimens. The number is considerable in view of the sum of the work entailed in the preparation of this fragile and perishable material, which cannot be ready for study before 1956. It will have cost five years in mounting, in the ecological recording of all the conditions surrounding each specimen, and in labelling.

Competent study of collections of this magnitude, essential for serious knowledge of flora and of fauna, present great difficulties due to lack of specialists in various branches of zoology. Thus, several families of insects collected in the Albert National Park (between the Lakes Kivu and Albert, and including Mount Ruwenzori) during the exploration of 1933–35 have not yet been examined for lack of available specialists. The size of the collections from the Belgian African National Parks often constitutes a big problem for the scientist who has to examine them. Thus, an American specialist has found himself charged with the examination of 170,000 specimens of *Chloropidae*, a little fly of which the larvæ of some species live in grass thatch or as parasites on non-vertebrate animals.

It is difficult as yet to appreciate the full value of the results of the recent exploration of the Garamba Reserve. A complete abstract of the observations and collections will first be essential to allow of any general conclusion. The botanical specimens being studied show very numerous species new to the Congo, and one family new to science. The zoological collections from the Garamba include 46,776 vertebrates, of which 2,914 are mammals, 3,122 birds, 4,641 fish, 34,511 frogs, 1,588 reptiles, and a number of albino bats. One bio-geographical discovery has, however, been made. It has long been observed that there is considerable similarity between the fish in the basins of the Nile and of the Congo, without there being any obvious present physical connexion. The Garamba expedition has now found, on the northern border of the Reserve, a marsh situated in a gap in the north-western section of the Congo–Nile divide; this marsh overflows in the rainy season both southward to the Congo towards the Atlantic and simultaneously northward into the Mediterranean basin through the Nile.

Henri de Saeger, who organized and led the Garamba exploration, feels that there is good reason for believing that the results will be found to have brought to science an exceptionally rich contribution.

# ORGANIZATION OF DEFENCE RESEARCH IN THE UNITED STATES

DURING the past three years the expenditure of the United States Department of Defense, the Atomic Energy Commission and the National Advisory Committee for Aeronautics on research and development has been at an annual level of 2,000 million dollars. These activities have recently been reviewed by a Sub-Committee of the Committee on Business Organization of the Department of Defense, and this sub-committee has communicated its findings to the Commission on Organization of the Executive Branch of the Government, by which the report has been approved for publication*. The Sub-Committee was charged with appraising and evaluating such research and development activities and determining the degree of overlapping and the cost of such activities in the Department of Defense and other agencies conducting research related to defence. So far as the Atomic Energy Commission is concerned, the Sub-Committee limited its survey to research and development activities relating to atomic weapons and nuclear power production; but it included those activities of the National Science Foundation that relate to, and are co-ordinated with, the military research and development programmes.

The Sub-Committee's report gives a clear picture of the organization of defence research and development activities in the United States and of the problems encountered in relation to overlapping and co-ordination, the evaluation of new weapons and the use of personnel. In spite of the wide difference in structural organization between the United States and Great Britain, the Sub-Committee's comments and recommendations should be of considerable interest in Britain, both to those concerned with defence research itself and to those concerned with the effective use of scientific and technical man-power and the balance of the effort in research and development, including that between fundamental research and applied research whether for defence or for civil purposes.

Prior to 1953, the Research and Development Board was the only organization in the United States Department of Defense directly concerned with the research and development programmes. Operating through a large group of committees, panels and sub-panels staffed by part-time civilians and officers from the three Departments, the Board did little effectively to co-ordinate and eliminate duplication in these programmes, and in 1953 the Board was dissolved and its functions transferred to the Secretary of Defense, who was provided with an Assistant Secretary (Research and Development). In consequence, a real improvement in effectiveness and economy appears to be developing; but the Sub-Committee doubts whether the new pattern of itself will produce the degree of co-ordination and integration that is desirable, although the professional capacity of the personnel concerned has, in general, been increasing and the traditional attitudes of self-sufficiency of each of the three Armed Services is diminishing. The Sub-Committee emphasizes that it is essential that the Assistant Secretary (Research and Development) be trained in science and te nology. Besides possessing experience in resea and development and their administration, he sho be supported by an adequate staff with li experience, and the Sub-Committee also recommen the full development of the Research and Develo ment Policy Council, of which the Assistant Secreta is chairman. It did not consider, however, that t creation of a further Assistant Secretaryship (Appli tions Engineering) was sound and recommended th if combined operation of the two posts proved unsat factory, as it anticipates, the functions of the t should be integrated into the office of one Assista Secretary. It also recommended that the Secreta of Defense should wisely and fearlessly use h authority to withhold appropriated funds from a research and development project to promote integ tion of the programmes of the three Department prevent duplication and encourage effectiveness a efficiency in the use of research and developme funds.

Substantially all the basic research of the Depa ment of Defense is carried out under contracts plac in the civil economy. This policy is approved b the Sub-Committee, which nevertheless considers th level of 20 million dollars in 1954 too low and reco mends that it be significantly increased. Expenditu on basic research in the physical sciences by th Atomic Energy Commission is regarded as more near in balance with the scope of its activities and with th size of its development programmes. Arrangemen for co-ordinating these basic research programm with that of the National Science Foundation a regarded as excellent, and the present organizati of the Department of Defense is considered adequate for identifying duplication in research a development of weapons if used with continui alertness and energy. The organization does no however, provide adequately for the initiation radically new approaches to systems of weapons, a the appointment of a standing committee of outstan ing scientists and technologists, reporting directl to the Assistant Secretary of Defense (Research an Development), is recommended. This committ could canvass periodically the needs and oppo tunities for studies leading to radically new system of weapons. While the Weapons Systems Evaluati Group of the Joint Chiefs of Staff is potentially great importance and can make contributions of re value, the Sub-Committee recommends that th Group be shifted to contract work with a universit or non-profit organization, and that it then be e panded to an adequate size. An administrative revie of the operations and contributions of the hundre of committees and consultants used by the Depar ment of Defense and the military departments recommended, and those found to be ineffecti should be discontinued. Maximum use should b made of the National Research Council in establishin such committees.

Criticism of the civilian administration of th research and development operations of the thre military departments is severe, and the Sub-Com mittee recommends the establishment of an office Assistant Secretary for Research and Developmen in each of the three military departments. Th Assistant Secretary should be trained in science an technology and experienced in the conduct an administration of research and development an should be assisted by a small staff with simila qualifications.

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* Commission on Organization of the Executive Branch of the Government of the United States: Sub-Committee Report on Research Activities in the Department of Defense and Defense Related Agencies. Pp. x+91. (Washington, D.C.: Government Printing Office, 1955.) 30 cents.

Commenting on the research and development operations of the three Armed Services, the Sub-ommittee considers that too large a proportion—ome 50 per cent in 1954—of the Army's appropriated unds for research and development is expended on activities within the Army's own facilities and that larger proportion should be shifted to the civil conomy. It commends the new organization plan created in December 1954, but emphasizes the need or strong staff control and for staffing the organization with officers and civilians of the highest technical competence. Of the Navy, it emphasizes the importnce of strong administrative support for the new unctions of the Office of Naval Research in co-rdinating and integrating the research and development programmes of the Navy, and for providing a staff of adequate size and technical competence, though the Navy has gone far to develop such officers. The military organization of the Air Force for research and development appears to be sound, but the Sub-Committee was concerned at the fragmentation of Army and Navy research and development programmes; whereas the Army pattern is potentially adequate to minimize the consequent deficiencies, hat of the Navy is not.

Some 39,000 military personnel and 63,000 civilians participated in the 1954 research and development effort of the three military departments; and while all three departments are giving much attention to personnel problems and have excellent training problems, in view of the increasing national shortage of scientists and engineers, the Sub-Committee recommends that each department should make a realistic examination of its growing needs for technical officers and, if necessary, expand its programmes to provide for an increased number of officers trained in research and development. Each should also revise its policies for such officers so as to permit adequate specialization: the average period of two to three years for the technical assignments is too short. Pay scales should be more nearly competitive with industry, and the number of the higher-level posts in the Civil Service should be materially increased. Where a choice is possible, however, research and development should be carried out at that place in the United States where the work can be done most efficiently and effectively, and it is suggested that some 125–150 million dollars of the programme for 1954 should have been done in the civil economy.

Generally, the Sub-Committee commends the organization for, and the operations in, the military applications of atomic energy, and particularly the Atomic Energy Commission's policy of staff control and co-ordination with operation by civilian contractors. It is concerned, however, that the Department of Defense's assignment of "cognizance" to a military department for certain specific weapons may endanger integration of the development programme and the relations with the Atomic Energy Commission. Unqualified approval is given to the work of the National Advisory Committee for Aeronautics; but it is emphasized that the quality of the work in its laboratories may suffer if salary-levels for professional positions there are not made more nearly competitive with industry. The Sub-Committee anticipates that adoption of its recommendations could bring in the next five years a 25 per cent increase in the effectiveness and efficiency of the present effort in research and development; but it also suggests that in the present rapidly developing technical situation serious consideration should be given to the adequacy of the present level of expenditure.

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# THERMAL REACTION BETWEEN HYDROGEN AND NITROGEN DIOXIDE

By Dr. P. G. ASHMORE and B. P. LEVITT

Department of Physical Chemistry, University of Cambridge

THERE has been little published work on the reaction between hydrogen and nitrogen dioxide, although there have been many studies of the effect of nitrogen dioxide on the reaction between hydrogen and oxygen[1]. Ashmore has reported[2] sensitized gnitions of mixtures of nitrogen dioxide and hydrogen, and Pollard and Holbrook have kindly informed us of work in Bristol which shows that the two gases gnite at temperatures above 500° C., and that the products of ignition and of the slow reaction are nitric oxide and water. The present communication outlines results, to be published fully later, of a photometric study of the reaction at about 400° C.

Parallel light of wave-length 4450–5000 A., which s below the photochemical threshold[3] for nitrogen dioxide, passed through a plane-ended, cylindrical, Pyrex' reaction vessel (20 cm. long, 4 cm. diameter) and fell on a 931-*A* photomultiplier tube; the output, when amplified as suggested by Sweet[4], was proportional to the logarithm of the light absorbed and hence to the molecular concentration of nitrogen dioxide. The photometer was calibrated accurately at 102° C. against nitrogen dioxide in the reaction vessel. The linearity and absolute response at 400° C. were shown to be satisfactory by immediate comparison with admitted quantities and also by comparison of kinetic and equilibrium studies for the reaction $2NO_2 = 2NO + O_2$ with published data[5]. The absence of any photochemical effect on the hydrogen – nitrogen dioxide reaction was confirmed by duplicate runs with a neutral density filter (of ¼ per cent transmission) first between the light source and the reaction vessel, and then between the latter and the photomultiplier.

Fig. 1 shows typical plots of the concentration of nitrogen dioxide against time for a wide range of hydrogen pressures, with 10 mm. of nitrogen dioxide present initially, at 411° C. The rate of disappearance of nitrogen dioxide is more rapid the more hydrogen is present. It is also initially more rapid the more nitrogen dioxide is present.

Nitric oxide has a strong inhibiting effect, as shown in Fig. 2; in these experiments, mixtures of nitrogen dioxide and hydrogen were run into nitric oxide already in the reaction vessel. The effect cannot be

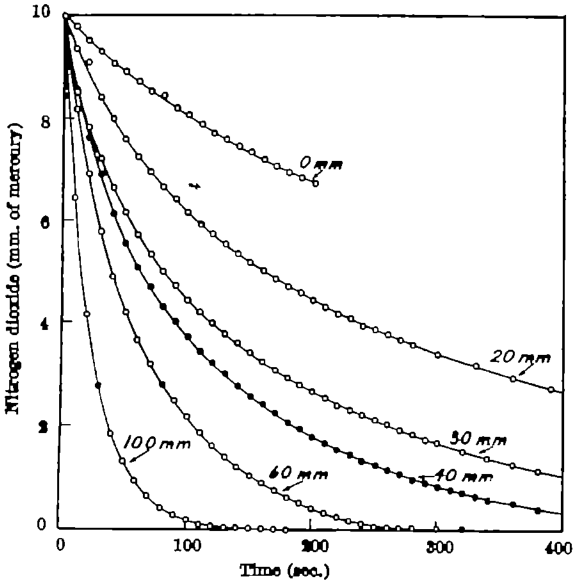

Fig. 1. Decay of concentration of nitrogen dioxide with time. 10 mm. of nitrogen dioxide with indicated pressures of hydrogen, at 411° C.

due to the termolecular reaction between nitric oxide and oxygen, for calculations based on equilibrium data[3] and observed rates for the bimolecular decomposition show that several tens of millimetres of oxygen would have to be present, whereas the amount there is negligible.

The effect of several tens of millimetres of oxygen appears to be negligible initially, but reduces the rate late in the reaction. The effect of water vapour is also slight except near the end of the reaction, when it appears to accelerate the rate of disappearance of the nitrogen dioxide.

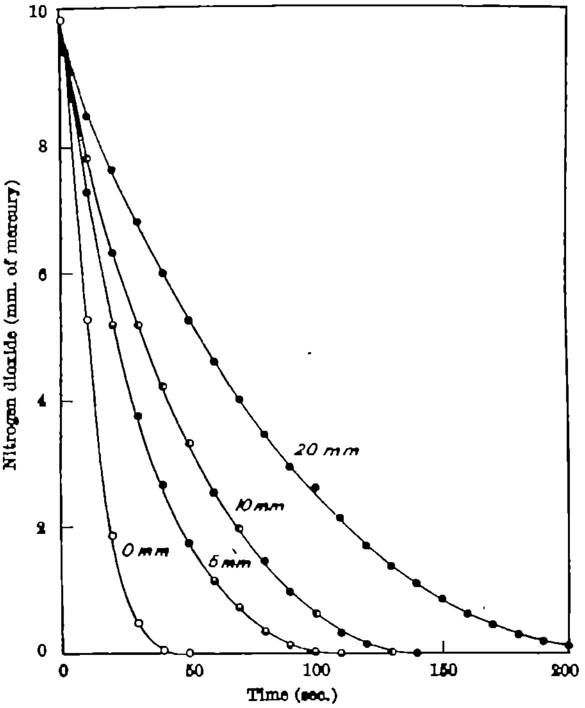

Fig. 2. Inhibiting effect of nitric oxide. 5 mm. of nitrogen dioxide, 100 mm. of hydrogen and the indicated pressure of nitric oxide, at 411° C.

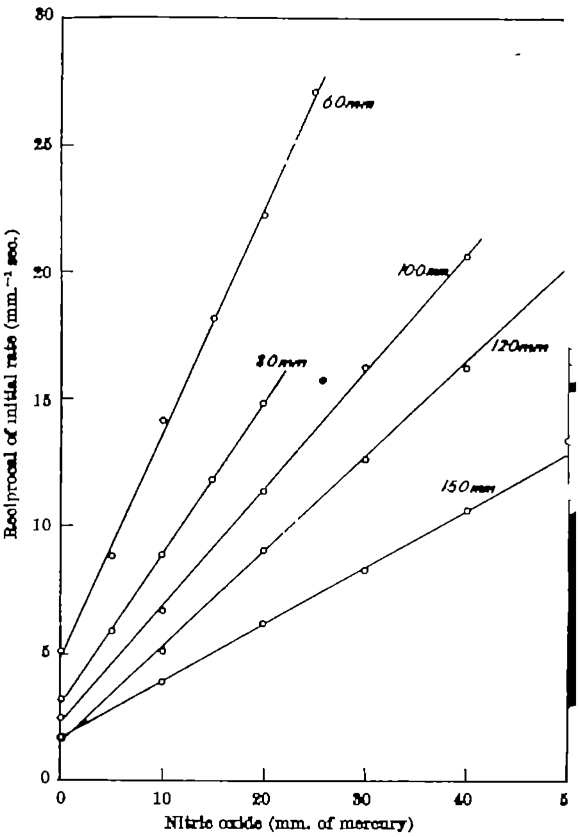

Fig. 3. Plots of the reciprocal initial rate of the inhibited reaction against concentration of nitric oxide added. All runs initially have 10 mm. of nitrogen dioxide and the indicated pressure of hydrogen, at 411° C.

There is no detectable pressure change ($< 0 \cdot 1$ mm.) in the reactions with high ratios of hydrogen to nitrogen dioxide, even when retarded by added nitric oxide. With 10 mm. of nitrogen dioxide and 40 mm. of hydrogen, a pressure increase of 0·2 mm. took place rapidly; this is almost certainly due to the bimolecular decomposition of nitrogen dioxide taking place while its concentration is high. The absence of appreciable pressure change agrees with the stoichiometric equation, $H_2 + NO_2 = H_2O + NO$. An exact analysis of the products has been unsuccessful due to the difficulties of determining accurately small quantities of water vapour; but attempts have shown the bulk, at least, of the products to be nitric oxide and water, as found by Pollard and Holbrook. Calculations for the reaction $3NO_2 + H_2O = 2HNO_3 + NO$ show that the equilibrium concentration of nitric acid is negligible under all reaction conditions[4].

The plots of the logarithm of nitrogen dioxide concentration against time are reasonably linear for the first half-minute with high hydrogen to nitrogen dioxide ratios; the initial rate of disappearance of nitrogen dioxide could thus be determined, and the calculated initial rate of the bimolecular decomposition of nitrogen dioxide subtracted to give the initial rate of the reaction under study.

Fig. 3 shows plots of reciprocal initial rates against nitric oxide added; these are straight lines of reproducible slope, and rather less reproducible intercept, for each ratio of hydrogen to nitrogen dioxide, suggesting the relation:

$$\text{Initial rate} = \frac{A}{[NO] + B}$$

, the reciprocal slope of the lines in Fig. 3, appears be first order with respect to nitrogen dioxide. appears to increase as nitrogen dioxide increases, ut to decrease as hydrogen increases. The values of from the slopes of Fig. 3, and also from plots of itial rates against hydrogen with no nitric oxide lded, suggest an order for the initial rate, with spect to hydrogen, between 1 and 1·5. The order r hydrogen in $A$ is at least unity, but it is hard to ecide how the remainder is apportioned between $A$ nd $B$. This may be cleared up when the photoeter output is amplified and fed to a high-speed corder instead of the present short-period galvanoeter.

Large pressures (about half an atmosphere) of oxygen reduce the initial rate by about 50 per cent, of which calculations show an appreciable part to be due to the reaction $2NO + O_2 = 2NO_2$. However, half an atmosphere of nitrogen also retards the initial rate, although less effectively, so that it is clear that inert gases retard the reaction.

We thank the Royal Society for a grant towards the cost of the photometer, and Dr. B. A. Thrush for his advice on its construction. [July 12

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# EFFECTS OF HYPOTHERMIA ON BEHAVIOUR

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UNTIL recently it was generally believed that +15° C. was the lowest level of deep body emperature compatible with the survival of nonibernating, homoiothermic animals. However, in 951 Andjus[1] reported the reanimation of adult rats fter cooling to much lower body temperatures, uring which prolonged respiratory and cardiac rrest had occurred. Since then, improvements in echniques for reanimating rats subjected to extreme ypothermia have been described, and it is now ossible to maintain body temperature below +15° C. or as long as 70 min. with an expectancy of complete ecovery in a very high per cent of the cases[2-4].

Previous studies have been concerned primarily ith the effects of extreme hypothermia on hysiological processes; during the course of hese studies we became interested in certain eneral observations regarding the behaviour of the nimals. With the exception of a very small number hich showed impaired temperature regulation, nimals appeared to suffer no noticeable after-effects fter successful reanimation from hypothermia t approximately +15° C. or at 0° to +1° C. Animals xposed to the severe treatment recovered reflexes nd posture within two hours of re-warming, and fterwards showed apparently normal activity. lthough there was some reduction in food- and ater-intake during the first 24 hr. after reanimation, here was a return to the normal level or above etween the second and fifth days. Within two or hree days it was difficult, if not impossible, to disinguish between the behaviour of control and xperimental animals living in adjacent cages in the nimal colony. Observations of breeding performnce gave evidence of a temporary impairment of ertility; but the majority of animals had progeny ithin three months of exposure to extreme hypohermia. The offspring were healthy and were reared ormally by their mothers. In general, it seemed hat the very drastic treatment to which the animals ad been subjected was not reflected in any serious, ermanent impairment of their normal behaviour atterns.

This is a preliminary report of research designed to study, by means of certain standardized procedures of comparative psychology, the effects on two aspects of behaviour—learning and memory—of reducing the deep body temperature of non-hibernating, homoiothermic animals. Fifty-six hooded rats from the animal colony at the National Institute for Medical Research were used as subjects in two experiments. In the first, two groups of rats were subjected to identical treatments except that the deep body temperature of one group was lowered to between +1° and 0° C. before both groups began learning a serial problem-solving task. The second experiment was designed to include three groups of animals: a control and two experimental groups, the deep body temperature of animals in one of the latter being reduced to between +13·4° and +13·5° C. and that of the other to between +1° and 0° C. Except for the 'hypothermia' phase of the design, all groups in this second experiment received identical treatments in the following order: training on a maze, hypothermia, tests for retention of the maze habit, and training on a serial problem-solving task.

Deep body cooling was done in two stages. The first involved narcotizing the animals by anoxia and hypercapnia as well as deep hypothermia until they became flaccid and lethargic with colonic temperatures at or below +20° C. Animals cooled to temperatures as low as +13·4° C. re-warmed spontaneously when left at ambient temperatures of +20° C. Other animals were subjected to a second stage in the cooling procedure, during which their body temperatures were lowered to between 0° and +1° C. By use of the technique of Andjus and Lovelock[2], these animals were resuscitated completely even after 60–70 min. at body temperatures below +15° C., and after 40–60 min. without detectable heart-beat, circulation or respiration. The results of research by other investigators[3-5] suggests that cerebral electrical activity may have been arrested for as long as 1½–2 hr. Despite this extreme cooling, there is no evidence[6] of the neurological damage to the brain described by other investigators[7].

The results may be summarized as follows. Animals whose body temperature had been lowered to

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+ 1°–0° C. showed a significant impairment in problem-solving performance when compared with control animals. On the other hand, no significant differences were found between the performances of control animals and those cooled to +13·4°–+18·5° C. As with such physiological processes as heart-beat and respiration, a body temperature of approximately +15° C. appeared as a 'crucial point' below which performance on later learning tasks was impaired. Our results suggest that this may have been a temporary effect, since the degree of impairment decreased as the interval between body cooling and testing increased.

Although our results show a consistent trend towards poorer retention following hypothermia, the differences among experimental and control groups were very small, and in no instance were they statistically significant. These results support evidence reported by Ransmeier[8] that severe hypothermia, not following immediately after practice of a habit, has little or no effect on measures of memory. This similarity of results is interesting, particularly since Ransmeier's evidence was based upon the behaviour of hibernating mammals following induced hypothermia. Physiological effects of hypothermia at the levels employed are different in such animals from those shown by the rat and other non-hibernating mammals—heart-beat, circulation and respiration being arrested in the latter but not in the former. The fact that suppression of these physiological processes and of electrical signs of brain activity during hypothermia appears to have little or no effect on memory is difficult to explain in terms of a 'dynamic' physiological model[10], in which long-term memory is dependent upon the continuous norm activity of the central nervous system.

Speed of locomotion and amount of food intal were observed in both experiments, and no significa differences were found among the various groups animals during the periods in which the behavio measures were being taken. This suggests that th results reported above cannot be accounted for terms of differences in locomotion or in caloric intal resulting from the different experimental treatmen to which the various groups were subjected.

Within the limits of our experimental procedur we have failed to find evidence that arrest of vit metabolic processes as a result of extreme hyp thermia produces any very serious permanent effec on an animal's behaviour once it has been successfull reanimated. This conclusion is, of course, limite to the types of behaviour we have studied, althoug it conforms with our previous observations ma during the course of research on physiological chang accompanying the lowering of deep body temperatur Before final generalizations are made, it would see desirable to assess the possible effects of hypotherm on other types of behaviour and other species subjects. [July 22

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# CHEMISTRY AND INHERITANCE OF FLOWER COLOUR IN THE DAHLIA

By DRS. E. C. BATE-SMITH, T. SWAIN and C. G. NORDSTROM
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AS a result of the work of Lawrence, Scott-Moncrieff, Price and ourselves[1–6], it is known that the following classes of pigments are concerned in the variations of colour in the garden dahlia (*D. variabilis*):

Magenta, purple, crimson and scarlet shades: anthocyanins.

Yellow shades: chalkones, and aurones[6] (benzylidenecoumaranones).

'Ivory' shades (that is, white petals becoming yellow when fumed with ammonia): flavones and flavanones.

Intermediate shades are produced by combinations of these basic pigments.

Lawrence[1] distinguished the following four basic genes as responsible, singly or in combination, for all the colour variations in the species: *A*, light anthocyanin pigmentation; *B*, heavy anthocyanin pigmentation; *Y*, yellow pigmentation; *I*, ivory pigmentation. He interpreted the bottom recessive condition *a b y i* as that present in 'white' flowers, that is, those not becoming yellow when fumed with ammonia. Lawrence and Scott-Moncrieff[4] mention, however, that the petals of some at least of these white genotypes give a pale straw or maize colour when treated, the substance responsible giving a gree reaction with ferric chloride and being "probabl tannin".

It has been of especial interest to us to ascertai the identity of the substances present in the petals o 'white' varieties, since it seemed that this informatio would be essential to the understanding of th mechanism of variation of flower colour in th species.

*D. variabilis* is an allo-octoploid species. Eac of the genes for flower colour may be present in an number from one in the 'simplex' to four in th 'quadriplex'. The genes *A*, *B* and *Y* are expresse in the simplex and higher condition, but the gene must be at least duplex for it to have an effect Without deliberate selection, therefore, recessiv white genotypes appear exceedingly rarely, bu 'whites' can usually be found in a fair-sized plantin of mixed coloured seedlings. A chromatogram fro one such 'white', *DJ*/18, was illustrated in the firs of our publications[5]; but this plant failed to surviv and the present work was carried out with a chanc seedling of the dwarf Coltness strain, here name lare White'. This plant also failed to survive its cond winter, although divided and the portions kept several different storage places. It seems that ese recessive genotypes, as might be expected, are nsiderably lacking in vigour. However, in its cond season, three two-way crosses were made tween 'Clare White' and other single-flowered rieties, and altogether 122 seedlings were raised m the six families. Two of the other parents were bright red and a yellow Coltness variety, and the ird a patterned variety, with a purplish eye, shading rough red-mauve to blue-mauve at the tip. This lend' variety had itself been raised by crossing the mmercial varieties 'Chancellor' (crimson-brown th a deep purple-brown eye pattern) and 'Mrs. 'illiam Clark' (blend, shading from gold at the base rough salmon to red-mauve at the tip). The netic constitution of these parents was not known, d could only be inferred from the distribution of lour forms in the progeny. The numbers of these ere, of course, not sufficient for accurate genetic terpretation of the data.

Of the 122 seedlings, twenty-three were phenopically white. Fourteen gave an overall yellow lour when fumed with ammonia, two a patterned ellow (shaded from base to tip) and seven no yellow ut on longer treatment became maize-coloured and en deep chestnut-brown. Moreover, eight also ut of the first fourteen became a deep chestnut-rown when kept for several minutes in ammonia. was therefore evident that the situation was more mplicated than a simple division into 'white' and vory' genotypes; there appeared to be an interediate group which might be described as 'ivory-hite'. The petal pigments of each of the seedlings ere therefore studied by paper chromatography.

## Identification of the Phenolic Constituents

All the substances with which the present discuson is concerned occur in the tissues of the plant mbined as glycosides or (in the case of caffeic nd other substituted cinnamic acids) as esters. It is ecessary to consider here, however, only the nature f the phenolic residues obtained by hydrolysing e tissue with 2 *N* aqueous hydrochloric acid at 100° nd extracting with a small volume of amyl alcohol f. Bate-Smith[10]). The petal tube and lower part f the petal were not included in the examination, nce in normal flowers these invariably contain ellow pigment. The chromatographic solvent mployed was water/glacial acetic acid/concentrated ydrochloric acid in the proportions (vol.) 10 : 30 : 3 'orestal solvent), in which the anthocyanidins do ot fade and the different constituents are well parated; delphinidin and pelargonidin, for example, ave $R_F$ values 0·30 and 0·68. With a knowledge f the constituents to be expected, chromatograms an be read by inspection in visible and ultra-violet ght, with and without fuming with ammonia. The entity of individual constituents was proved, as ccasion required, by *in situ* ultra-violet spectrohotometry on the paper[11] or by elution of strip hromatograms run on Whatman No. 3 paper[8]. Synhetic specimens of all the substances identified have een available for comparison.

## Phenolic Constituents of 'White' Genotypes

The main constituent, and that responsible in rge degree for the chestnut-brown reaction of the etals when fumed with ammonia, proved to be eriodictyol, in some instances accompanied by naringenin in lesser amounts. The 'ivory-white' genotypes were found to contain, in addition to these flavanones, the flavonols quercetin and (in lesser amount) kaempferol. It is to these constituents and not to luteolin and apigenin that the 'ivory' reaction in these forms is most often due. Luteolin and apigenin were occasionally present as well as flavonols and flavanones. The presence of quercetin and kaempferol was, for reasons discussed later, completely unexpected. Once having been detected in the 'ivory-whites', in which they were present in considerable amounts, smaller amounts could be recognized on the chromatograms of 'white' varieties, and it became clear that the 'white' and 'ivory-white' forms differed only in the relative amounts of flavanone and flavonol that they contained. The flavonols also appeared sporadically among the coloured—especially the paler-coloured and the colour-patterned—progeny of these crosses. They were not, however, present in any of a number of larger-flowered, commercial varieties examined.

## Influence of Parentage on the Occurrence of Flavonols in the Petals

The common parent, 'Clare White', was a true 'white' genotype in Lawrence's sense and contained only a trace of flavonols. The families from the red and yellow parents, respectively, contained the same relative numbers of 'whites' and 'ivory-whites'. The 'blend' crosses produced only one white phenotype, a 'white', containing a moderate amount of flavonol. The genetic equipment permitting the appearance of flavonols in the offspring resulting from crossing with 'Clare White' would seem, therefore, to be shared by all three of the non-white parents. What all four parents had in common, distinguishing them from the commercial varieties examined, was their derivation from the Coltness strain; but it cannot be deduced from this that it was in itself responsible for the presence of flavonols in the petals. Perhaps because of their rarity (and perhaps also their lack of vigour) no 'whites' or 'ivory-whites' other than *DJ*/18 of non-dwarf habit have so far been encountered.

## Significance of the Presence of Flavonols in 'White' Genotypes

There is no reason for disagreeing with Lawrence and Scott-Moncrieff's interpretation of the 'white' condition in flowers of *D. variabilis* as recessive to coloured (including therewith 'ivory'). It is reasonable to suppose (cf. Beale[12]) that, of two allelic genes, that one will be dominant which effects the more elaborate of the two processes expressed, and of all the flavonoid compounds found in *Dahlia*, the flavonols, being the most completely oxidized, should be those requiring the most elaboration in the process of synthesis. Yet it is in a bottom recessive situation that they appear, together with the more expected (because most reduced) flavanones. A certain amount of further information has been obtained by way of a study of the flavonoid compounds in the leaves of a number of genotypes and varieties.

## Phenolic Constituents of the Leaves of Dahlia Varieties

Flavonols, leuco-anthocyanins, and complex substances yielding caffeic, *p*-coumaric, ferulic and sinapic acids[13] are the commonest phenolic constituents of leaves. Of these phenolic constituents, the Compositae do not contain leuco-anthocyanins (*Cosmos bipinnatus* possibly excepted); but the others are commonly present, and *D. variabilis* is not exceptional in this respect. It was found that, irrespective of the colour of the flowers, the leaves of all genotypes contained quercetin, butein, caffeic and ferulic acids, and probably kæmpferol. Of many hundreds of species of plants, including those of a number of closely related Compositae, the leaves of *Dahlia* only have been found to contain butein. Kæmpferol, in Forestal solvent, is overlain by the more highly coloured butein, and when the latter is present cannot be detected by inspection. Its presence in a typical leaf was confirmed, however, as were also the identities of quercetin and butein, by elution from a strip chromatogram as described above.

The situation in the leaf, therefore, as compared with that in the petal, is that the former possesses phenolic constituents—caffeic and ferulic acids—not present (or not conspicuously present) in the latter; it contains quercetin, found in the petals of rare recessive forms only; and it contains a constituent, butein, present in the petal only when a particular gene is present in dominant condition.

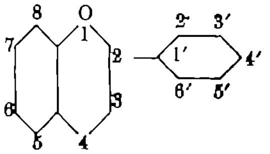
## Theory of Factorial Balance in *Dahlia*

Lawrence and Scott-Moncrieff[4] observed the following gene interactions in *D. variabilis*: in presence of *Y*, the action of *I* is suppressed; in presence of *A* or *B* alone, either cyanin or pelargonin is produced; *Y* in presence of *A* or *B* may suppress the formation of cyanin; *I* in presence of *A* or *B* may suppress the formation of pelargonin; a gene *H* is present the inheritance of which, like that of *A*, *B*, *Y* and *I*, is polysomic; *H* cumulatively inhibits the expression of *Y*. There may also be a gene inhibiting the expression of *I*.

As a working hypothesis, it may be assumed that dominant allelic genes acting in the petals modify a situation present generally throughout the soma. If this is so, the action of *Y* should be solely that of suppressing or modifying the action of genes *A*, *B* and *I*, allowing butein then to appear in the *Y* genotype. The actions of *A*, *B*, and *I* in the petal will presumably be mainly exerted upon processes which, in the leaf, lead to the formation of flavonols and chlorogenic acid (the form in which caffeic acid is usually present in the plant tissues).

At this point it is necessary to consider the differences in structure between the various substances produced by the action of the postulated genes.

The most significant difference between the yellow pigments and all the others is the absence of a substituent hydroxyl group from the position corresponding to 5 in the flavonoid skeleton:



Both the aurone, sulphuretin, and the chalkones, butein and 2′,4,4′-trihydroxychalkone, lack this substituent, and it must be through active inhibition of the oxidation of this carbon atom that the epista of *Y* is expressed.

The specific actions of *A*, *B* and *I* are concern only with oxidations at positions 2, 3, 4 and 3′, sin all the substances affected by them are oxidized positions 5, 7 and 4′. The following equivalenc should be noted: (1) aurones and anthocyanidi are at the same level of oxidation as the correspondi flavones, the equivalent of one oxygen lower th flavonols; (2) chalkones are at the same level oxidation as the corresponding flavanones, th equivalent of one oxygen lower than (1).

The action of the individual genes is seldo absolute. We have observed that there is wi variation between apparently identical phenotyp in the relative amounts of their constituent pigment and while this might be capable of quantitati explanation in terms of the polysomic action of th five postulated genes, *A*, *B*, *Y*, *I* and *H*, it seem more likely that the ultimate result is achieved b competitive action in which physiological (edaphi factors can play a considerable part (cf. the muc lower intensity of anthocyanin pigmentation in lat autumn). It seems worth while noting, howeve that the balance can be shifted between 4′ and 3′,4 hydroxy substituted molecules (cyanidin–pelargon din, eriodictyol–naringenin) and between those mo or less oxidized at position 3 (sulphuretin–butei luteolin–eriodictyol) both dependently and inde pendently. It is worthy of consideration whethe these particular oxidations may be carried out b specific enzymes, the ability of which to act i dependent upon a precise pattern of glycosidatio of the molecules made available as a result of th presence of particular dominant alleles. A hint o the likelihood of this being the case is provided b the report of the presence in *Cosmos sulphureus* of a enzyme capable of oxidizing chalkone to aurone[14] by the ability of phenoloxidases to act on phenoli substrates glycosidically substituted in certain positions, but not on the same substrates substituted i other positions[15]; and by the decolorization b normal green beech leaves of anthocyanins presen in extracts of leaves of the copper beech[16].

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[June 14

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Anode and Cathode Arcs

ARCS which are in general less than one micron in ngth occur at the opening and closing of low-voltage itches. These arcs are initiated and maintained field emission currents. They are of two quite stinct kinds which are most readily distinguished the marks which they leave on polished surfaces.

One type, which we call an anode arc, produces a cular pit on the anode and a general roughening the opposed cathode. Photomicrographs of single ode-type arcs were published[1] before the second pe of arc was discovered. In Fig. 1 is shown the rface of a cathode after the occurrence of a single c of the second type, which we call a cathode arc. he corresponding anode often shows no mark hatsoever.

A feature of the cathode arc is the way in which accentuates scratch lines on an imperfectly polished rface. At high magnification in an electron microope (Fig. 2), each line on the cathode is found to e made up of a large number of single pits, each e result of the explosion of an original roughness field emission current of very high density flowing rough it. Each pit overlaps one of its neighbours, indicating that an arc was moving intermittently along the original scratch.

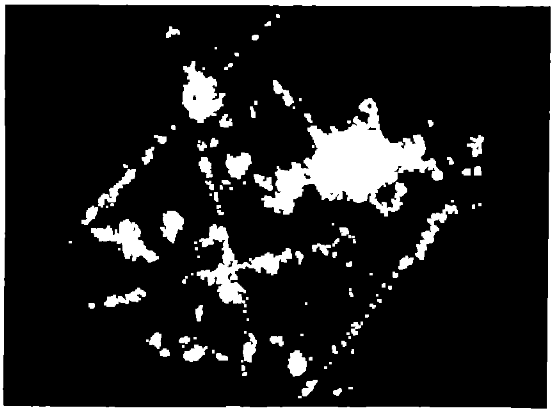

Fig. 1. Photomicrograph of the surface of a polished cathode after a single cathode arc. × 1,200

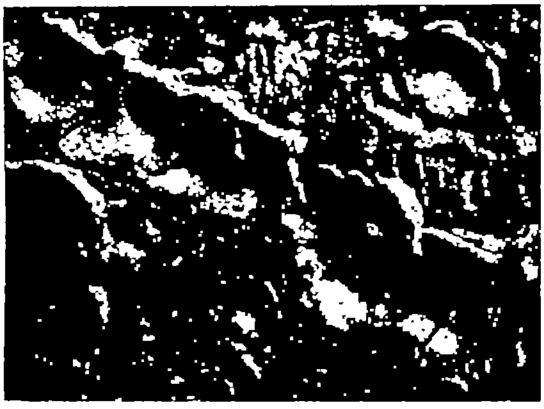

Fig. 2. Electronmicrograph of part of the mark made on a polished cathode by a single cathode arc. × 19,800. Constant current of 4 amp. for 0 45 μsec.

Table 1. CHARACTERISTICS OF ANODE AND CATHODE ARCS (polished palladium electrodes)

| | Anode arcs | Cathode arcs |
|---|---|---|
| 1. Anode appearance | Hole | Nothing or shallow hole |
| 2. Cathode appearance | Roughened | Along scratches |
| 3. Occurrence | | |
| Striking potential > 400 V. | Never | Always |
| Striking potential < 300 V. | Sometimes | Sometimes |
| 4. Arc voltage | 9–12 | 13–18 |
| 5. Striking field | High, $9 \times 10^{6}$ V./cm. | Low, $4 \times 10^{6}$ V./cm. |
| 6. Metal transfer by radioactive tracers | Both directions, net from anode to cathode | Cathode to anode |

Some of the characteristics of the two types of arcs are summarized in Table 1. For palladium electrodes, both cathode and anode arcs occur at striking potentials of 300 V. and lower, with anode arcs favoured by clean surfaces and cathode arcs favoured by dirty surfaces. At 400 V. and higher, only cathode arcs occur. The difference in metal transfer given on line 6 of Table 1 is of importance in understanding the direction and size of the erosion of electrical contacts. It would appear that the confusion associated with erosion measurements in the past is resolved when we identify the type of arc responsible for the erosion.

Experimental details, together with a theory of the mechanisms of the two types of arcs, will appear in a forthcoming paper.

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## Neutron Yields from Americium–Beryllium Alloys

THE neutron yields from two americium – beryllium alloys have been measured. The alloys were prepared by the reduction of americium trifluoride with powdered beryllium metal in vacuum, according to the reaction :

$$2\,{}^{241}\mathrm{AmF}_3 + x\mathrm{Be} \rightarrow 2\mathrm{Am}.(x-3)\mathrm{Be} + 3\mathrm{BeF}_2$$

The beryllium fluoride readily distilled, leaving a fluoride-free alloy.

The α-radioactive purity of the americium was > 99·99 per cent. The total inactive impurities were < 0·5 per cent. Americium trifluoride was prepared by fluorinating americium dioxide with a mixture of dry hydrogen fluoride and hydrogen at 650° C. in platinum. The americium trifluoride was mixed with powdered beryllium, 99·8 per cent pure, and heated in a beryllium oxide crucible at a pressure of $5 \times 10^{-5}$ mm. mercury. The chemical reaction was followed by observing neutrons from the nuclear reaction ${}^{9}\mathrm{Be}(\alpha,n){}^{12}\mathrm{C}$ using a boron trifluoride counter connected to a Marconi scaler.

The results of one beryllium reduction of americium trifluoride are illustrated in Fig. 1. A mixture of

Table 1. NEUTRON YIELDS FROM TWO AMERICIUM–BERYLLIUM ALLOYS

| Source | Be : Am atom ratio | Am α-activity | Neutron yield | Neutrons/10 alpha particles* |
|---|---|---|---|---|
| 1 | 263 : 1 | $2 \cdot 97 \pm 0 \cdot 05 \times 10^6$ d./s. | $2 \cdot 13 \pm 0 \cdot 02 \times 10^2$ n./s. | $71 \cdot 7 \pm 1 \cdot 8$ |
| 2 | 14 : 1 | $3 \cdot 24 \pm 0 \cdot 07 \times 10^6$ | $1 \cdot 57 \pm 0 \cdot 02 \times 10^2$ | $48 \cdot 5 \pm 1 \cdot 4$ |

* The limits of error quoted are due to uncertainties in the americium α-activity determi tions and in the comparative neutron measurements. They are subject to a further deviat of ± 5 per cent because of the uncertainty in the absolute neutron yield of the Chalk Ri Ra-α-Be standard.

25·9 mgm. of americium as the trifluoride and 279·8 mgm. of beryllium was weighed into a beryllium oxide crucible. When this loose-packed mixture was in position in the cold furnace, the neutron counting-rate was 3,250 counts/min. The rate of neutron-emission remained unchanged at 675°. When the furnace temperature was raised to 900° the counting-rate increased slowly, indicating that the americium – beryllium alloy was forming. At 1,125° the alloy formation was rapid. After eight minutes a constant counting-rate indicated that the chemical reduction was complete. On raising the furnace temperature to 1,375°, where the alloy was molten, the neutron count increased abruptly to 9,100 counts/min. and remained at this level when the alloy was cooled to room temperature. The resulting shiny ingot weighed 275·0 mgm. A comparison of its γ-activity with that of the reduction apparatus indicated that 5 ± 1 per cent of the initial charge of americium had distilled during the heating period to colder parts of the furnace. The estimated americium content of the ingot from these measurements was 24·6 ± 0·5 mgm. Later, the ingot was dissolved in dilute hydrochloric acid. The total americium α-activity in the solution was $2 \cdot 97 \pm 0 \cdot 05 \times 10^6$ disintegrations/sec., as determined by α-counting aliquots from three independent dilutions. The calculated beryllium – americium atom ratio in the alloy, using Harvey's value[1] of 470 yr. for the half-life of americium-241, was 263 : 1.

A second alloy was prepared at 1,125°, with a beryllium – americium atom ratio of 14 : 1. The product was sintered and crystalline. An X-ray powder diffraction pattern of this alloy served to identify $AmBe_{13}$, an intermetallic compound isostructural with $UBe_{13}$[2] and $NpBe_{13}$[3]. $AmBe_{13}$, beryllium-rich, is face-centred cubic with $a_0 = 10 \cdot 283 \pm 0 \cdot 002$ A. and space group $O_h^6$-*Fm3c*. Since the ratio of γ-intensities of source 1 to source 2 was 1·09 ± 0·01, the americium α-activity in source 2 was estimated at $3 \cdot 24 \pm 0 \cdot 07 \times 10^6$ disintegrations/sec.

The neutron yields from the two alloys were determined by direct comparison against standard $^{227}$Ac-α-Be and Pu-α-Be sources, using a boron t fluoride counter embedded in paraffin. The actiniu and plutonium sources had been calibrated again the Chalk River Ra-α-Be standard and a Nation Bureau of Standards Ra-γ-Be source by activatic of a manganese sulphate solution (Hanna, G. C and Runnalls, O. J. C., unpublished).

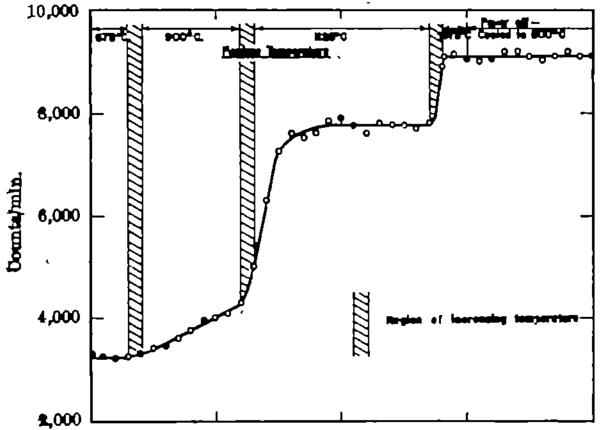

Fig. 1. Measurements of the neutron emission-rate during the conversion of an americium trifluoride – beryllium mixture to a sintered, and eventually molten, americium – beryllium alloy

The neutron yields are indicated in Table 1.

An approximate method for calculating t maximum theoretical neutron yield from these da has been suggested by Dr. A. P. Baerg (private con munication), as follows:

$$\text{Maximum theoretical neutron yield} = n\,\frac{S_{\rm Am}+N.S}{N.S_{\rm Be}}$$

where $n$ is measured neutron yield, $N$ is the rati of beryllium to americium atoms, $S_{\rm Be}$ is atomi stopping power of beryllium (0·63), and $S_{\rm Am}$ atomic stopping power of americium (4·6).

The values quoted for the atomic stopping powe relative to air were obtained by extrapolating know data for α-particles of about 6 MeV. energy[4]. Th calculated maximum theoretical yields were 73·7 an 74 neutrons/$10^6$ α-particles for sources 1 and respectively.

The abrupt increase in neutron yield from source on raising the temperature from 1,125° to 1,375° i attributed to the conversion of solid $AmBe_{13}$-ric aggregates in solid beryllium to a homogeneous liqui solution of americium in beryllium. The precipitatio of americium-rich aggregates would be expecte during the solidification of the molten alloy. Sinc no measurable decrease in the yield of neutrons wa observed, however, when the liquid solidified, th particle size of the aggregates must be small compare to the range of the α-particle.

A detailed report on neutron yields from actinium plutonium, americium and curium alloys will b published later. It should be noted, however, tha the neutron yield for $PuBe_{13}$ measured in the abov manner is 38·7 ± 1·2 neutrons/$10^6$ α-particles. I one assumes that the specific activity of the pluton ium used by Stewart[5] was $1 \cdot 4 \times 10^8$ disintegration min., the neutron yield from her $PuBe_{13}$ sourc was ∼ 40 neutrons/$10^6$ α-particles.

We wish to thank Dr. J. P. Butler, who supplie the americium, and Mr. J. Baird, who prepared th americium trifluoride.

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## Neutrons produced in the Bombardment of Beryllium by Deuterons

THE purpose of the present measurements was to btain a thin-target yield-function for neutrons[1] for he $^9$Be$(d,n)^{10}$B reaction from 0·7 to 1·5 MeV. of euteron energy.

The neutrons were detected with two Hornyak uttons, 3 cm. in diameter and 1·5 cm. thick (purhased from Isotope Development, Ltd., London), with a magnesium oxide reflector in a thin aluminium ox, on 6260 *EMI* photomultiplier tubes. A cathode-ollower, a Bell amplifier, an integral discriminator nd a scaler were used. The efficiency for fast neutrons, om 0·5 to 5 MeV., is about 1 per cent; for gamma ays it is very low. The geometry used is shown in ig. 1. The neutron counters were placed as near as ossible, so that the angle of detection was 90° ± 25° with respect to the deuteron beam. A Cockcroft–Walton accelerator with a maximum voltage of ·5 MeV. was used. The beam of deuterons was eflected through 30° by a magnetic analyser. The Be$(p,\gamma)$ reaction was used for calibration.

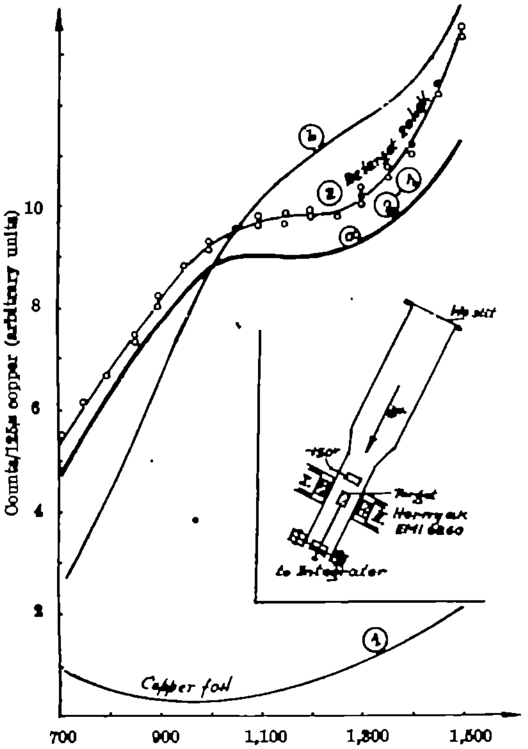

Fig. 1

Bombarding currents were measured by a new current integrator with low impedance input (precision better than 1·0 per cent)[2]. The deuteron beam was collimated with a tungsten foil slit[3]. Beryllium targets, 20–60 keV. thick, were prepared by evaporation of beryllium in high vacuum on to a copper foil of 0·05 mm. thickness. Target thicknesses were determined by weighing on a microbalance. Fig. 1 shows the measured excitation curve (*a*), together with the curve of Evans *et al.*[1] (*b*), taken at 0°. Resonance at 1,000 keV. is indicated by the shape of the curve. The mean values of counts of two detectors were always taken and the curve is a result of many repeated measurements.

Details of this work will be described in the *Bulletin of the Boris Kidrich Institute of Nuclear Sciences*, Belgrade.

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## Amplification of 1-cm. Waves in the Helium Negative Glow

IN the course of detailed examination of the attenuation of microwaves in the negative glow of an abnormal discharge in helium, we have observed a negative attenuation. This occurs in a very narrow layer near the beginning of the negative glow and is a function of the gas pressure and the current density in the discharge tube.

A discharge tube 50 cm. long with two aluminium electrodes of 5 cm. diameter contained helium at pressures of 1–3 mm. mercury. A low-powered klystron beamed 1·25-cm. waves at right angles to the discharge tube with the electric vector of the waves parallel to the axis of the tube. The transmitted radiation was detected by means of a crystal detector and a sensitive galvanometer. Changes in attenuation were measured by means of a calibrated precision attenuator. The whole microwave assembly was carefully aligned and could be moved parallel to the discharge tube. The attenuation, because of the discharge, was measured at each position along the discharge tube as the difference in readings of the calibrated attenuator when the discharge was on and off.

Fig. 1 shows the attenuation in db./cm. as a function of the distance *d* from the cathode for a discharge current of 15 m.amp. and a pressure of 2·5 mm. mercury. Near the beginning of the negative

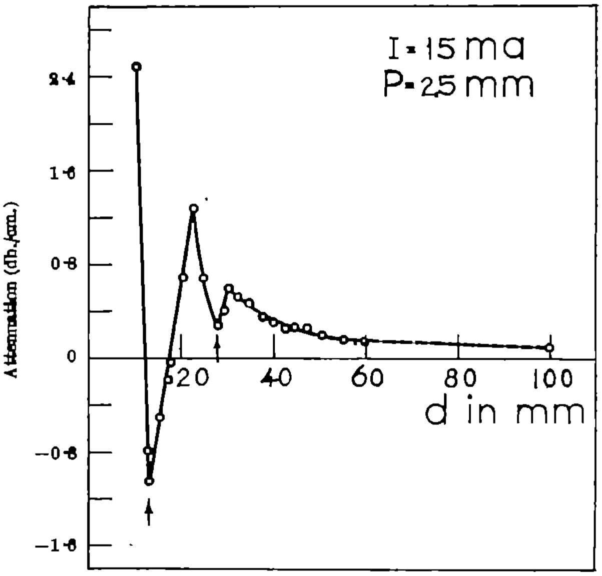

Fig. 1. Attenuation in db./cm. as a function of the distance *d* from the cathode

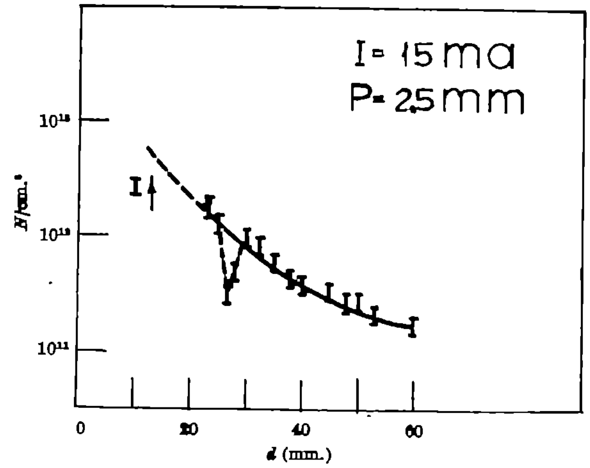

Fig. 2. Electron density as a function of the distance *d* from the cathode, calculated on the basis of a collision-frequency of 2·3 × $10^9$ × gas pressure in mm. mercury

glow, with *d* approximately 13 mm., we observed consistently a negative attenuation, or amplification, of the same wave-length in a very narrow layer. A secondary dip in the attenuation is found at about 27 mm. from the cathode. These changes are unlikely to be due to selective interference or diffraction effects because (*a*) they are independent of the distance of either the sending or receiving antenna from the discharge tube, and (*b*) no such effects are found when the polarity of the voltage is reversed.

If one assumes a collision-frequency of 2·3 × $10^9$ × gas pressure in mm. mercury for helium[1], one can readily calculate the electron density in the negative glow as a function of *d*. This is shown in Fig. 2. The extrapolation of this curve into the region of amplification indicates an electron density *N* of about 7 × $10^{12}$/c.c. at *d* approximately 13 mm. The electron density calculated from the plasma frequency at 1·25 cm. is 7·8 × $10^{12}$/c.c., in close agreement. The secondary dip is at an electron density corresponding to a plasma frequency of about 2·5 cm.

The amplification increases with the current density and with the pressure. The observed amplifications are in very similar regions to the oscillations in narrow sheets observed by Merrill and Webb[2] and other authors[3–5]. Unlike our experiments, these violent oscillatory potentials have been observed in hot-cathode discharges and at frequencies not larger than $10^9$ Mc./sec.

A possible explanation of the mechanism of the amplification is that the plasma oscillations are being excited by means of the impinging radiation. As the radiation passes across the discharge tube, it is being amplified by the longitudinal oscillations. The secondary dip is possibly due to the coupling of a harmonic of the plasn oscillations with the electromagnetic field.

The results of our experiments may have a bearir on the explanation of the propagation of solar an stellar radio waves and possibly on the practic application of amplification of microwaves of cent metre and millimetre wave-lengths.

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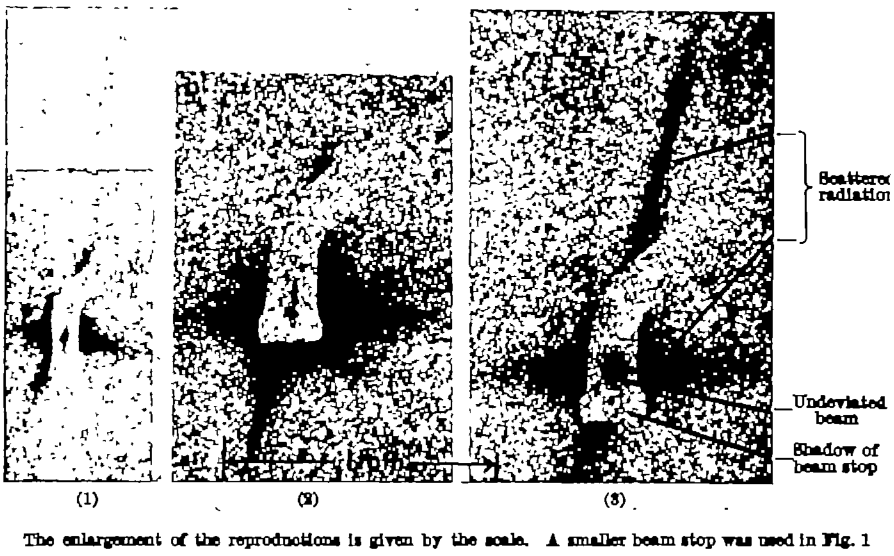
## Investigation of the Fatigue of Metals by X-ray Scattering

It has generally been concluded[1] from previou X-ray studies of the fatigue of metals that th diffraction patterns do not give direct informatio of the fatigue damage.

Some promising results, however, have now bee obtained in an X-ray study of fatigue by a low-angl scattering technique, using the optically focusin camera described by Franks[2]. Individual selecte grains in a polycrystalline copper foil, the orientation of which had been determined by Laue photographs were examined after a preliminary tensile stress an after subsequent amounts of cyclic stressing. Th irradiated area was 100μ × 50μ. The modification in the low-angle scattering patterns from a typica grain are illustrated in the accompanying photo graphs.

The pattern (Fig. 1) after a single tensile stres of 6 tons/in.², equal to the maximum loading i cyclic stressing, shows only a hint of diffractio streaks; but after fatiguing for 1 hr. (3,000 cycles/min and mean stress of 3·2 tons/in.²), two streaks ar readily apparent (Fig. 2). A further 1 hr. of fatigue after which the specimen failed, produced enhance ment of the pattern as shown in Fig. 3.



(1) (2) (3)

The enlargement of the reproductions is given by the scale. A smaller beam stop was used in Fig. 1

The streaks are due to scattering material of anged electron-density within the grain. A tenta-ve interpretation suggests that they are caused by les, their number, size and distribution changing ith differing amount of fatigue. Patterns so far tained suggest that the holes are disk-like in shape, ith a diameter of the order of 100 A. Within the nits of experimental error, the holes lie on those 11} planes on which slip had taken place. It is ggested that the holes result from the plastic formation within the grains caused by cyclic ressing, and that it is these holes which finally glomerate to form a visible crack.

Further experiments are in hand to show whether e information obtained by this technique may be ed as a criterion for estimating fatigue damage.

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## Photochemical Processes in Solids at Room Temperature

Although this subject has received little study, he situation of the 'reactive sites' (excited molecules r free radicals) as 'embedded' in the solid matrix may be expected to lead to unusual kinetic effects. The molecular structure and close packing of the matrix should exert a profound effect on the collisional nd energetic interactions of the reactive molecules. Phenomena such as energy transfer and Franck-Rabinowitch recombination should be most efficient n specific cases, although generally this may not be he case. Wilson[1], applying the Laplace transformation technique, has considered recently the interaction f diffusion and reaction kinetics for a series of heoretical cases. We report here some results of ork with nylon polymer films, which have a bearing n this subject.

When thin nylon polymer films (approximately 0μ thick) are irradiated by an unscreened Hanovia .250 *U* mercury arc in the presence of oxygen, a ew absorption band develops centred around 2900 A., which shows the following unusual features, illustrated in Fig. 1. (1) If the incident radiation is cut off and the film stored in the dark, the band continues to increase in intensity with an initial rate greater than that immediately prior to storage. (2) The increase in the band intensity in the dark is found to be a constant fraction of the total intensity change, at all stages of reaction. (3) On re-irradiation the band intensity falls rapidly to a value corresponding to that immediately prior to the dark period; this 2900 A. band is quite clearly resolved and there is no suggestion from the spectra that a different product is formed in the dark from that in the light.

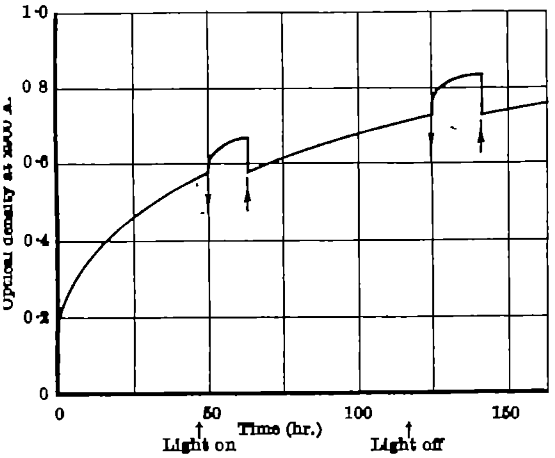

Fig. 1

The following simple reaction scheme can explain this behaviour:

$$\text{Nylon} \xrightarrow[k_1]{h\nu_1} B^{\cdot} + C^{\cdot}\,;\ k_1 I_1 \qquad (1)$$

$$B^{\cdot} + M \xrightarrow[k_2]{} BM\,;\ k_2\,[B^{\cdot}]\,[M] \qquad (2)$$

$$BM \xrightarrow[k_3]{h\nu_2} B^{\cdot} + M\,;\ k_3 I_2\,[BM] \qquad (3)$$

where $I_1$ and $I_2$ are the intensities at frequencies $\nu_1$ and $\nu_2$ respectively, $B^{\cdot}$ and $C^{\cdot}$ are free radicals, $M$ is a molecular species (probably oxygen), and $BM$ the product detected spectroscopically. The kinetics of such a system of consecutive reactions cannot be solved easily unless the simplifying assumption is made that the rate of primary photolysis is much slower than the other reactions involved. The system is then described as being in 'progressive equilibrium', for which the kinetics have recently been considered in some detail (Ford, R. A., unpublished work). In intermittent light a system of this type will show exactly the same characteristics as those found with the nylon films. Further, the kinetics lead to a relationship between rate and light intensity of the following type when $I_1$ and $I_2$ are increased in proportion:

$$\frac{1}{k_1 I_1} = \frac{1}{\mathrm{d}[BM]/\mathrm{d}t} - \frac{\omega}{K k_1}$$

where $\omega$ is $I_2/I_1$ and $K$ is the equilibrium constant for reactions 2 and 3; thus there is a linear relationship between the reciprocal of the rate and the reciprocal of the light intensity, which is confirmed experimentally for the nylon films.

The characterization of the species $BM$ is very difficult because of its instability and very low concentration. However, its sensitivity to light and the evidence of chemical analysis after prolonged irradiation, which shows photo-oxidation has occurred, have led us tentatively to assign the 2900 A. band to a peroxy radical, and therefore species $M$ to the oxygen molecule. The reaction between a doublet organic radical and the $^{3}\Sigma$ ground-state of the oxygen molecule should give a doublet peroxy radical.

The prolonged existence of free radicals in a solid is to be expected, since termination rates will be so slow. Several workers[2] have observed such phenomena. Recently, Porter and Norman[3] have reported work in rigid glasses at 86° K., and Bijl and Rose-Innes[4] in 'Perspex' films at room temperature. Deoxygenated solvents were used for the rigid glass and the temperature was so low that chemical reaction other than photolysis was virtually ruled out. Thus the spectra of the simple free radicals were detected. However, our results suggest that for solids at room temperature rapid diffusion of oxygen will result in only the oxygenated radical being detected. This was probably the case in work by Bijl and Rose-Innes.

It therefore appears that the diffusion processes in solids may be separated kinetically into two classes with rates of a very different order: (1) very slow diffusion of organic free radicals and their oxygenated derivatives; (2) much more rapid gaseous diffusion. The effects described by Wilson[1] appear likely to occur only in the case of the former processes.

If this unusual behaviour in nylon films is due to oxygenated radicals, one would expect it to be a fairly general phenomenon, although it may be unique for solids since a rigid medium is necessary to prevent processes of radical termination. Similar effects have been reported for polystyrene by Reiney *et al.*[5]. But it was then thought that a different product was obtained in the dark from that in the light, and therefore their results were interpreted differently. However, no new band was clearly resolvable in their spectra, which leaves their interpretation open to doubt.

I wish to acknowledge an interesting discussion with Dr. E. J. Bowen, and the permission of British Nylon Spinners, Ltd., to publish this communication.

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## A Simplified Method of preparing Pure Mono-, Di- and Tri-glycerides

GLYCERIDES of known structure are usually prepared by blocking one or two hydroxyls of glycerol and esterifying the remaining hydroxyl or hydroxyls with fatty-acid chlorides. Thus monoglycerides are obtained by the action of a fatty-acid chloride on acetone–glycerol according to the well-known method of Fischer *et al.*[1], whereas mixed di- and tri-glycerides have been synthesized by Verkade and co-workers[2] by the use of triphenyl-chloro-methane.

However, the greater reactivity of primary hydroxyls of glycerol, as compared with that of secondary hydroxyl, makes possible a selective esterification without recourse to blocking. This technique has been employed to a limited extent in the past[3]. Selective esterification has now been developed in this laboratory into a general method covering the whole range of glyceride syntheses. One of the difficulties has been to bring into a homogeneous solution glycerol, fatty-acid chlorides and chloroform (used commonly as solvent in such reactions). The difficulty has been overcome by the addition of N,N-dimethyl formamide, which ensures the miscibility of glycerol with other components.

Monoglycerides can now be prepared directly from fatty-acid chlorides and a large excess of glycerol (5–10 mol. of glycerol per 1 mol. of fatty-acid chloride). To obtain monoacid αα′-diglycerides, 1 mol. of glycerol is esterified with 2 mol. of a fatty-acid chloride in a single step. In both cases sufficient dimethyl formamide is employed to obtain a hom geneous mixture at about 10° C., with pyridine catalyst. Diacid diglycerides are produced in th reaction between a monoglyceride and another fatty acid chloride used in approximately equimolar pr portions. By extending this procedure to the pr paration of mixed triglycerides, all three isomers triglyceride containing stearic, palmitic and ole acid radicals have been obtained in good yields b three-stage direct esterification. Their characteristi conformed with those of the triglycerides synthesize by Prof. P. E. Verkade[4], who kindly supplied sampl of his products. Although Fischer's and Verkade methods have been indispensable in establishing th configuration and properties of synthetic glyceride for preparative purposes selective direct esterificatio of glycerol might be useful.

It is hoped to publish experimental details of th work elsewhere.

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## Molecular Orbital Theory of the Relative Reactivities of Substituted Aromatic Molecules towards Radical Addition

THE results obtained recently by Farenhorst an Kooyman[1] on the relative reactivities of substitute anthracenes towards radical attack lend support t the validity of the simple molecular orbital theor of radical reactions. The results show (Table 1) tha substitution at the 9-position enhances the activit towards radical attack at the 10-position irrespectiv of the polarity of the substituent group.

Two theoretical criteria have been used for th description of radical reactions: first, the free valenc $F_r$ at atom $r$ in the unperturbed ground-state[2], an secondly the radical localization energy $\Delta E_r$ require to localize a free electron at position $r$, calculate according to the technique introduced by Wheland[3] Now it has been shown[4] that in the simplest molecula orbital theory the change in free valence $\delta F_r$ in passin from a parent alternant hydrocarbon to the mono substituted derivative is an even function of th electronegativity of the substituent group. That i to say, the sign of the change in free valence at an atom of the conjugated molecule is independent o the sign of the electronegativity of the substituen group referred to a conjugated carbon atom. In th present case, the free valence $F_{10}$ at atom 10 increase in passing from the parent hydrocarbon to any of th 9-substituted derivatives of Table 1. Thus the pre

Table 1

| Anthracene | Relative rate-constants for 10-position 55° C. | 70° C |
|---|---|---|
| Unsubstituted | 1·00 | 1·00 |
| 9-Methyl | 2·06 | 2·06 |
| 9-Ethyl | 1·48 | — |
| 9-Cl | 1·64 | 1·62 |
| 9-Br | 1·83 | 1·28 |
| 9-OCH$_3$ | 2·09 | 2·06 |
| 9-CN | 4·24 | 3·94 |

oted increase in free valence is paralleled by the served increase in activity of the 10-position.

Similarly, it has been shown[3] that the change in calization energy $\Delta E_r$ in passing from the parent drocarbon to the monosubstituted derivative is so an even function of the electronegativity of the bstituent group. In the present case, the localization ergy $\Delta E_{10}$ at atom 10 is reduced in passing from e parent hydrocarbon to all 9-substituted deriva- ves. Again, the observed increased activity at the )-position parallels the predicted reduced activation ergy.

To emphasize the significance of these results, it ay be pointed out that, for example, the charge nsity $q_{10}$ (which is used as an index for ionic activity) at atom 10 would increase for 9-sub- ituents less electronegative than carbon and crease for those more electronegative. Similarly, e localization energy for electrophilic attack at e 10-position would decrease for 9-substituents ss electronegative than carbon and increase for ose more electronegative. These quantities are, fact, odd functions of the electronegativity at the sition of substitution[4,5]. It may be noted that e dependence upon electronegativity in the treat- ent described here is deduced analytically, and e result is free from the usual arbitrary choice of arameter.

The new experimental results bear out the earlier ork of Hey and Williams[6] on radical attack upon nzene derivatives, which also support the simple olecular orbital theory in that the effect of various ibstituent groups is independent of their polarity. here exists, however, one interesting anomaly. The mple theory predicts an increase in free valence at e *ortho*- and *para*-positions and a decrease at the *eta*-position for all substituents[3]. Hey and Williams ave found, however, that all three positions are tivated, except in the case of pyridine, which mani- sted an increased relative rate factor in the α- and -positions and a decreased value in the β-position. here are good reasons for believing that the simple eory, which represents the effect of a substituent y a change of coulomb integral at the position to hich it is attached, reproduces adequately the erturbation produced in the charge distribution at ositions for which the effect is not small, provided ectron-attracting groups are represented by an crease in electronegativity, and electron-donating y a decrease, at the position of attachment. The gns of the changes in charge density and free alence, indeed, are then correctly represented mpublished calculations). The changes produced t the meta-position are, however, always small, and ere the simple theory is generally not adequate. ut for the particular case of pyridine, the hetero tom N is coincident with the position of substitution nd the simple theory is strictly valid. It is interesting o note that in this case[6] the β(*meta*)-position is, in ct, deactivated, as predicted by the theory.

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## Adsorption of Methylene Blue by High-Silica Sands

HIGH-SILICA sands from which the intergranular material has been washed away have been found to adsorb considerably more methylene blue per unit of superficial surface as determined by the air permeability method[1] than was adsorbed by crushed quartz crystal. A sample of the latter material (from B.D.H.) took up $1 \cdot 2 \times 10^{-4}$ mgm. of dye per sq. cm. superficial surface, and this figure agrees well enough with that calculated by Gaudin and Rizo Patrón[2] for the adsorptive capacity of a quartz surface for positive ions to suggest that the surface accessible to methylene blue was very nearly the same in extent as the superficial surface for this material. The same was not true of most sand samples. Values for the surface accessible to methylene blue calculated from the figure obtained for crystal quartz were found in some instances to be many times the superficial surface.

Sixty-five samples from forty-five localities, eight of them outside the British Isles, have been examined. Forty-eight of the samples had values of between 2 and 5 for the ratio superficial to accessible surface, eleven had ratios greater than 5, and the remainder had ratios less than 2. The extreme range was about 0·5–15·9.

From the following evidence the adsorptive layer seems to consist of finely divided silica, that is, the grain surfaces are involuted to a greater or lesser extent. (1) 40 per cent hydrofluoric acid reduced the adsorptive capacity to a very low figure, and a marked reduction was effected by solutions containing as little as 0·1 per cent hydrogen fluoride. (2) *N* sodium hydroxide reduced the adsorptive capacity of all but one of the samples examined; subsequent washing with dilute acid to remove any adsorbed sodium ions did not increase the adsorption of dye. (3) Attrition and comminution reduced the ratio of superficial to accessible surface. (4) Sand coated artificially with $Fe_2O_3$ or $Cr_2O_3$ adsorbed very little methylene blue.

That the adsorptive layer did not consist of silicic acid[4] or hydrated silica seems to be proved by the behaviour of the sands on ignition at 700° C. Nineteen samples were ignited, and of these, eleven showed reduction in adsorptive capacity (which could be attributed to sintering of surface impurities), three were unchanged, and five adsorbed more dye than previously.

Sands which were strongly stained with iron generally adsorbed most dye, and rather surprisingly the adsorptive capacity was not increased by extraction with 11 *N* hydrochloric acid, except in a few cases. Of twenty-six samples extracted, only four adsorbed more dye after treatment, fourteen adsorbed less, and the remainder were unchanged. Most of the sands carried $Fe_2O_3$ or $Al_2O_3$ on the surface of the silica grains. $Al_2O_3$ was detected, on the paler sands, by the pink colour obtained with aurine tricarboxylate[5].

It does not seem possible to account for the reduction in adsorptive capacity after acid treatment by assuming that hydrogen ions were taken up from the acid solution and so prevented subsequent adsorption of methylene blue[6]. Samples which had been extracted with hydrochloric acid and then ignited at 500° C. showed no regular change in adsorptive capacity. Of eight samples so treated, two showed a slight increase, two were unchanged, two showed a slight decrease, and two showed a marked decrease. It seems reasonable to suppose that adsorbed hydrogen ions would be driven off below 500° C., with a consequent increase in adsorptive capacity for methylene blue.

We are led to conclude that the observation that acid extraction does not in general lead to increased dye adsorption must be accounted for by the inaccessibility to methylene blue ions of the sites occupied by the basic compounds on the silica surface. The reduction in adsorptive capacity observed in many cases may arise from disruption of capillaries adjacent to the positions occupied by the basic compounds, or of capillaries of which these latter form structural units, leading to a general 'smoothing out' of the surface.

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## Radioactivation Analysis of Phosphorus in Silicon

In a previous communication[1], a radioactivation method for the determination of arsenic in 'high purity' silicon was outlined. Further work on trace impurities in this element has resulted in the development of a technique for estimating submicrogram quantities of phosphorus.

On irradiating a silicon sample with thermal neutrons, the following reactions take place.

$$^{30}\mathrm{Si}\ (n\gamma)\ ^{31}\mathrm{Si} \xrightarrow{\beta'} {}^{31}\mathrm{P} \quad t_{1/2} = 2\cdot 62 \text{ hr.} \qquad (1)$$

$$^{31}\mathrm{P}\ (n\gamma)\ ^{32}\mathrm{P} \xrightarrow{\beta'} {}^{32}\mathrm{S} \quad t_{1/2} = 14\cdot 3 \text{ days} \qquad (2)$$

It can be seen that phosphorus atoms are produced by the decay of silicon-31 and that these are then activated according to equation (2). As these phosphorus-31 atoms are produced exponentially during irradiation, they are subjected to varying irradiation times and so the activity they produce, when extrapolated to zero time, merely indicates an apparent phosphorus concentration. The following expression has been derived for this concentration:

$$C_{\mathrm{app}} = \frac{6\varphi\sigma T\times 10^{6}}{0\cdot 69\ N}\left\{\frac{0\cdot 69\ T_i}{(1-\exp -0\cdot 69\ T_i/T)T} - 1\right\}$$

in parts per million (3)

where $\varphi$ is neutron flux, $\sigma$ is cross-section of silicon-30 (barns), $T$ is half-life of phosphorus-32 (sec.), $T_i$ is irradiation time (sec.), and $N$ is Avogadro's number.

The above relationship indicates that the apparent phosphorus concentration varies as the neutron flux and irradiation time, so that irradiation conditions for phosphorus in the submicrogram range must be carefully chosen to give optimum analytical conditions. We have selected an irradiation time of one week at a pile factor of ten for routine determinations, when equation (3) gives 0·0011 p.p.m. of apparent phosphorus, although under these conditions th total phosphorus-31 impurity introduced into silic by radioactivation is 0·0024 p.p.m. ($4\cdot 7 \times 1$ atoms/gm. silicon).

We have used the following method for separatin the active phosphorus chemically. Sufficient time allowed to elapse after irradiation for the silicon- activity to have decayed to a negligible amount (c to two days for a sample of 0·5–1 gm.). The silic is slowly dissolved in a hydrofluoric–nitric acid mi ture with disodium hydrogen phosphate present carrier, the rate of reaction being controlled b addition of nitric acid. After complete removal the silicon as the gaseous silicon tetrafluoride, th solution is reduced to small bulk, perchloric acid added and taken to fuming to remove hydroge fluoride. Dilute hydrochloric acid is added to th solution and the phosphate present is precipitate as $MgNH_4PO_4.6H_2O$ with magnesia mixture an ammonia in the usual way[2]. After standing for 24 h the precipitate is filtered, washed and redissolved wit dilute hydrochloric acid. The magnesium ammoniu phosphate is again brought down as before but i the presence of citric acid, and the whole is allowe to stand for a further 24 hr. It is then centrifuge washed and slurried into a crucible and ignited 1,100° C. to constant weight. The $Mg_2P_2O_7$ thu formed is finely ground and transferred to a countin tray to be counted and weighed.

Red phosphorus and disodium hydrogen phospha were tried as standards. Known amounts were seale in silica ampoules and irradiated with the silico samples. They were dissolved and the phospha extracted as already described. Although agreeme was obtained between the two standards, disodiu hydrogen phosphate was selected as the more sui able due to its higher purity and to the ease wit which it could be dissolved.

Samples of 'pure' silicon from various sources, fo use in semi-conductor devices, have been examine by this technique and found to contain phosphoru impurity ranging from 2·0 to 0·004 p.p.m. Th distribution of phosphorus within a 'doped' singl crystal has also been investigated by this metho and the results obtained are consistent with publishe segregation coefficients[3], conductivity and aut radiographic measurements.

We wish to acknowledge helpful discussions wit colleagues in this Laboratory, especially Mr. R. H. A Crawley.

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## Alpha-Oxidation of Omega-(2 : 4-Dichlorophenoxy)alkanenitriles and 3-Indolylacetonitrile within Plant Tissues

BIOLOGICAL and chemical investigations carried ou here on the plant growth-regulating activity ω-aryloxyalkanecarboxylic acids have established th importance of β-oxidation as a mechanism by whic these acids are degraded in plants[1]. As a logic extension of this work, the corresponding nitriles we pared and examined in the wheat cylinder ngation test (Table 1, Fig. 1) and pea curvature t (Table 1). Extracts of the wheat and pea tissues d of the solutions used in these tests were then parately examined by paper chromatography in the scending manner using butanol/ammonia/water 00 : 6 : 36 at 20° C.). The chromatograms were vided transversely into ten equal segments and ch was assayed for growth-regulating activity by e wheat test. Authentic 2 : 4-dichlorophenoxy etic acid was also run in each experiment. By ch means it was possible to correlate activity of the bstance originally tested with the production of e dichlorophenoxyacetic acid, a compound highly tive in the wheat cylinder test. In every instance ere growth-regulating activity was shown, chromographic evidence for degradation of the compound 2 : 4-dichlorophenoxyacetic acid was obtained. us, when the homologous series of acids used in ese experiments ($RO(CH_2)_nCOOH$) was treated th both wheat and pea tissue, an alternation in tivity associated with β-oxidation[1] was accom nied by the appearance of 2 : 4-dichlorophenoxy etic acid when *n* was 1, 3 and 5.

The nitrile series, $RO(CH_2)_nCN$, however, behaved ite differently. Thus, in the pea test, only 2 : 4-di lorophenoxyacetonitrile ($n = 1$) was active and as correlated with the production of the correspond g acid. No activity was shown in the pea test by y of the higher homologues, and this was in agree ent with the fact that no 2 : 4-dichlorophenoxyacetic id was found in solutions of these compounds eated with pea tissue. In view of the inactivity of ose members where *n* is 3 or 5, it would seem that e —CN → —COOH conversion does not readily cur in these higher nitriles in presence of pea sue.

In the wheat cylinder test, all members of the trile series showed significant activity (Fig. 1), and : 4-dichlorophenoxyacetic acid was produced in all ses in amounts corresponding to their activities. id production is readily explicable in the alternate mologues ($n = 1$, 3 and 5) in terms of hydrolysis llowed by β-oxidation; but the production of the id from other members of the nitrile series ($n = 2$, 4 d 6) must involve a type of side-chain breakdown t hitherto recognized in plant biochemistry. The fact that β-(2 : 4-dichlorophenoxy)propionitrile ($n = 2$) is partially converted to 2 : 4-dichlorophenoxyacetic acid shows that a one-carbon fragment can be lost. A similar degradation in the other nitrile homologues with $n = 4$ and 6, followed by β-oxidation, would explain the production of the 2 : 4-dichlorophenoxyacetic acid in these cases.

Table 1. GROWTH-REGULATING ACTIVITY IN TWO TESTS OF ω-(2 : 4-DICHLOROPHENOXY)ALKANE-CARBOXYLIC ACIDS, $RO(CH_2)_nCOOH$, AND NITRILES, $RO(CH_2)_nCN$

| *n* | Wheat cylinder elongation test* Acids | Wheat cylinder elongation test* Nitriles | Pea curvature test* Acids | Pea curvature test* Nitriles |
|---|---|---|---|---|
| 1 | Active† | Active† | Active† | Active† |
| 2 | Inactive | Active† | Inactive | Inactive |
| 3 | Active† | Active† | Active† | Inactive |
| 4 | Inactive | Active† | Inactive | Inactive |
| 5 | Active† | Active† | Active† | Inactive |
| 6 | Inactive | Active† | Inactive | Inactive |

* Within concentration range of 0 01–10 p.p.m.

† 2 : 4-Dichlorophenoxyacetic acid detected by paper chromatography and bioassay.

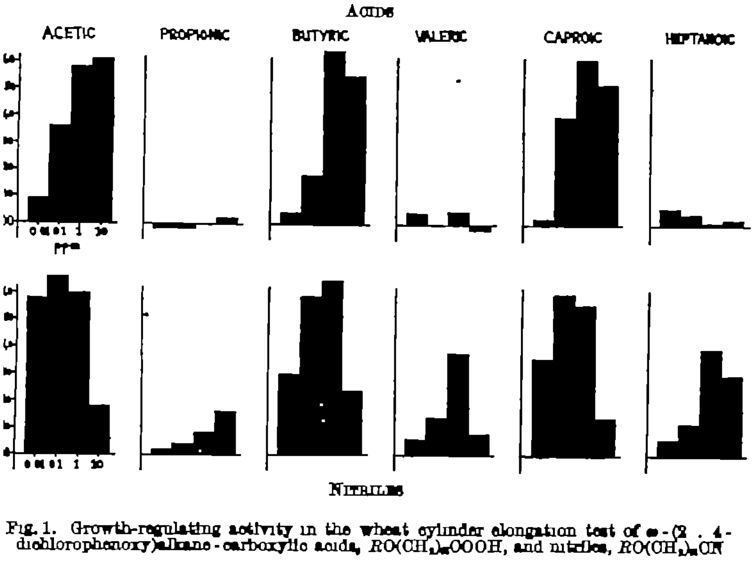

Fig. 1. Growth-regulating activity in the wheat cylinder elongation test of ω-(2 : 4-dichlorophenoxy)alkane-carboxylic acids, $RO(CH_2)_nCOOH$, and nitriles, $RO(CH_2)_nCN$

In a parallel investigation we have studied the breakdown of 3-indolylacetonitrile within pea and wheat tissue using similar chromatographic techniques. The negligible activity of this compound in the pea test was consistent with the absence of 3-indolylacetic acid on the chromatogram, a result in agreement with the work of Thimann[2]. On the other hand, it was readily detected on the chromatogram from the wheat cylinder test, in which the nitrile was highly active. The presence of 3-indolylacetic acid was proved by its $R_F$ value, bioassay, and the production of distinctive colours with Ehrlich and other reagents. In all experiments where pea or wheat tissues were treated with the nitrile, however, the chromatogram showed a distinct red spot of $R_F = 0{\cdot}12$ when sprayed with Ehrlich reagent followed by concentrated hydrochloric acid. This new compound was shown to be an acidic substance, inactive in both the wheat and pea tests, and it possessed the same $R_F$ values (0·12 in butanol/ammonia/water; 0·20 in isopropanol/ammonia/water) as 3-indolylcarboxylic acid. When run mixed with an authentic specimen of this substance, a single spot was obtained. Further evidence of its identity was provided by ultra-violet absorption spectra measurements kindly carried out for us by Prof. E. A. Braude.

In view of the above findings, it was reasonable to expect 3-indolylcarboxylic acid to be present in some of the plant tissues where the acetonitrile occurs naturally. Other chromatographic studies carried out here by Dr. P. M. Cartwright have, in fact, revealed that 3-indolylcarboxylic acid is present with a substance suspected to be 3-indolylacetonitrile in germinating peas.

The conversion of 3-indolylacetonitrile to 3-indolylcarboxylic acid in pea and wheat tissue represents a similar type of degradation, $—CH_2CN \rightarrow —COOH$, to that indicated in the phenoxy nitrile experiments discussed above. In both cases the loss of a one-carbon fragment occurs. Since the α-methylene group becomes converted to carboxyl, the process may be regarded as one of α-oxidation. Various mechanisms by which such conversions may take place are now being studied. The results of preliminary experiments on the behaviour of the corresponding amides both in the phenoxy and indole series indicate that the amide is not an important intermediate product in such α-oxidation.

The possibility that aliphatic nitriles may be metabolized in the animal body by a mechanism involving oxidation of the α-methylene group arises from the work of Lang[3] and Adeline[4]. More recent work of Pattison[5] on the toxicity to rats of ω-fluoroalkylnitriles provides further evidence of such breakdown. Thus, in the animal there is evidence that certain nitriles may be metabolized by a process of α-oxidation followed by β-oxidation of the resulting acid. The present work indicates that a similar sequence of breakdown reactions may occur in plant biochemistry.

These results will be published in detail elsewhere.

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## Inhibition, Restoration and Enhancement of Proteolytic Action by Polylysine and Polyglutamic Acid

POLYELECTROLYTES of high molecular weight have been shown to inhibit a variety of enzymes in what Spensley and Rogers[1] have called macroanionic and macrocationic inhibition. This phenomenon is probably due to an interaction of the polyelectrolytes with the enzyme or the enzyme-substrate complex. The inhibition of pepsin by the polypeptide polyelectrolyte poly-L-lysine has been reported by Katchalski, Berger and Neumann[2]. Polylysine has been shown to combine reversibly with albumin to form insoluble complexes which dissolve in the presence of excess of either component[3]. We have also studied the inhibition of the proteolytic action of pepsin by the macrocation, poly-L-lysine, and the reversal of this inhibition by excess polylysine, and the inhibition of trypsin by the macroanion, polyglutamic acid, as well as the restoration and enhancement of trypsin action by excess polyglutamic acid.

Poly-L-lysine (average molecular weight 2,100) was added to pepsin (25γ per ml.) in 0·001 *M* acetate buffer at *p*H 4·7 and the per cent transmittance of the solution was determined at 400μ. The complex was then added to the substrate and peptic activity determined by the method of Anson[4]. The results obtained from these experiments are shown in Table 1.

Table 1. EFFECT OF POLY-L-LYSINE ON PEPSIN

| Concentration of poly-L-lysine (γ per ml.) | Mole ratio of poly-L-lysine to pepsin | Transmittance (per cent) | Inhibitio (per cent |
|---|---|---|---|
| 0 | — | 100 | 0 |
| 1·56 | 1 | 98 | 0 |
| 2·1 | 1·5 | 56 | 0 |
| 3·12 | 2·2 | 77 | 13 |
| 6·25 | 4·4 | 98 | 100 |
| 12·5 | 8·8 | 99 | 100 |
| 25 | 17·5 | 99 | 98·5 |
| 50 | 35 | 99 | 46·5 |
| 100 | 72·5 | 100 | 29·5 |
| 200 | 150 | 100 | 2·4 |

Poly-L-lysine was observed to inhibit pepsin completely at low concentrations, but at higher concentrations of the peptide, 98 per cent of the original
enzymatic activity was restored. At the same tim
it was observed that polylysine and pepsin form
insoluble complexes at low concentrations of t
polyelectrolyte, which dissolved when the concentr
tion of the peptide was increased. Addition of t
peptide to the substrate rather than to the enzy
did not inhibit the proteolytic activity of pepsin.

The inhibition of trypsin (100γ per ml.) by t
macroanion, polyglutamic acid (average molecul
weight 2,580), was carried out in much the san
manner as the inhibition of pepsin by poly-L-lysi
except that phosphate buffer 0·005 *M* at *p*H 7·5 w
used. The per cent transmittance of the solution w
again determined at 400μ, and the tryptic activi
was followed by the method of Anson[4]. Polyglutam
acid was found to inhibit the proteolytic action
trypsin at low concentrations, whereas at higher co
centrations of this peptide the activity was not on
restored but also greatly increased. At the highe
concentration of peptide used, a molecular ratio of
to 1, the activity of trypsin was increased almo
three-fold. An insoluble complex was shown to for
at low concentrations of polyglutamic acid; th
precipitate dissolved when the concentration of t
peptide was increased. A summary of the resul
obtained is shown in Table 2.

The inhibition of the two enzymes is similar, a
it is probable that a common mechanism exists f
both cases. At low concentrations of the peptid
the enzyme and the peptide must combine, probab
due to electrostatic attraction, to form complex
which aggregate to give the precipitates. Inhibiti
may then be due to either the masking of the acti
site of the enzyme or the precipitation of the enzym
When the concentration of the peptide is increase
the complex dissolves and enzymatic activity
restored. The mechanism for the enhanced proteolyt
action of trypsin by polyglutamic acid is unknow
It may be due to the action of the added ion
charges on the soluble polyglutamic acid – trypsi
complex in increasing the rate of combination wi
the substrate.

This communication is published with the approv
of the Director of the Wisconsin Agricultural Expe

Table 2. EFFECT OF POLYGLUTAMIC ACID ON TRYPSIN

| Concentration of polyglutamic acid (γ per ml.) | Mole ratio of polyglutamic acid to trypsin | Transmittance (per cent) | Change in activity (per cent) |
|---|---|---|---|
| | | | Inhibitior |
| 0 | — | 100 | 0 |
| 1·3 | 0·4 | 76 | 70 |
| 3·6 | 0·8 | 48 | 75 |
| 6·25 | 1·6 | 50 | 80 |
| 12·5 | 3·2 | 77 | 80 |
| 25 | 6·4 | 100 | 85 |
| 50 | 13 | 100 | 75 |
| | | | Activatio |
| 100 | 26 | 100 | 250 |
| 200 | 52 | 100 | 290 |

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## ffect of 2,4-Dichlorophenoxyacetic Acid and Maleic Hydrazide on Potato Proteins as shown by Paper Electrophoresis

PREVIOUS studies[1] have shown that 2,4-dichloro-henoxyacetic acid increases the total protein content potato tubers and that maleic hydrazide upsets ll-division in the meristematic zone in tuber eyes[2]. he present work was concerned with changes in otato tuber proteins, resulting from plant spray eatments with 2,4-dichlorophenoxyacetic acid ,4-D), maleic hydrazide, and a combination of the vo chemicals. Analyses were made immediately after arvest and after sixty days storage.

Potatoes used in this experiment were of the Red IcClure variety, grown at the San Luis Valley xperimental Farm near Center, Colorado, during e 1953 season. There were four plots, each replicated ree times. Treatments were as follows: (1) maleic ydrazide (*MH*–40, U.S. Rubber Co.) at 3 lb. per re active ingredient; (2) alkanolamine salts thanol and *iso*propyl series) of 2,4-dichlorophenoxy-etic acid (Dow Chemical Co.) at 0·5 lb. per acre, nd equivalent; (3) alkanolamine salt of 2,4-di-lorophenoxyacetic acid at 0·5 lb. per acre plus aleic hydrazide (*MH*–40) at 3 lb. per acre sprayed hr. apart in that order; (4) control, no treatment. The treatments were applied as plant sprays when e tubers were about ½ in. in diameter. At harvest, ibers were selected at random from each treatment id frozen. Comparable samples were stored for xty days in a potato cellar (average temperature )° F.), after which they were also frozen. The tubers from each sample were allowed to thaw and the juice was concentrated to one-fifth its original volume by lyophilization.

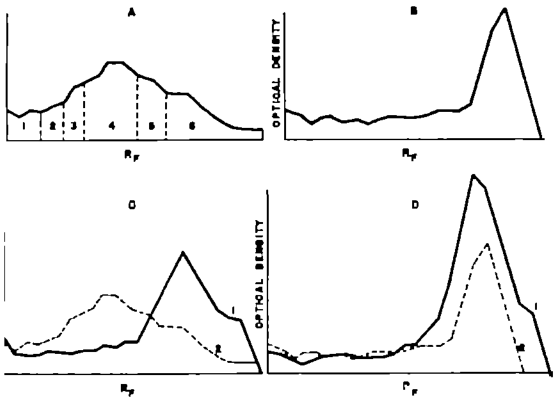

Fig. 1. Optical density curves showing the protein fractions in Red McClure potato juice. (*A*) Untreated sample showing six probable fractions at harvest. (*B*) Untreated sample after 60 days of storage. (*C*,1) Sample treated with 2,4-D; at harvest. (*C*,2) Untreated sample at harvest. (*D*,1) Sample treated with 2,4-*D*, after 60 days storage. (*D*,2) Untreated sample after 60 days storage

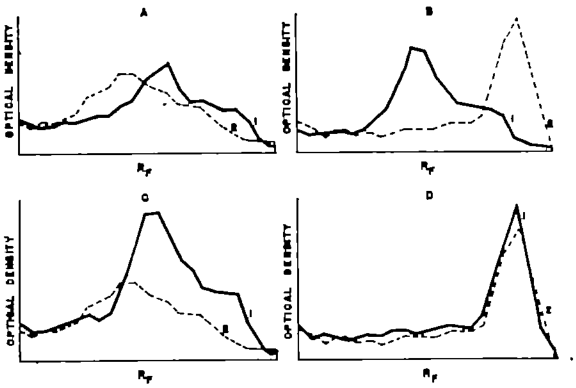

Fig. 2 Optical density curves showing the protein fractions in Red McClure potato juice. (*A*,1) Sample treated with maleic hydrazide at harvest. (*A*,2) Untreated sample at harvest. (*B*,1) Sample treated with maleic hydrazide; after 60 days storage. (*B*,2) Untreated sample after 60 days storage. (*C*,1) Sample treated with maleic hydrazide and 2,4-D at harvest. (*C*,2) Untreated sample at harvest. (*D*,1) Sample treated with maleic hydrazide and 2,4-D; after 60 days storage. (*D*,2) Untreated sample after 60 days storage

A Wieland-type of instrument modified by Grassmann and Hannig[3] was used for producing zone electrophorograms. Cacodylic buffer of *p*H 6·93 (above the isoelectric point of the potato protein) was used in the instrument. The ionic strength was 0·1. A 0·02-ml. aliquot of concentrated juice was pipetted on a buffer-dampened filter-paper strip (Whatman No. 1), 1½ in. wide. The instrument was run for six hours at 300 V., 5 m.amp., after which the paper strips were taken out and dyed in amido-black 10*B* (Farbenfabriken Bayer, Leverkusen, Germany) for 10 min. Upon coming out of this bath, the strips are dyed a dark colour. Three 10-min. baths of 5 per cent phenol were used to de-stain the strips of paper, followed by fixation in 10 per cent concentrated glacial acetic acid in absolute methanol.

The relative amounts of proteins in the tuber juices were measured by a densitometer (Welch and Co., 'Densichron') using the electrophorograms. Since the amido-black stains proteins proportionately to the concentration, the optical density curves were plotted for each treatment. The total area (proteins) under the curves was measured with a planimeter in square inches.

A typical optical density curve for each of the four treatments is shown in Figs. 1 and 2. The dotted line in all cases represents the untreated samples. Six probable protein fractions appeared in the electrophorograms of the untreated samples (Fig. 1,*A*). After sixty days of storage (Fig. 1,*B*) the main protein fraction decreased and the fastest-travelling fraction increased. Groot *et al.*[4], using a Tiselius electrophoretic apparatus, showed there were two protein fractions in potato juice. The main fraction was a globulin known as tuberin and a second fraction was called tuberinin. A third fraction was suggested but was not named. In 1953, Schwarze[5] used paper electrophoresis and obtained one large and four smaller bands, a total of five different protein fractions. Fig. 1,*A* shows six fractions. The sixth one is probably the unnamed protein suggested by Groot, and may be part of the wide band shown by Schwarze. A similar change occurred at harvest in the samples treated with 2,4-dichlorophenoxyacetic acid (Fig. 1,*C*) and after storage (Fig. 1,*D*). Maleic

Table 1. Relative Amount of Proteins in Red McClure Potato Juice, measured by the Areas under the Optical Density Curves

| Treatments | Total protein | | |
|---|---|---|---|
| | Rate/acre (lb.) | At harvest (area units, sq in.) | After 60 days storage (area units, sq. in.) |
| (1) Maleic hydrazide* | 3 0 | 2 61‡ | 1·66 |
| (2) 2,4-D† | 0·5 | 2 68 | 2·71 |
| (3) Maleic hydrazide + 2,4-D | 3·0 + 0·5 | 3·23 | 2 26 |
| (4) Control, no treatment | none | 2·10 | 2 28 |

* As *MH*-40, the sodium salt, active ingredient.
† As alkanolamine salt, active ingredient.
‡ Planimeter measurements of areas under density curves; each value is the mean of six different samples.

hydrazide produced very little change at harvest (Fig. 2,*A*) but appeared to prevent the shift after storage (Fig. 2,*B*) which occurred in the controls. This failure to change in the maleic hydrazide samples may be the basic reason why maleic hydrazine prevents sprouting, whereas 2,4-dichlorophenoxyacetic acid (at 0·5 lb. per acre) does not prevent sprouting in potatoes. Combination effects (Fig. 2,*C* and *D*) resembled those of 2,4-dichlorophenoxyacetic acid used alone.

The relative amount of proteins in the tuber juice, as measured by the areas under the optical density curves, is shown in Table 1.

The results indicate that all three treatments increased the total protein in potato tubers, as compared to the untreated sample, based on protein analysis immediately after harvest. The greatest increase resulted from the combination treatment. After sixty days of storage, the maleic hydrazide decreased, and the 2,4-dichlorophenoxyacetic acid increased, the total protein as compared to the control. The combination treatment produced little change on the total protein. As indicated in an earlier paper[1], this study has further substantiated the fact that treatment of Red McClure potato plants prior to harvest with 2,4-dichlorophenoxyacetic acid increases the protein content of the tubers.

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## Growth of Sarcoma 37 Mouse Ascites Tumour in Peritoneal Fat

THERE are no previous reports that ascites tumours grow in or on tissues before fluid and cells increase in the peritoneal cavity. Therefore, it is thought to be of interest to present evidence that such growth takes place in peritoneal fatty tissue.

In early passages of a sarcoma 37 mouse ascites tumour, histological sections invariably showed sarcomatous infiltration of peritoneal fatty tissue. Afterwards similar infiltration was revealed befo ascitic fluid had accumulated. As a result of the findings an experiment was carried out in whi 3·1 million sarcoma cells were inoculated int peritoneally into male mice that were killed intervals after inoculation. The peritoneal fluid w collected and measured; if the amount was less th 0·1 ml. it was recorded as such. The sarcoma ce in the fluid were counted in a hæmocytometer ar recorded in millions per ml. From these results tl total number of sarcoma cells in each peritoneal flu was estimated. Histological sections were prepar from the fatty tissue in the peritoneum between tl stomach and spleen and from the bodies of f attached to the gonads. The results are shown Table 1.

Table 1. Increase of Sarcoma Cells and of Fluid in the Pe toneal Cavity and Infiltration of Peritoneal Fat aft Intraperitoneal Inoculation of Male Mice with 3·1 Milli Sarcoma Cells

| Time after inoculation in hr. | No. of mice | No. of mice with 0·1 ml. or more of fluid | Total sarcoma cells in millions | No. of mic showing sarcoma cells in fa |
|---|---|---|---|---|
| 6–10 | 5 | 0 | Av. < 2·9<br>Range < 2·4 to < 3·5 | 5 |
| 18–22 | 4 | 0 | Av. < 2·5<br>Range < 2·2 to < 3·0 | 4 |
| 30–48 | 6 | 2 | Av. < 6·8<br>Range < 3·6 to 11·6 | 6 |
| 72 | 3 | 3 | Av. 11·2<br>Range 9·6 to 12·1 | 3 |

It can be seen that during the first twenty-tw hours there is no significant increase in the numb of cells over those inoculated and no accumulatio of peritoneal fluid. During the first period (6–10 hr it was necessary to examine many sections from eac mouse; but, in some sections from each, sarcom cells could be recognized within the fatty tissue itse by their very large size, basophilic cytoplasm an large vesicular nucleus. Some cells could be see applied to blood vessels, some to fat cells and son were in mitosis. In sections removed from mi killed between 18 hr. to 22 hr., sarcoma cells we more numerous, sometimes occurring in groups r placing fat cells. Between 30 hr. and 48 hr. the appeared to be an increase in the total number cells in the peritoneal fluid, and two of the si mice had more than 0·1 ml. of fluid. Sections showe that groups of sarcoma cells were in the fatt tissue and small vascular sheets of them replace fat cells. At 72 hr. there was a definite increase i sarcoma cells in the fluid, and three of three mi had excess fluid. Sections showed vascular shee of sarcoma replacing relatively large areas of fatt tissue.

These results show that invasion and multiplicatic of sarcoma 37 cells takes place in peritoneal fatt tissue before there is an increase of cells or fluid in tl peritoneal cavity. This suggests that intraperitoneall inoculated sarcoma cells invade fatty tissue, whe they can obtain nutriment for multiplication fro nearby blood vessels.

These findings permit the explanation that th ascites tumour grows initially in fatty tissue an when growth is sufficiently advanced, cells pass in the peritoneal cavity. If this is the mechanism growth of this tumour, the hypothesis that the cel multiply actively while freely suspended in periton fluid remains to be proved.

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## A Proprioceptor in the Body Musculature of Lepidoptera

DURING a study of muscle histolysis in saturniid ths[1], sense organs were found in association with intersegmental muscles. So far as we can ascer- n, they are of a type not previously described for ects. They resemble the receptors discovered by exandrowicz[2] in the Crustacea. Each receptor con- ts of a modified muscle fibre in which the striations faint, but which is capable of contraction. In final instar larva of *Antheraea pernyi*, there is a ir of these receptors in the meso- and meta-thorax d in abdominal segments 1–9. The receptors lie the dorsal longitudinal muscles[1] and are attached the epidermis at the intersegmental folds. They rsist during metamorphosis and are present in the domen of the pupa and adult, but so far they have t been located in the thorax of these stages. Near middle of the fibre, a swelling is formed by an oid sac filled with an unidentified substance which ins with some nuclear stains such as hæmatoxylin d celestin blue. Attached to the receptor at this int is a single large sensory neurone the dendrites which enter a fibre tract running the full length the receptor. The fibre tract appears to be com- sed of connective tissue fibres. A rich motor ervation is present, with nerve endings at intervals along the organ. Similar receptors have been found *Platysamia cecropia*, *Telea polyphemus*, *Samia lkeri* and *Actias selene*.

The function of the receptors of the pupa of *pernyi* has been investigated oscillographically. ter exposure of a single receptor with a suitable gth of nerve, a strip of cuticle bearing the receptor removed from the pupa. Flaps of cuticle from the ghbouring segments are left at either end of the paration. These flaps are clamped in an apparatus signed for stretching and relaxing the receptor. It nsists of a 'Perspex' trough with a fixed clamp for end of the cuticle strip and an adjustable clamp the other end. The adjustable clamp is attached a metal rod which can be locked when the prepara- n is in a suitable position. The bracket for the l is in turn attached to a solenoid which causes the l and clamp to flick to and fro in the direction of longitudinal axis of the preparation. The amount stretching and relaxation thus imposed on the eptor is controlled by micrometer screws. Through- t the experiments the preparation is immersed in ect Ringer's solution[3].

A regular single unit impulse discharge can be orded from this preparation. The duration of pulse is approximately 5 msec. at room tempera- e, and the discharge frequency depends on the sion. Frequencies of about 30 impulses/sec. are nmonly found when the preparation is set up with nimum of tension. The discharge activity con- ues unaltered for an hour and longer. Stretching the preparation evokes an immediate increase in the discharge frequency, and the higher level of activity is maintained while the stretch lasts. There is a certain amount of adaptation; but the time course of the adaptation is very slow. After cessation of stretch, there is a marked post-stimulatory depression followed by a gradual return of the impulse activity to the initial discharge frequency.

The presence in insects of proprioceptor organs closely resembling both in structure and in mode of function[4] those recently discovered in Crustacea appears to be of considerable interest. A detailed study of the histological structure of the organ and of the quantitative aspects of its responses is in progress, and the results will be published elsewhere.

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## Sodium Extrusion in Muscle

THE extrusion of sodium from the living cell against a concentration gradient has been demonstrated by Steinbach[1], Desmedt[2] and Maizels[3]. The mechanism of such an extrusion is often referred to as a 'sodium pump'. We have repeated the above experiment with nerve and muscle; but we find it difficult to obtain consistent results, because toad (*Bufo marinus*) tissue does not always lose potassium and gain sodium in the cold. This pump is not entirely activated by temperature change, as the above authors neglect to stress that extrusion of sodium does not take place unless the external potassium is increased above physiological level.

In the course of work on ionic equilibria[4,5], we had occasion to investigate the level to which the intracellular sodium would fall when the tissues were placed in Ringer solution of which half the sodium had been replaced by sucrose. A pair of muscles (or nerves) is allowed to equilibrate in normal Ringer solution for 2 hr. (longer for nerves), and then one member is analysed and the companion transferred to Ringer solution in which half the sodium has been replaced by sucrose. It is found that the intracellular sodium decreases to half that of the control. It will be apparent from a study of Fig. 1 that this sodium has been extruded against a chemical gradient. We have found that this 'pump' is extremely reliable when contrasted with the vagaries of the Steinbach pump.

A survey of the time relationships shows that the sodium extrusion may be complete (in small muscles) in as short a period as half an hour, usually within an hour, and no further ionic alteration takes place during the following three hours.

The 'pump' described differs in one particular respect from that of Steinbach in that the potassium-levels remain constant throughout the whole of the experiment, whereas according to Steinbach there is a concomitant pumping in of potassium when the

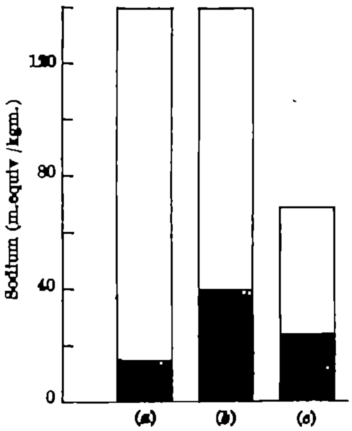

Fig. 1. (*a*) Muscle unsoaked (shaded) and in normal plasma (unshaded); (*b*) muscle soaked (shaded) and in normal Ringer (unshaded); (*c*) muscle soaked (shaded) and in half-sodium Ringer (unshaded).

Sodium content of muscle is calculated on an intracellular basis and on wet-weight. (The loss of sodium from muscle soaked in normal Ringer, when placed in half-sodium Ringer, is a loss against a concentration gradient)

cold muscles are warmed. Thus our experiment provides another example of the non-reciprocity of sodium and potassium movements (for other examples, see ref. 4).

The independence of the movements of sodium and potassium is further emphasized when we consider the action of metabolic inhibitors on the extrusion of sodium into the half-sodium Ringer solution.

The nature of the 'pump' has been investigated in the following manner:

*Cold*: the extrusion of sodium is entirely inhibited by reducing the temperature to 5° C.; but the potassium-level is unaffected.

*Monoiodo acetic acid* (1 m$M$): prevented extrusion of sodium and caused considerable loss of potassium. The tissues were bunched and failed to contract on stimulation.

*Sodium fluoride*: toad muscle appears to be resistant to the action of this inhibitor, but at high concentration (30 m$M$) the extrusion of sodium is inhibited without affecting the potassium-level.

*Calcium lack*: as the level of calcium will be reduced by sodium fluoride, the effect of calcium-free Ringer solution was tested. Extrusion of sodium was not inhibited and potassium remained constant.

2 : 4-*Dinitrophenol*: the extrusion of sodium is not inhibited by 2 : 4-dinitrophenol at a concentration of $10^{-3}$ $M$, although the muscles showed marked loss of potassium, and failed to contract on stimulation.

*Azide*: this inhibitor was also without effect on the extrusion, but at a concentration of 3 m$M$ caused marked loss of potassium and bunching of the tissue.

*Yohimbine*: did not affect the extrusion of sodium or alter the potassium level; but at $5 \times 10^{-4}$ $M$ the muscles failed to respond to stimulation.

*Cyanide* (5 m$M$): did not affect the extrusion of sodium, or alter the potassium-level. The muscles contracted well on stimulation.

It would appear probable from this limited range of inhibitors that the energy for the extrusion of sodium is derived from the glycolytic part of the respiratory cycle.

There was no extra oxygen uptake by the muscle during the extrusion of sodium.

The resting and action potentials were follow by means of internal micro-electrodes. During whole of the period there was little or no alterati in the resting potential (88 mV.). Within a f minutes of placing the muscle in the half-sodi solution the action potential fell from 132 mV. 115 mV. There was no subsequent rise in acti potential, although sodium was being extruded fr the cell until the original gradient was restored, wh is in contradistinction to the results of Desmedt[2].

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## Adenosine Triphosphate in the Adrenal Medulla of the Cow

During investigations on the specific adre medullary granules containing adrenaline and n adrenaline[1], it was found that these structures ha high contents of acid-labile phosphorus. In prel inary experiments with ion-exchange chromatogra on 'Dowex 2' using formic and hydrochloric acid eluting agents, a fraction was obtained in which t main part of the acid-labile phosphorus was recover Judging from the ultra-violet absorption and t ratio pentose : acid-labile phosphorus : total ph phorus, the chief compound in this fraction seem to be adenosine triphosphate. Therefore the meth of Cohn and Carter[2] for separation of adenos phosphates was applied to adrenal medullary extrac

The medulla of cow suprarenal glands, remov from the body 40–60 min. after killing the anima was extracted with 10 per cent trichloroacetic ac in the cold. The barium and alcohol-insoluble ph phorus compounds were precipitated together by t method of LePage[3], dissolved in 0·1 $N$ hydrochlo acid and the barium removed with sulphu acid. The solution was brought to about $p$H 8 with ammonium hydroxide and the phosphorus co pounds were adsorbed on a 'Dowex 2' colu (200–400 mesh, chloride form, 40 mm. × 13 mm flow-rate 0·5 ml./min.). They were eluted (flow-ra 1 ml./min.) according to the method of Cohn a Carter[2] (two experiments) or according to the mo fication of this method by Deutsch and Nilsson[4] (fi experiments). Fractions of 25 ml. were collecte analysed for inorganic phosphorus, acid-labile ph phates, total phosphorus and pentose, and the ult violet absorption was measured. Phosphorus w determined by the method of Martin and Dot Acid-labile phosphorus was estimated after hydroly (8 min.) in 1 $N$ hydrochloric acid at 100° C. Pent estimations were carried out according to the meth of Albaum and Umbreit[6]. Optical densities we measured in a Beckman spectrophotometer, Mo *DU*, the molecular extinction coefficient of adenos triphosphate at 257 mμ (14,200) being used.

Only 7–14 per cent of the acid-labile phosphor ($P_2$ in Fig. 1) appeared in the fractions eluted wi 0·01 $M$ hydrochloric acid – 0·02 $M$ sodium chlori and with 0·01 $M$ hydrochloric acid – 0·05 $M$ sodi chloride. The remaining part (86–93 per cent of t

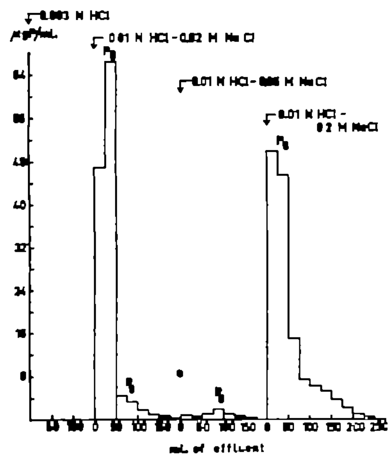

Fig. 1

al acid-labile phosphorus of the barium and ohol-insoluble phosphorus compounds) was eluted th 0·01 $M$ hydrochloric acid – 0·2 $M$ sodium loride (Fig. 1). The ultra-violet absorption and e molar ratios pentose : acid-labile phosphorus : tal phosphorus of these latter fractions indicated at the eluted compound was adenosine triphosphate. e identity and purity of the preparations were ecked after isolating them as the barium salt from oled fractions and converting the salt to the free id with 'Dowex 50' (hydrogen form) by paper romatography and by counter-current distribution alyses.

$R_F$ values, identical with those of adenosine phosphate isolated from rabbit muscle, were tained by two-dimensional paper chromatography cording to Deutsch and Nilsson[7].

Craig counter-current distributions were carried t with 11 ml. of each phase per tube in system 6 ed by Plaut, Kuby and Lardy[8] for separation of osphoric esters by solvent partition.

It would appear from Fig. 2 that the experimental rves, calculated from pentose and ultra-violet sorption, agree well with the theoretical ones. Moreover, the calculated partition coefficient is in se agreement with that obtained for adenosine phosphate isolated from rabbit muscle. The partin coefficients obtained under our experimental nditions (10·1) have been compared with those ported by Plaut, Kuby and Lardy[8] (15), and the ference seems not to lie beyond the limits of error.

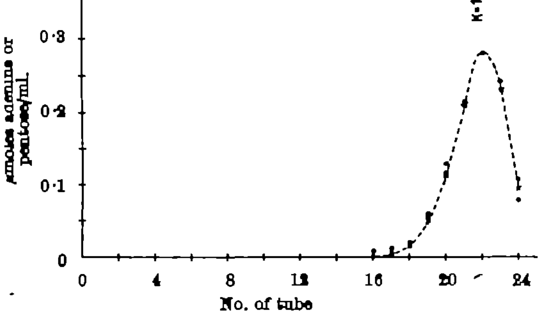

Fig. 2. Counter-current distribution of adenosine triphosphate rom cow adrenal medulla in the system hexanol, octadecylamine/ ater (pH 7·05); ●, pentose; ○, ultra-violet absorption optical density at 257 mμ; × – – ×, theoretical curve for $K = 10·1$

In the seven experiments, the following amounts of adenosine triphosphate were found, calculated on the basis of the phosphorus contents : 520, 445, 585, 500, 420, 595 and 400 mgm. (free acid) per 100 gm. wet weight of cow medulla. Preliminary experiments show that practically all the adenosine triphosphate is localized to the particular granules containing adrenaline and noradrenaline in the cytoplasm of the medullary cell, and that no appreciable breakdown occurs during several days in granules isolated and suspended in 0·3 $M$ sucrose and kept at 4° C.

The large amounts of adenosine triphosphate and its stability in the cow suprarenal medulla suggest that this tissue may be a suitable source for large-scale preparation of this substance.

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## Filterability of the Swarmers of *Rhizobium* and *Azotobacter*

ALTHOUGH the existence of tiny, motile swarmers as a stage in the life-cycles of the nitrogen-fixing bacteria, *Rhizobium* and *Azotobacter*, has been known for many years, recent authoritative reviews[1] have cast doubt upon the genuineness of the phenomenon.

The ability of the swarmers of *Rhizobium* to pass through a Chamberland candle has been recorded[2]; but those of *Azotobacter* are not known to have been filtered successfully[3].

In the course of some observations upon the life-cycles of these bacteria, the swarmers of both genera have been separated from the vegetative cells by filtration, and from the filtrate new cultures have successfully been made. This offers conclusive proof of the validity of the complex life-cycle in both cases.

It appears that much of the previous work in this field has been carried out without consideration of the size of the filter-pores or that of the gonidia to be filtered. Microscopic examination showed that the size of the gonidia was about a quarter of the width of the vegetative cell, that is, 0·3 micron in the case of *Rhizobium* gonidia and 0·8 micron with *Azotobacter*. 'Sinterware' sintered glass filters were employed. These were cleaned with concentrated nitric acid each time they were used ; then, after washing well with water, the filter, filter flask and a container for the filtrate inside the filter flask were autoclaved before use.

Cultures were grown on potato agar and the growth emulsified with Ringer's solution. A coarse filter (No. 2) was first employed in order to remove the large aggregates of particles. A manometer and an air-leak were fitted to the pump so that the pressure could be controlled at – 500 mm.

With *Rhizobium* cultures a No. 5 filter was used. This has a pore size of one micron and will pass particles up to 0·8 micron. Results were rather variable; sometimes it was possible to filter the gonidial stage, at other times it was not, although microscopic examination showed that gonidia were being produced. These variations may possibly be due to the close size of the swarmers and the filter pores.

In the case of *Azotobacter*, consistent results were obtained with a No. 4 filter, which will pass particles less than 3 microns in diameter. Young cultures were used as controls. These were examined microscopically to ascertain that they were not producing gonidia. It was found that filtrates from these cultures contained no viable cells, whereas filtrates from the gonidia-producing cells gave a heavy growth on subculture. By centrifuging the filtrates and examining microscopically, it could be shown that no vegetative cells had passed through the filter.

Failure in the past to filter *Azotobacter* gonidia would appear to be due to workers using filters that were too fine; de Regel[3], for example, used filters with a pore size of 0·75 micron. This would certainly not allow the passage of *Azotobacter* gonidia.

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## Erosion in Meanders

Secondary flows are developed when a non-uniform stream passes through a bend, the plane of which contains the vorticity vector of the entry flow[1]. The importance of such secondary velocities in the erosion of river meanders was pointed out originally by Thompson[2], and large transverse secondary velocities have been observed in the flow of air through pipe bends, at Cambridge and elsewhere[3].

Experiments have been conducted in Cambridge on a water flume to investigate the rate of erosion in meanders of different amplitude. The cross-section of the channel at the beginning of each of these experiments was an equilateral triangle of side 4 in., and the water velocity was 6–8 in. per sec. during the experiments. A standard mixture of sand and aluminous cement was used to form the meanders.

Fig. 1 shows the shape of the meanders in the first experiment, and the nature of the erosion observed.

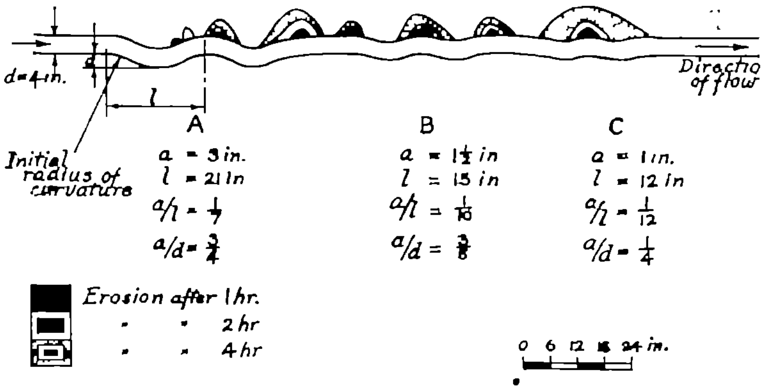

Fig. 1

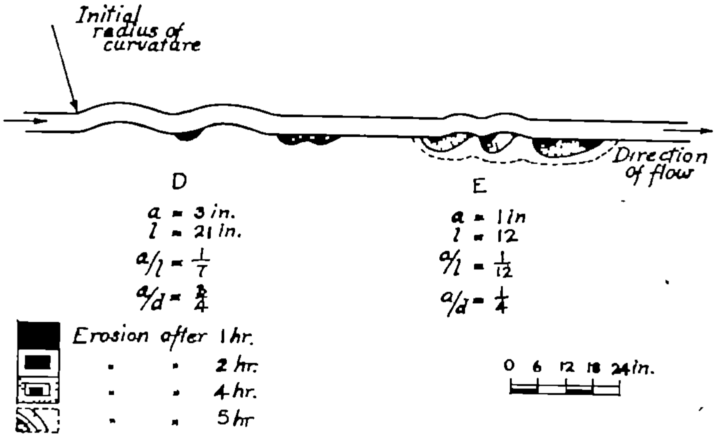

Fig. 2

The rate of erosion was greatest for the smalle meander (*C*) and least in the largest meander (*A* The walls of the channel were eroded on the outsi of the meander bends; but almost all the erosic was confined to one wall of the channel, namely, t wall on the outside of the initial bend curvatur The high-velocity water near the surface would l displaced towards this wall by secondary motion i the initial bend[3].

In a second experiment, the initial curvature each meander was reversed, and the direction any secondary rotation therefore also reverse Fig. 2 shows the development of the meanders an indicates that erosion was now completely confine to the other side of the channel; that is, once aga the side towards which the high-velocity part of th stream should be diverted by secondary motion i the initial bend. A longer settling length between large and a small meander was used in this secon experiment; but the small meander (*E*) was erode more rapidly once more, the erosion starting in eac meander on the outside of those bends of the san radius of curvature as the initial radius of curvatur

These investigations were made in co-operatic with the Ouse Catchment Board.

J. H. Horlock

Department of Engineering,
University, Cambridge.
July 21.

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[1] Hawthorne, W. R., *Proc. Roy. Soc.*, A, 206, 374 (1951).

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# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

### Monday, November 28

RITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture atre of the Science Museum South Kensington, London, S.W.7), .30 p.m.—Mr. Frank Greenaway: "Models of Molecules—Some orical Observations".

OCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (at the mical Society, Burlington House, Piccadilly, London, W.1), at p.m.—Mr. K. Wilson-Jones: "The Control of Parasitic Weeds".

### Tuesday, November 29

NIVERSITY OF LONDON (at Bedford College, Regent's Park, London, .1), at 4.30 p.m.—Dr. W. J. L. Sladen: "Biological Research he Antarctic" (Stevenson Lecture).*

NSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT SECTION nt meeting with the RADIO SECTION, at Savoy Place, London, 2), at 5.30 p.m.—Dr. C. J. N. Candy: "The Specification of the perties of the Thermistor as a Circuit Element in Very-Low- quency Systems" and "A Vector Method for Amplitude-Modulated nals".

OYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at the Sir n Cass College, Jewry Street, London, E.C.3), at 6.30 p.m.—Dr. J. P. Martin, F.R.S.: "Gas–Liquid Chromatograph".

NSTITUTION OF MECHANICAL ENGINEERS, EDUCATION GROUP (at irdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—ussion on "Laboratory Work—Purpose and Methods".

OYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, .), at 7 p.m.—Mr. F. B. Greatrex: "The Noise of Jet Engines".

OCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, Portland e, London, W.1), at 7 p.m.—Mr. A. St. Johnston: "Electronic nputing Methods".

OCIETY FOR ANALYTICAL CHEMISTRY (in the Beveridge Hall, versity of London, Senate House, London, W.C.1), at 7.30 p.m.—f. J. Heyrovský (Prague): "The Development of Polarographic lysis".

### Wednesday, November 30

RITISH NUCLEAR ENERGY CONFERENCE (joint meeting of the TITUTION OF CIVIL ENGINEERS, the INSTITUTION OF MECHANICAL INEERS, the INSTITUTION OF ELECTRICAL ENGINEERS, the INSTI- E OF PHYSICS and the INSTITUTION OF CHEMICAL ENGINEERS, he Institution of Civil Engineers, Great George Street, London, .1), at 2.15 p.m.—Inaugural Meeting. Sir Christopher Hinton, .S.: Opening Address; Sir John Cockcroft, F.R.S.: "The ted Kingdom Atomic Energy Project"; Mr. V. A. Pask and Mr. . Duckworth: "The Place of Nuclear Energy in United Kingdom er Development"; Mr. H. J. Grout: "The Use of Research ctors in Nuclear Power Development"; Mr. A. S. Maclean and Dr. H. Marley: "Health and Safety in a Nuclear Power Industry".

OYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at p.m.—Anniversary Meeting.

OYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, .2), at 2.30 p.m.—Mr. L. C. Nickolls: "Scientific Aspects of the ection of Crime".

RITISH INSTITUTION OF RADIO ENGINEERS (at the London School Hygiene and Tropical Medicine, Keppel Street, Gower Street, don, W.C.1), at 6.30 p.m.—Mr. H. J. Leak: "High Fidelity dspeakers—the Performance of Moving-Coil and Electrostatic nsducers".

OYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting the SOUTH-WEST ESSEX TECHNICAL COLLEGE CHEMICAL SOCIETY, he South-West Technical College, Forest Road, Walthamstow, don, E.17), at 7 p.m.—Dr R. N. Haszeldine: "Fluorocarbons their Future".

OCIETY FOR ANALYTICAL CHEMISTRY (at the Chemical Society, ington House, Piccadilly, London, W.1), at 7 p.m.—Mr. A. A. les: "Atomic Energy and the Analyst".

### Thursday, December 1

NSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, .2), at 5.30 p.m.—Lieut.-Cdr. F. R. J. Spearman, Mr. J. J. Galt, A. V. Hemingway and Mr. R. W. Hynes: "TRIDAC—a Large logue Computing Machine".

OYAL AERONAUTICAL SOCIETY (in the Main Dining Hall, Airmen's , A. and A.E.E., Boscombe Down), at 6.30 p.m.—Mr. P. A. ton: "Free Flight Techniques for High Speed Aerodynamic earch".

HEMICAL SOCIETY (at the Royal Institution, Albemarle Street, don, W.1), at 7.30 p.m.—Dr. E. W. R. Steacie, F.R.S.: "Re- ns of Radicals in Gaseous Systems" (Liversidge Lecture).

### Friday, December 2

NIVERSITY OF LONDON (at Charing Cross Hospital Medical School, ndos Place, London, W.C.2), at 5 p.m.—Dr. R. K. Burns (Carnegie itution of Washington): "Experimental Studies of Sex Differ- tion in the Opossum".*

OYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at n.—Mr. E. J. H. Corner: "Botanical Collecting with Monkeys".

### Saturday, December 3

BRITISH INTERPLANETARY SOCIETY (in the York Hall, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Mr E. Burgess: "Probing Interplanetary Space".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (Grade B) IN PHYSICS—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (November 30).

ASSISTANT LECTURER (with a good honours degree or Associateship of the Royal Institute of Chemistry, and research and/or industrial experience) IN CHEMISTRY, at the Technical College of Monmouthshire, Crumlin—The Director of Education, County Hall, Newport, Mon. (November 30).

BIOCHEMIST, Scientific Officer grade, for research work on the organic chemistry of the hop plant—The Registrar, Wye College, near Ashford, Kent (November 30).

COMPUTER (with an ordinary pass degree in mathematics or equivalent qualification) IN THE DEPARTMENT OF PHYSICS, for work in connexion with a programme of research on the crystal structure of organic compounds—Joint Clerk to the University Court, Queen's College, Dundee (November 30).

RESEARCH FELLOW (with research experience, preferably on natural products) IN CHEMISTRY, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (November 30).

AREA CHIEF SCIENTIST (preferably with a good honours degree, with considerable experience of industrial science, fuel technology and laboratory administration)—The Staff Director, National Coal Board, East Midlands Division, Sherwood Lodge, Arnold, Notts, quoting S.V.467 (December 3).

LECTURER or ASSISTANT, Grade B (with special interests in inorganic chemistry, high academic qualifications with good teaching and/or research experience), IN THE DEPARTMENT OF CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (December 3)

LIBRARIAN (with a scientific background, preferably with a pass degree or equivalent, and proficient in German) for a small but specialized library—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (December 8).

ASSISTANT LECTURER or LECTURER IN PHYSICS—The Registrar, The University, Sheffield (December 10).

RESEARCH ASSISTANT (with a first-class or good second-class honours degree in chemistry) IN THE COAL CONSTITUTION LABORATORY of the Department of Mining, to be a member of a team carrying out research on the chemical constitution of coal, including the examination of the products of mild oxidative degradation of coal—The Professor of Mining, The University, Edgbaston, Birmingham 15 (December 12).

SENIOR LECTURER and LECTURERS (2) IN THE DEPARTMENT OF BOTANY, University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 12).

LECTURER IN PHYSIOLOGY, at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (December 15).

PROFESSOR OF MARINE ENGINEERING; PROFESSOR OF HYDRAULIC MACHINES; PROFESSOR OF TEXTILE ENGINEERING; and a PROFESSOR IN PRODUCTION OF ARMAMENTS AND AMMUNITIONS—The Dean, Faculty of Engineering, Alexandria University, Alexandria, Egypt (December 17).

RESEARCH STUDENT (with a good honours degree in chemistry) IN CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffs (December 17).

LECTURER/SENIOR LECTURER (preferably with experience in endocrine or reproductive physiology) IN VETERINARY PHYSIOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 19).

LECTURER (with special qualifications in hydraulics) IN THE DEPARTMENT OF FLUID MECHANICS—The Registrar, The University, Liverpool (December 19).

LECTURER (with special interest in the fields of low temperature and solid state physics) IN THEORETICAL PHYSICS, in St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (December 31).

RESEARCH ASSISTANT IN AERONAUTICS—The Secretary of University Court, The University, Glasgow (December 31).

SENIOR LECTURER IN CIVIL ENGINEERING, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (December 31).

IMPERIAL CHEMICAL INDUSTRIES FELLOWS (3) for research in chemistry, physics and allied subjects, including the biological application of chemistry—The Registrar, University Office, 46 North Bailey, Durham (January 9).

STAFF TUTOR (with qualifications in and, if possible, experience of extra-mural teaching in zoology and/or botany with particular reference to the promotion of field studies among adult students) IN NATURAL HISTORY in the Department of Extra-Mural Studies—The Secretary, Queen's University, Belfast (January 16).

ASSISTANT LECTURER (Grade A) IN THE DEPARTMENT OF CHEMISTRY AND BIOLOGY, College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

ASSISTANT LECTURER (with an honours degree in chemistry and able to teach one branch of chemistry up to B.Sc. special chemistry degree standard, and preferably with industrial experience) IN THE SCHOOL OF CHEMISTRY—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

BIOCHEMIST (with a first- or second-class honours degree in biochemistry or equivalent qualification, and with postgraduate research experience) to assist in the study of certain physico-chemical properties of mucin, initially for a period of two years—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 55/20.

BRADFORD DYERS' ASSOCIATION LIMITED RESEARCH FELLOW (with high qualifications in science) to undertake research in tinctorial chemistry, textile chemistry or an allied subject—The Principal, Technical College, Bradford.

CHEMIST or BIOCHEMIST (with an honours degree) in the Serum Department, for the routine control of therapeutic sera and research on biochemical and biophysical problems in the field of serum proteins—The Secretary, The Lister Institute, Elstree, Herts.

ENGINEERS and PHYSICISTS, Senior Scientific and Scientific Officer grade (with an appropriate first- or second-class honours degree or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments, chiefly in the Weymouth and Portsmouth areas and Home Counties—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.344/5A.

HOSPITAL PHYSICIST (Senior grade), to serve the Radiotherapy Departments of the General Hospital, Southend-on-Sea, and the Essex County Hospital, Colchester, in association with the Physics Department of the London Hospital—The Secretary, Southend-on-Sea Hospital Management Committee, General Hospital, Southend-on-Sea.

MATHEMATICAL CONSULTANT (with a mathematical or science degree, and preferably with experience of electrical computing machines) IN THE ENGINEERING RESEARCH DEPARTMENT for work consisting of computation and mathematical analysis of problems relating to all branches of audio and radio frequency and television engineering—Engineering Establishment Officer, Broadcasting House, London, W.1, quoting E 315.N.

PHYSICISTS, Scientific Officer class and Experimental Officer class, at Ministry of Supply Research and Development Establishments, chiefly near Farnborough, Hants; Malvern, Worcs; Salisbury, Wilts; and Sevenoaks, Kent; for work on guided weapons, rockets, gas turbines, aerodynamics, aircraft structures and equipment, armaments, instrumentation including optics, and electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.396/5A.

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent, and at least three years postgraduate research experience, and a good basic knowledge of radio engineering and experience in the development of telecommunications apparatus) at the Ministry of Supply Headquarters, London, for work associated with the development of field and fixed radio equipment, television, counter measures, telemetry, vehicle installations, and radio navigation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.520/5A.

PSYCHOLOGIST in the Research Department—The Secretary, Royal Eastern Counties Hospital, Abbeygate House, Colchester, Essex.

RESEARCH ASSISTANTS for research on the chemical physics of polynuclear aromatic compounds, and on the melting mechanisms of ionic crystals—Prof. A. R. Ubbelohde, Imperial College, London, S.W.7.

RESEARCH FELLOW (with a degree in electrical engineering or in physics) IN THE ENGINEERING LABORATORY, University of Oxford, to work under the direction of the Donald Pollock Reader, Dr. H. Motz, on problems of millimeter wave generation—Prof. A. Thom, Engineering Laboratory, 19 Parks Road, Oxford.

RESEARCH WORKER (with a veterinary qualification or a good honours degree in a biological subject, and preferably with experience in microbiology and/or histology), to study problems associated with virus infections of animals; and a RESEARCH WORKER (with an honours degree in a biological subject and an interest in ecology) for original research on parasitic worms of livestock—The Secretary, Animal Diseases Research Association, Gilmerton, Edinburgh 9.

SENIOR SCIENTIFIC OFFICERS (with a first- or second-class honours degree or equivalent in physics or engineering, and preferably with a knowledge of aircraft or aircraft systems) at a Ministry of Supply Experimental Establishment, near Amesbury, Wilts, for planning and development of special trials of aircraft guided weapon systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.410/5A.

SENIOR TECHNICIAN IN ZOOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

TECHNICAL EDITOR (with a degree in engineering, metallurgy or science, experience of technical editing, and familiarity with welding terms)—The Secretary, Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1.

THEORETICAL PHYSICIST (with a first- or second-class honours degree in physics, and at least three years postgraduate research experience, preferably in the field of motion and coagulation of particulate suspensions) to work on problems of size distribution in coagulating and dispersing particulate suspension—The Senior Recruitment Officer, United Kingdom Atomic Energy Authority, Aldermaston, Berks, quoting 726/2.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Foot-Rot of Sheep—Stamp It Out. By Prof. W. I. B. Beveridge. Pp 11. (London: Universities Federation for Animal Welfare, 1955.) [29

*Crypton News*. Vol. 1, No. 1 (August, 1955). Pp. 7. (Bridgwater, Somerset: Crypton Equipment, Ltd., 1955.) [29

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 660, Vol. 239 (30 August, 1955): Sporodistichy Re-interpreted. By Mary Snow. Pp. 45–88. (London: Royal Society, 1955.) 15s. 6d. [29

Proceedings of the Royal Irish Academy. Vol. 57, Section A, No
Note on the *Tamm-Dancoff* Method. By E. Arnous. Pp. 81–86.
Vol. 57, Section A, No. 4: The Application of Certain Linear Qua-
nion Functions of Quaternions to Tensor Analysis. By C. W. Kilmis
Pp 37–52. 2s. 6d. Vol. 57, Section B, No. 5: The Precipitatio
Serum Proteins by Branched-Chain Paraffinic Compounds. Part 1: '
Precipitation of Serum Proteins by certain Branched-Chain A
tubercular Compounds and Its Relation to the in Vitro Inhibit
of these Compounds by Human Serum. By W. M. D. Armstro
Pp. 55–70. 1s Vol. 57, Section B, No. 6: The Old Red Sandstone of
Kerry Head Anticline, County Kerry. By M. F. H. Khan. Pp. 71-
1s. Vol. 57, Section B, No. 7: The Tertiary Lava Succession in
Northern Part of the Antrim Plateau. By H. M. Patterson. Pp. 79-
+5 plates. 7s. 6d. Vol. 57, Section B, No. 8: *Amphilochus Brun*
Della Valle, an Amphipod New to Britain and Ireland, and Notes
other Amphipods not previously recorded in Irish Coastal Wat
By Margaret Duhig and Carmel Humphries. Pp. 123–130. 1s. Vol.
Section B, No. 9: Genus *Paraphyllopodopsyllus* Lang (Copepo
Harp). By Katherine M. Roe. Pp. 131–139. 1s. 6d. (Dublin: Hod
Figgis and Co , Ltd., 1955.)

National Oceanographic Council. Proceedings of the Commonwe
Oceanographic Conference, 18–22 October, 1954, held at the Natio
Institute of Oceanography, Wormley, Surrey. Pp. v+93. (Cambrid
At the University Press, 1955.) 7s. net.

## Other Countries

International Scientific Radio Union. Proceedings of the 1
General Assembly held in The Hague from August 23rd to Septem-
2nd, 1954. Vol. 10, Part 4: Commission 4—On Radio Noise of T
restrial Origin. Pp. 60. (Brussels: International Scientific Ra
Union, 1955.) 60 Belgian francs; 8s. 8d.; 1.20 dollars. [

International Council of Scientific Unions. Mixed Commission
the Ionosphere. Proceedings of the Fourth Meeting, held in Brus
from August 16th to 18th, 1954. Pp. 238. (Brussels: Internatio
Scientific Radio Union, 1955.) 300 Belgian francs; 43s.; 6 dollars. [

Annual Report of the Trustees of the Museum of Applied Arts
Sciences, Sydney, for the year ended 31st December, 1954. Pp.
(Sydney: Museum of Applied Arts and Sciences, 1955.) [

State of California. Department of Fish and Game: Marine Fishe
Branch. Fish Bulletin No. 99: A Description of Two Species of Bon
*Sarda Orientalis* and *S. Chiliensis*, and a Consideration of Relationsh
Within the Genus. By H. C. Godsil. Pp. 43. Fish Bulletin No. 1
Catch Localities for Pacific Albacore (*Thunnus germo*) Landed
California, 1951 through 1953. By Harold B. Clemens. Pp. 28. F
Bulletin No. 101: Age Determination of the Northern Ancho
*Engraulis mordax*. Pp. 66. (Sacramento, Calif.: Printing Divis
Documents Section, 1955.) [

Annual Report of the Calcutta School of Tropical Medicine and
Carmichael Hospital for Tropical Diseases, 1953. Pp. ii+147. (
cutta: Calcutta School of Tropical Medicine, 1955.) [

Indian Forest Bulletin (New Series). No. 195: Cellulose and Pape
Indigenous Cellulosic Raw Materials for the Production of Pulp, Pa
and Board. Part 25: Wrapping Papers from *Acacia decurrens* W
(Wattle Wood). By R. V. Bhat and H. K. Kaushik. Pp. ii+
(Delhi: Manager of Publications, 1955.) As. -/14/-; 1s 2d. [

Forest Research Institute and Colleges, Dehra Dun. Pp. 28. (De
Dun: Forest Research Institute and Colleges, 1954.) [

State of Illinois. Department of Registration and Educatio
Natural History Survey Division. Biological Notes No. 35:
Evaluation of the Red Fox. By Thomas G. Scott. Pp. 16. (Urba
Ill.: Department of Registration and Education—Natural Hist
Survey Division, 1955.) [

United States Naval Observatory. Circular No. 59: Solar Eclip
1960–1963. By Simone Daro Gossner. Pp. 8. (Washington, D.
United States Naval Observatory, 1955.) [

Smithsonian Miscellaneous Collections. Vol. 128, No. 5: Revi
of Some Recent Foraminiferal Genera. By Alfred R. Loeblich,
and Helen Tappan. Pp. i+37+4 plates. (Publication 4214.) (Wash
ton, D.C.: Smithsonian Institution, 1955.) [

Colony of Singapore. Annual Report of the Botanic Gardens Depa
ment for 1954. Pp. i+11+4 plates. (Singapore: Government Publi
tions Bureau, 1955.) 50 cents. [

World Health Organization. Technical Report Series No.
Joint FAO/WHO Expert Committee on Nutrition. Fourth Rep
Pp. 58. (Geneva: World Health Organization; London: H
Stationery Office, 1955.) 2 Swiss francs; 3s. 6d. net, 0.60 dollars.

Report of the All-India Institute of Hygiene and Public Hea
Calcutta, 1951–53. Pp. iii+83. (Calcutta: Government of India Pr
1955).

Publications de l'Institut National pour l'Étude Agronomique
Congo Belge. Rapport Annuel pour l'Exercice 1954. Pp. 4
(Bruxelles: Institut National pour l'Étude Agronomique du Co
Belge, 1955.) 160 francs.

Geological Survey of Nigeria. Bulletin No. 24: The Niger
Coalfield—The Geology of Parts of Onitsha, Owerri and Be
Provinces. Pp. viii+85+5 plates. (Kaduna Junction: Geolog
Survey, 1954.) 10s. 6d.

Companhia de Diamantes de Angola (Diamang). Servicos Cultur
Dundo–Lunda–Angola. Museu do Dundo. Publicacoes Cultur
No. 26: Psocoptères de l'Angola. Par A. Badonnel. Pp. 266. (Lisb
Companhia de Diamantes de Angola, 1955.)

List of Scientific Papers published in the Middle East. (Afghanist
Cyprus, Egypt, Iran, Iraq, Israel, Lebanon, Pakistan, Sudan, Sy
and Turkey.) No. 11 (February, 1955). Pp. i+84. (Cairo: UNES
Science Cooperation Office, 1955.)

Thirty-Eighth Annual Report of the National Research Council
Canada, 1954–55, including the Annual Report of Canadian Pate
and Development Limited. (N.R.C. No. 3607.) Pp. 44. (Ottaw
National Research Council, 1955.)

Indian Agricultural Research Institute. Pp. 80. Souvenir—Gol
Jubilee, 1905–1955. Pp. 92. (New Delhi: Indian Agricultural Resea
Institute, 1955.)

Calendar of the New South Wales University of Technology, 19
Pp. 412. (Sydney: New South Wales University of Technolo
1955.)

# SUPPORT FOR SCIENCE TEACHING IN SCHOOLS

ALTHOUGH the Appleton Committee, in reporting on the supply of teachers of mathematics d science in Scotland, rejected the suggestion that or conditions in many school laboratories is a eason for the lack of recruits to science teaching, it d not deny that some school buildings are old and attractive and that some laboratories are sparingly uipped. Moreover, if the standard of school science ildings and equipment is, in general, as satisfactory England and Wales as the Appleton Committee und it to be in Scotland, the indications are that e standard is likely to deteriorate rapidly in the sence of special assistance. The maintained condary schools are able to look to public funds to able them to extend their laboratories and to prove their equipment and facilities for science aching ; and Sir David Eccles has said enough in cent months to justify them in facing the impending ulge' with some confidence that their resources will increased sufficiently to enable them to cater ficiently for the anticipated and desired increase scholars studying science.

The independent schools in Britain have no such nfidence, and any expansion must be financed out their own resources. They are reluctant to raise eir fees further, although these have not risen ough to cover the whole cost of running and panding the schools. If indeed fees have not yet ached the limit, that limit must shortly be set by e same factor of increasing taxation in the higher vels which is already drying up the private benections and endowments which in the past brought e schools into being, and have made possible the tstanding education for which they are famous.

These schools, with their fine tradition of scholarip in the humanities, represent a valuable potential urce of scientists and technologists. But first it ll be necessary to overcome the reluctance apparent them to enter on such careers ; a reluctance to hich the Advisory Council on Scientific Policy and eakers in both Houses of Parliament in recent detes on scientific and technical man-power, the shorte of science teachers and similar themes have rected attention, as well as Sir Alexander Todd in s address to the Parliamentary and Scientific Comittee last July on the scientific man-power probm. For that reason alone it is fitting that industry ould come forward and assume some of the sponsibility which private individuals are ineasingly unable to discharge. The Industrial Fund r the Advancement of Scientific Education in hools, which as announced in *Nature* of November p. 860, has been established by seventeen chemical, ectrical and mechanical engineering companies, is tended to provide funds for the considerable pansion in the provision of buildings and equipent which is required if the independent schools d direct grant schools in the United Kingdom, the Channel Islands and the Isle of Man are to make their fitting contribution to the increased supply of scientists and technologists that the nation needs.

This initiative was warmly welcomed by the Minister of Education, Sir David Eccles, in the course of a reply to a question in the House of Commons on November 1 regarding the improvement of facilities for advanced science teaching in the schools. In that reply Sir David said that since 1945, about a thousand new laboratories had been built or started in maintained grammar or technical schools. In a written reply on November 10 he estimated the cost of these as £1·5 million in technical schools, just under £3 million in grammar schools and £9 million in modern secondary schools. He expressed the hope that authorities will continue to use their freedom in minor works to improve science accommodation ; but he said he is ready to consider on their merits projects which could not be executed for less than £10,000.

Whatever reservations may be held as to the effect of the establishment of the Industrial Fund for the Advancement of Scientific Education in Schools on the supply of science teachers, it cannot be other than beneficial and will enable the schools to offer opportunities in science to an increasing number of boys and girls. This is desirable not only from the point of view of public or industrial administration, but also from that of the production of scientists or technologists, as Sir Henry Tizard emphasized in his Haldane Memorial Lecture last March. Moreover, it should be noted that the examples of research carried out in schools cited by Dr. A. G. Lowndes in his paper at the Birmingham meeting of the British Association were carried out in independent schools. The improved facilities which this new Fund may make possible in such schools should assist the recruitment of first-class science teachers, and Mr. J. T. Stock has recently directed attention to this aspect. In a recent note in *The Times Educational Supplement*, he described the results which have followed the granting to him and a colleague at Norwood Technical College, in consequence of the Ministry of Education Circular 94 of 1946 on Research in Technical Colleges, of five hours a week relaxation of teaching duties for research in chemistry. Some 90 per cent of this work, largely on the design and development of micro- and semi-micro-apparatus and techniques, has been carried out with equipment and materials normally available in schools.

This particular work has received a fair amount of recognition, notably in exhibits at the Science Museum and at the International Congress on Analytical Chemistry at Oxford in 1952 and in a B.B.C. Science Review telefilm ; but its importance in the present connexion is its demonstration of the potentialities of research with a modest official allowance of time. The factor is certainly one not to be discounted lightly ; and it is even possible that, as regards the recruitment of science teachers and the supply of scientists and technologists, the great value of the establishment of the new Fund will lie in the increased prestige which is thereby given to science and to technology as careers. Indeed, if its full effect is to be felt, it is important that scientists should make every effort to overcome whatever obstacles continue to hinder the ablest boys and girls in the independent or the grant-aided schools from taking up a science career. Equally, of course, it is important that other firms should follow the lead of the institutors of the Fund.

In this connexion it is worth recalling the provocative remark made by Sir Henry Tizard thirty-five years ago, and which he quoted in his Haldane Memorial Lecture, that the fame of the old School of Greats at Oxford was not really due to the intrinsic merits of the two subjects studied, but rather to the fact that men who took high honours in it had been specially selected at school to read classics because of their outstanding ability. Sir Henry went on to argue that any other two subjects would serve equally well for the training of the minds of men who are going into the Civil Service and other professions, provided that they are equally difficult and well taught, and to suggest that in this scientific age one of the subjects of Modern Greats should be science, and the other modern philosophy, history or economics. The suggestion was even then taken quite seriously; but its relevance to the teaching of science in the independent schools is in stressing the importance of quality. If, as there seems to be some reason for believing, in spite of the increase in the number of university students since the War, there has been no proportionate increase in the number of those obtaining first-class honours, it is of the utmost national importance that a reasonable proportion of the ablest students entering the universities each year should study science.

To ensure this, there must be no undue bias against science in the schools; and every effort must be made to see that the opportunities of science and technology as careers are fairly presented, and that the claims of science and technology as intellectual disciplines are fully understood by headmasters and their staffs. On them must rest a large responsibility for guiding the ablest young minds under their care to consider the claims of a career in science or technology; but it is no less important that such careers should have the prestige and status in the public mind which can be as important as remuneration in attracting recruits of high quality. The decisive factor is often the influence of the science master himself. If the new Fund, by furthering the provision of laboratories and equipment and improving teaching conditions generally, increases the prestige of science and those who teach it in the schools, then it may well help to attract teachers of ability and enthusiasm. In this way it may make a decisive contribution, not so much to the early removal of the shortage of science teachers, as to ensuring that a fitting proportion of the ablest minds in the sixth forms of schools each year turn to science or technology as a career.

# ISOTOPES IN THE SERVICE OF GEOLOGY

**Isotope Geology**

By Prof. Kalervo Rankama. Pp. xvi+535. (Londo
Pergamon Press, Ltd.; New York: McGraw-H
Book-Company, Inc., 1954.) 75s. net.

IN 1950 Prof. K. Rankama proposed the ter
'isotope geology' to cover the investigation
geological problems by means of research on t
occurrence and natural history of isotopes, a
especially the variations of their relative abundance
Some of the vast possibilities of this fascinating a
rapidly expanding field of discovery are bei
actively explored by several enthusiastic teams
workers, and already the output of literature h
become an accelerating stream with which only
specialist can hope to keep pace. Geologists hav
therefore good reason to be grateful to Prof. Rankan
for giving them this admirable account of the pri
ciples of the subject and for making so readily avai
able the results achieved up to very nearly the da
of publication. The book is divided into two part
of which the first is a remarkably lucid account
the physical and chemical principles involved in t
various methods and techniques, while the second
devoted to summarizing and discussing all t
relevant information about the isotopes of most
the elements, with special reference to actu
examples of isotope fractionation in Nature and t
geochemical processes responsible. Part 2 is muc
more than a compilation of data and a guide to t
literature—although in these respects alone it
invaluable—for on every appropriate occasion t
author discusses the geological significance of t
results and directs attention to the many critical ga
where more data are urgently required. Indeed, fe
books can have been written in which so man
opportunities for productive research are freely pr
sented. For example, we can now clearly see how
solve some of the more tantalizing problems of petr
genesis and ore deposits, while at the same tim
realizing that each successful forward step will requi
organized and patient team-work, and the expenditu
of much time and money. The stimulating effect
of this book should help to shorten the time very su
stantially by adding to the numbers of eager worker

Among the problems to which useful contribution
have already been made, the measurement of ge
logical time stands out as by far the most famili
and successful. During recent years the radiocarbo
method has made it practicable to begin the co
struction of a world-wide 'atomic calendar', goin
back perhaps some thirty thousand years, whic
would provide an 'absolute' chronology if the fund
mental assumption of long-term constancy of cosmi
ray intensity could be justified. Dating of sampl
already dated by varves is the obvious requirement
but as yet this has not been systematically carrie
out. Indeed, if E. Antevs (*J. Geol.*, 63, 499; 1955)
correct in concluding that the radiocarbon age f
the celebrated Two Creeks forest bed (11,400 year
is at least 8,000 years too young, the method wi
eventually disprove the assumption and show ho
the intensity of cosmic rays can be 'calibrated' ov
the period that has been measured by varves.
the other end of the known time-scale, the metho
based on the accumulation of radiogenic isotopes
lead have been successfully applied to the dating
meteorites, by the use of techniques that would ha

med little short of miraculous a few years ago. the many topics involved in geochronology—and w outside, such as the 'age' of the elements them-res—are treated competently and critically, with rm and frank assessment of the difficulties that re still to be overcome. For example, in discussing ether or not the rates of decay of the radioactive lides have varied with time, Rankama pertinently nts out that the argument for constancy based on asurements of pleochroic haloes is not infallible, ce a considerable variation in the decay constant uld be necessary to produce a detectable change the range of the alpha-particle concerned.

n the field of petrogenesis the author very erously gives me credit for having made the first structive suggestions involving 'isotope geology', ed on the inference that the isotope of calcium erated by the radioactive isotope of potassium uld increase during geological time about twenty-en times as fast in granites as in basaltic rocks. that time (1932) it seemed to be quite practicable determine the abundance-ratios that were needed decide whether various rocks had been formed by ferentiation or not, and if not, whether some such cess as replacement or transfusion had operated. is optimism was based on the mistaken belief, n current, that the radioactive isotope of potas-m was of mass 41 and that its decay product was cium-41. It was not until 1935 that Nier showed active nuclide to be potassium-40. In the erim, as Rankama records on p. 315, "the method s actively investigated by the magneto-optic thod developed by F. Allison in the United States, no results were published". It was very fortunate us that we were cautious enough to abstain from blishing, and it may be of interest to place on ord how we eventually came to realize that, what-r was being measured, it was not calcium-41. er a period of two years I sent scores of analysed k-powders to Dr. Allison for the determination of lcium-41'. The results were dramatically exciting l, despite a few disturbing discrepancies, I felt e that we had found a powerful new key for ocking at least some of the secrets of petrogenesis. the hope of tracing the source of the discrepancies ent a dozen samples of marine limestones, fossils l shells of known age, ranging from the present to back in the Pre-Cambrian, expecting to find that ratio of 'calcium-41' to total calcium had increased tematically during geological time. Alas, there s no increase ! The Pre-Cambrian ratios did not fer appreciably from the values for modern shells l sea water. This pulled us up with a painful jerk ; l the discovery about the same time that no such tope as calcium-41 is detectable by the mass ctrograph (the decay product in question being cium-40) raised what were then, and still are, uperable difficulties against making a fresh start h the right isotopes. Increase of the ratio of ontium-87 to strontium-86 with geological time uld be much more easily detectable in marine mical sediments, as Wickman pointed out in 1948 ; Rankama has still to report that even this highly mising method has so far failed to yield satis-tory results.

More positive progress in tracing the origins of ks, minerals, natural waters and gases has been ieved by determining the variations in the isotopic stitutions of such elements as carbon and oxygen. e chapters on these elements are consequently ong the longest and most informative. Baertschi's investigations are notable for their demonstration that both oxygen-18 and carbon-13 vary considerably in metamorphic limestones, ranging from the relatively low values characteristic of sedimentary types to the higher values given by carbonatites of igneous origin. The high values occur at contacts where, presumably, great quantities of juvenile carbon dioxide, water, etc., traversed the rocks and effected isotope exchanges during their passage. Various investigators have found that oxygen-18 tends to be more abundant in granitic than in basaltic rocks, which is not what would be expected if these rocks were related by differentiation. The heavy isotope of silicon also tends to concentrate slightly in the more silicic rocks. However, much more evidence of this kind is required for a variety of elements, in critically selected suites of rocks having known relationships, before firm conclusions can be reached, and here the co-operation of field geologists is essential. Rankama's chapter on magnesium—twenty lines, only—reflects a paucity of data for a very common element that is lamentable in view of the many problems connected with stony meteorites, ultrabasic rocks and basalts that still await solution.

Important applications that are already under way include the assessment of the palæo-temperatures corresponding to the growth conditions of carbonate shells of Jurassic and later ages (the 'carbonate thermometer') and of the distributions of climate so implied. Similarly, the isotopic constitution of sulphur in pyrite depends on the temperature at which the mineral crystallized ; for example, in hydrothermal deposits the crystals become relatively enriched in sulphur-32 as the temperature decreases. A study of marine sulphates and sulphides of various ages has suggested to Thode and others that organic fractionation of sulphur did not occur on an appreciable scale until towards the close of the Pre-Cambrian. Here there is a hint that the earlier atmosphere may have been deficient in free oxygen and that the later rapid development of oxidizing conditions may have favoured the extraordinary efflorescence of Cambrian life-forms. While sounding a cautious note of warning, Rankama comments on the fascination of these problems and the urgent need for much more detailed research.

The book has a bibliography of more than thirteen hundred items, an index of authors and an unusually detailed and efficient subject index. The only criticism as to style is that the author has picked up the bad habit of using the word 'data' as if it were a singular noun. It may not be out of place to direct the attention of publishers' readers to this all-too-common fault. Few misprints have been detected ; one that should perhaps be mentioned occurs in equation 75.27 on p. 383, where $^{235}$U should be $^{238}$U. There is a related mistake in the reference to me on p. 386, concerning which I need only say that I was not guilty of having paid no attention to the isotopic constitution of uranium in my calculations.

Prof. Rankama is to be congratulated on a very impressive achievement, and the publishers on the production of a handsome volume that is worthy of its contents. The book will be found invaluable by scientific workers in a wide variety of subjects besides geology and geochemistry, and many of its readers will doubtless join with the reviewer in the hope that supplements embodying the results of current and future researches in the same fields may be prepared at intervals by this distinguished author to whom we owe so much already. ARTHUR HOLMES

# PHYSICAL MEASUREMENT IN GAS DYNAMICS AND COMBUSTION

### Physical Measurements in Gas Dynamics and Combustion

Edited by R. W. Ladenburg, B. Lewis, R. N. Pease and H. S. Taylor. (High Speed Aerodynamics and Jet Propulsion—Vol. 9.) Pp. xvi + 578. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1955.) 84*s*. net.

THE great advances in aeronautical science have been accompanied by remarkably fast developments in experimental techniques for studying the various aspects of the flow of gases. The first part of this volume, which is the ninth of a series of twelve on high-speed aerodynamics and jet propulsion, deals with methods of measurement of density, pressure, temperature, velocity and state of turbulence. Developments in the usual methods, such as schlieren photography, interferometry, hot-wire anemometry, piezoelectric pressure gauges, temperature measurements from infra-red radiation, and shielded thermocouples, are described. A number of interesting, and sometimes surprising, recent or possible techniques are also examined: these include the use of active nitrogen for following density changes at very low pressure; the use of ultra-violet or X-ray absorption spectra to measure density; determination of velocity from the quenching of glow discharges; study of polarization and wave-length distribution of scattered light for mist condensation problems; the use of light reflected at grazing incidence to determine the thickness of a shock wave; and the determination of the surface temperature of projectiles in flight by coating them with a temperature-sensitive phosphor.

The second part of the book deals with measurements on combustion gases; this is restricted to physical methods, as another volume, on "Combustion Processes", is in preparation. There are chapters dealing with flame photography, temperature measurements, determination of burning velocity, flame spectroscopy, the use of mass spectra, and analysis of the structure of the flame front. Standard methods are again covered, and some new techniques are discussed; these include developments in the spectrum-line reversal method of temperature measurement to give the temperature of complex flames, and the use of line broadening and Doppler shift to give pressure and gas velocity in rocket-motor flames; spectroscopic determination of effective rotational temperature; and the study of the thick reaction zone of flames at very low pressure.

The sections in the part of the book on gas dynamics tend to be rather short and specialized, so that the effect is like a series of articles in a review journal, such as *Reviews of Modern Physics*, rather than a unified book. The combustion section, although limited to physical measurements, consists of longer, more comprehensive articles. Dr. E. F. Fiock's on burning velocities is very clear and includes new results; Dr. F. P. Bundy and Dr. H. M. Strong's is particularly good on the spectroscopic temperature measurements; Dr. W. T. Reid's on flame photography is easy to read but incomplete; Prof. G. H. Dieke gives a good account of developments in photoelectric spectroscopy as applied to flames; and Mr. N. Thomas stresses the value of the new techniques for the detailed understanding of flame structure.

The rapid developments in the many aspects
this field of research made the book necessary. T
inevitable time-lag in publication is probably
sponsible for some omissions; there does not app
to be any mention of quantitative neutral-we
schlieren photography, or of studies of flame struct
from measurements of refractive index made with
inclined slit.

The book comprises twenty-four articles
twenty-two authors. Generally the standard is hi
and these articles, at an advanced level, in which
many developments in techniques are discussed,
welcome. Most of the articles are naturally rat
specialized, so that most people working in some p
of this extensive field will find a few articles
considerable value but also others which cann
easily be read. There is a single collected subje
index for the whole book, but no author-index. T
full references at the end of each article are, of cour
valuable.

A. G. GAYDO

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# MALARIA IN RETROSPECT

### Man's Mastery of Malaria

By Dr. Paul F. Russell. (University of Lond
Heath Clark Lectures 1953.) Pp. xv + 308 + 24 plat
(London: Oxford University Press, 1955.) 25*s*. n

THE sixteen years which have elapsed since t
start of the Second World War have seen gr
developments in the control and treatment of malar
In Ceylon the case-rate per 1,000 living has fal
from 574 in 1940 to 11 in 1953. In Greece the to
deaths from malaria in 1942 were 1,856; in 19
there were only 14 deaths from this disease. In Ita
Sicily and Sardinia malaria has been practica
eradicated. An illuminating commentary on impro
ments in treatment is given by the fact that, wher
in Italy, Sicily and Sardinia approximately 300,
cases resulted in 8,407 deaths in 1919, in 19
approximately 400,000 cases resulted in only
deaths. Since 1948 there have been no malar
deaths in the Italian Republic. Results of this nat
are conducive to a sanguine attitude, and an exp
assessment of the position is therefore to be welcom
Dr. Paul F. Russell devoted his Heath Clark Lectu
to this subject in 1953, and in their published fo
they provide an excellent résumé of the history
the disease and an authoritative discussion of t
results of recent measures.

Malaria has a venerable history. Empedocles
supposed to have delivered the city of Selinus fr
pestilence by diverting two neighbouring streams
that they cleansed the mouth of the river. In Rom
times malaria was associated with marshes, and
the Campagna and elsewhere Roman engine
carried out much drainage. Hippocrates gave exc
lent descriptions of the clinical features of malar
and also commented on the effect of marshes a
stagnant waters in producing enlarged splee
Despite the warnings given by Celsus, Varro, Colu
ella, Galen and other classical authors, the Pont
Marshes were not successfully drained until t
ten-year task which ended in 1940, and success
drainage in Greece is even more recent.

In the case of the malaria parasite there was a
an unconscionable lapse of time between the fi
glimmerings of recognition and the period wh
practical use could be made of the discovery. T
characteristic pigment was seen in spleen and br

otions by Lancisi in 1716 and by Bright in 1831. hey did not associate the pigment with malaria. oth Virchow and Frerichs described the pigmented lls and associated them with malaria. Frerichs and elafield (1872) probably described the parasite—e plasmodium—without recognizing it. In 1880 lphonse Laveran recognized the fact that these dies were living parasites, and as a result of his illiant studies and the work of the Italian investitors, Marchiafava, Celli, Golgi and their colborators, part of the life-history of the vivax and artan parasites was known within the next few ars. Yet in 1886 Osler was definitely sceptical—til he had found the crescent forms for himself. uring all this period there was much speculation on e means whereby the parasite was transferred from infected to an uninfected individual. Mosquitoes d been suspected from ancient times, but Beaurthuy (1854) was probably the first medical writer state that they were vectors. In 1882 King, of ashington, D.C., listed nineteen reasons why osquitoes must be considered responsible, and he as so convinced of his rightness that he recomended that the whole city of Washington should be vested in a closely woven metal screen as high the Washington Monument. Manson's brilliant osquito–malaria hypothesis (1894) is well known; ut it is perhaps not so frequently realized that he issed the fact that the parasite, sucked from man y the mosquito, was later injected directly into nother individual. He thought that the spores of e malaria parasite were liberated by the mosquito to water, which was later drunk by the individual ho became infected. Ross devoted three years of tensive research to the discovery of the malaria orozoites in the salivary gland of a mosquito, and though he worked out fully the life-cycle of the alaria parasite of birds (proteosoma), by ill-luck he as denied the final proof of the man-to-mosquito-man cycle, which was made by Italian workers in 898.

For nearly fifty years after these crucial disoveries there was doubt regarding what actually appened after an infected mosquito bit an uninfected dividual. In 1903 Schaudinn described how the orozoites penetrated the human red-blood coruscles; but no one else had ever seen this phenmenon. It was not until just before the Second orld War that it was discovered in birds that the orozoites developed into pre-erythrocytic forms in e liver, spleen and bone-marrow, and that these rms then developed into unpigmented exoerythrotic forms before they invaded the blood corpuscles. he demonstration of these phenomena in the human bject demanded a healthy individual who was illing to be infected experimentally and then to ave a small portion of his liver removed for histogical examination. In 1948 and 1949 this important emonstration was made for *Plasmodium vivax* and . *falciparum* by Shortt and his colleagues. The cubation period was thus explained, and a better tarting-point was provided for the testing of new herapeutic remedies.

Much has been written on the history of cinchona om its introduction to Europe in 1632. Pelletier nd Caventou discovered quinine and cinchonine, wo of its four basic alkaloids, in 1820, and the other wo, quinidine and cinchonidine, were discovered ithin the next twenty-five years. Although obviously ecifics for malarial attacks, all these substances ave certain disadvantages. Some of these have been obviated by the newer synthetic drugs, such as pamaquine, mepacrine, chloroquine, proguanil and daraprim. Despite the great strides which have been made, the ideal drug for both prophylaxis and treatment has probably still to be synthesized.

In this sphere of prophylaxis, enormous progress has been made by destruction of mosquito larvæ and by preventing bites of adult insects. In the destruction of larvæ, oil was first used by Dunlap in 1793, and paris green was introduced in 1916. The work of Gorgas during the cutting of the Panama Canal was a magnificent example of what could be done by persevering work of this nature. In the campaign against the adult mosquito, DDT was a discovery of the highest practical value.

In these valuable lectures Dr. Russell has presented a very detailed summary of the history of malaria in language which can be understood by anyone who knows the barest elements of protozoology. He avoids the clinical features of the disease and concentrates on the parasite, the mosquito, and the results of prophylaxis and treatment. The word 'summary' is used advisedly. The literature of the subject is enormous, and Dr. Russell's very extensive bibliography is merely a token of what is available. It need scarcely be said that it is very carefully selected. Though Dr. Russell is perhaps not quite at home with the older material, he is a complete master of the modern literature. It is surprising that the Oxford University Press has allowed a number of un-English terms to slip through—such as 'editorialized' and 'sanitating'; after all, the lectures were delivered in one English university and printed at the press of another. It is disconcerting also to find in the text that the title of an article in a journal is italicized as though it were a book—though the conventional practice is always used in the bibliography. Otherwise, the production of the book comes up to the high standard of previous Heath Clark Lectures.

In his preface Dr. Russell specifically explains that the title of his book does not necessarily mean that malaria has been eradicated. There are, indeed, some small clouds on the distant horizon. Although malaria parasites were exposed to cinchona and its alkaloids for three hundred years without showing signs of drug resistance, some strains have now begun to show this property. Further, in some areas these strains have been spreading—for example, *Plasmodium falciparum* in Malaya and *P. vivax* and *P. malariae* in Indonesia. At present this resistance can be overcome by the administration of full doses of proguanil from the outset; but the parasite apparently has the next move. Again, certain species of mosquitoes have become resistant to DDT, so that in Greece and Java this method of prophylaxis is no longer possible. There are many sociologists and demographers who hold that the great advances made in the control of malaria will lead to epidemics of that disease, or alternatively to over-population and famine. In the final part of his book Dr. Russell skates gracefully over this slippery ice without attempting to make much headway. Perhaps he does not intend to, since the legitimate goal of the medical man is yet far distant. Dr. Russell estimates that at the present time 250 million persons suffer attacks of malaria yearly and 2·5 million die of it. In this field there is still sufficient work in hand for the Rockefeller Foundation, of the staff of which Dr. Russell is a distinguished member.

E. Ashworth Underwood

# PROTEIN SYNTHESIS IN ISOLATED CELL NUCLEI

By DR. V. G. ALLFREY and DR. A. E. MIRSKY
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AND
SYOZO OSAWA*
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IN experiments described previously, it was noted that nuclei prepared from the thymocytes of the calf can actively incorporate DL-alanine-1-$^{14}C$ into their proteins when incubated *in vitro*. This activity of the isolated nucleus required that its deoxyribonucleic acid remain intact: the incorporation of amino-acid was seriously impaired by pretreatment of the nucleus with deoxyribonuclease. A partial recovery of deoxyribonuclease-treated nuclei could be observed when a supplement of calf thymus deoxyribonucleic acid was added to the incubation mixture[1].

The present communication is concerned with the further investigation of protein synthesis by the isolated nucleus, with the role of deoxyribonucleic acid (DNA) in this process, and with the capacity of the thymocyte nucleus to meet its energy requirements through the synthesis of high-energy phosphate bonds.

A rapid procedure for the preparation of nuclei from the thymus of the calf has already been described[1,2]. In its essentials, the method involves a controlled homogenization of the tissue in cold 0·25 *M* sucrose solution containing a small amount of calcium chloride. Coarse fibre is removed by filtration through gauze and through flannelette, and the nuclei are separated by fractional centrifugation and thoroughly washed. In the experiments about to be described the nuclei were prepared in 0·25 *M* sucrose containing 0·0020 *M* calcium chloride.

Nuclei so isolated meet a surprising number of the requirements which we consider desirable and necessary before a study of their biochemical attributes is undertaken. First, in overall composition and in enzymic constitution these 'sucrose' nuclei are the equivalent of nuclei prepared from the thymus under non-aqueous isolation conditions, that is, by a modified Behrens' procedure[3,4]. The latter nuclei are selected as a standard of comparison because their purity has been established by chemical, enzymatic and immunological tests, and because only non-aqueous conditions of isolation preclude an exchange of water-soluble materials between nucleus and cytoplasm. A detailed comparison of thymus nuclei isolated in sucrose with those prepared by the Behrens' procedure has shown that nuclei isolated in sucrose have retained their water-soluble enzymes[3]. The deoxyribonucleic acid content is the same (2·5 per cent DNA-P) for nuclei prepared by the two procedures, which indicates that their overall protein content is also the same.

Other evidence concerning the integrity and cleanliness of the 'sucrose' nuclei comes from careful examination of such preparations under the microscope. We have made use of ordinary light, phase-contrast, interference and electron microscopy. The electron microscope is of particular value for discerning and estimating the extent of contamination by intact, small thymocytes. The proportion of su intact cells in nuclear preparations is relatively lo For example, two preparations examined in this w have shown 45 and 77 small thymocytes per thousa nuclei, respectively. Thus the electron microgra support the demonstration by other optical a chemical methods that there is no gross contamination of the nuclei with whole cells or cytoplasm debris[5]. However, it should be noted that caref microscopic examination often reveals small bits strands of cytoplasm adhering to some of the nucl The extent of this contamination cannot be estimat quantitatively under the microscope, but nucleic ac analyses and enzyme measurements make it cle that the level of cytoplasmic contamination lies w below 10 per cent.

When a suspension of nuclei in buffered sucro medium is shaken at 37° C., in the presence DL-alanine-1-$^{14}C$ or glycine-1-$^{14}C$, there is a rap incorporation of the isotope into nuclear protein It should be mentioned that what is actually measur in most of the experiments described is the avera specific activity of the proteins which are precipitat in 5 per cent trichloroacetic acid (TCA). Nucle acids are extracted and removed with hot trichlor acetic acid and lipides are removed by successi treatments with hot alcohol, alcohol–chloroform ether mixtures, ether, and acetone. The remaini protein is homogenized in acetone, collected filter-paper planchets, and the carbon-14 activit measured using a Geiger–Müller tube and scali circuit[1]. More than 94 per cent of the carbon-1 activity of the isolated protein remains after trea ment with 0·25 *N* sodium hydroxide for two hour and more than 89 per cent remains after reactio with ninhydrin.

The time course of a typical incorporation exper ment is given in Fig. 1. It can be seen that after a initial lag period of 10–15 min., $^{14}C$-amino-aci incorporation proceeds linearly up to 90 min. an then begins to taper off. The phenomenon is aerobi The incorporation of $^{14}C$-alanine or $^{14}C$-glycine in a atmosphere of nitrogen is negligible (Table 1). Th uptake is also greatly inhibited by $10^{-3}$ *M* sodiu cyanide and by $10^{-4}$ *M* dinitrophenol. Methylen blue ($2·5 \times 10^{-4}$ *M*) has no effect on amino-aci incorporation. The addition of a supplementa energy source leads to a slight increase in nucle activity. For example, glucose or α-ketoglutara added to the incubation medium raises the level isotope incorporation by 10–20 per cent.

One of the most striking effects on nuclear amin acid incorporation is that produced by sodium ion Nuclei isolated by the procedure described require sodium ion supplement to the medium in order t synthesize protein actively. The effect of varied sodiu concentration on the level of amino-acid uptake shown in Fig. 2. There is a well-defined maximum about 0·068*M*. The specificity of the sodium requir

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* Fellow of the Rockefeller Foundation.

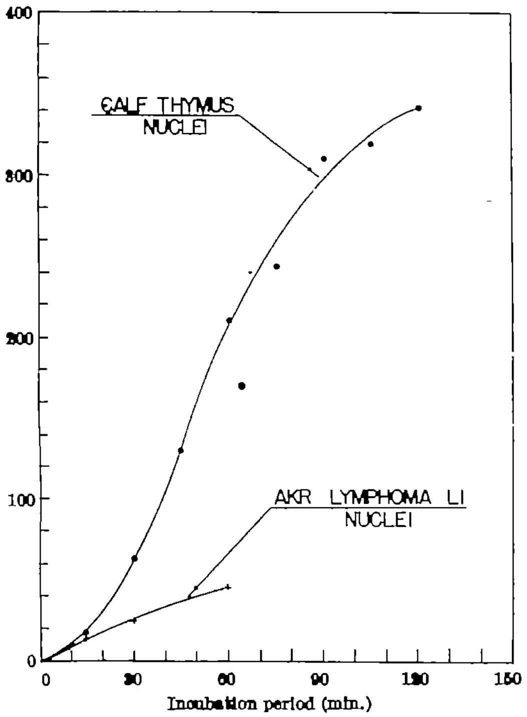


Fig. 1. The time course of incorporation of alanine-1-$^{14}C$ into the proteins of isolated nuclei. The incubation flasks contained 1 ml. of nuclear suspension (100 mgm. (wet weight) of nuclei per ml. of 0·25 *M* sucrose – 0·0020 *M* $CaCl_2$), 0·5 ml. of 0·1 *M* sodium phosphate – 0·25 *M* sucrose buffer at *p*H 7·3, 0·4 ml. of 0·1 *M* glucose containing 6·25 mgm. of NaCl per ml. and 0·1 ml. of DL-alanine-1-$^{14}C$ solution containing 0·5 mgm. = 0·008 mc. per ml. The flasks were shaken in a 37° bath for the indicated periods and the uptake then halted by the addition of an equal volume of 10 per cent trichloracetic acid. The protein was prepared and its carbon-14 activity determined as previously described (ref. 1)

ment is emphasized by a series of experiments summar-ed in Fig. 3. In these tests an attempt was made to ubstitute all or part of the sodium in the incubation medium with an equal amount of potassium. In all ases the total salt concentration was kept constant. t is evident that when all the sodium is replaced by potassium the synthetic activity falls to 15 per cent of the optimal value; increasing the $Na^+/K^+$ ratio results in a corresponding increase in the amount of amino-acid incorporated. The extreme dependence of the synthetic activity of the nucleus upon the sodium ion concentration has made it necessary to control rigorously the sodium-level of the incubation medium. In all the experiments described below supplements of sodium chloride were added to bring the final sodium ion concentration to 0·068 *M*. The relationship between the sodium- and potassium-level in the medium and that within the nucleus is at present being investigated.

able 1. Effect of Anoxia, Cyanide, Dinitrophenol and Added Metabolites upon $^{14}C$-labelled Amino-acid Incorporation by Isolated Calf Thymus Nuclei

| Conditions of experiment | Isotope administered as | Specific activity of nuclear protein (c.p.m./mgm.) |
|---|---|---|
| *A.* Nuclei in $O_2$<br>Nuclei in $N_2$ | glycine-1-$^{14}C$<br>,, | 71<br>14·7 |
| *B.* Nuclei in $O_2$<br>Nuclei in $N_2$ | DL-alanine-1-$^{14}C$<br>,, | 72<br>10·4 |
| *C.* Nuclei without added dinitrophenol<br>Nuclei in 2 × $10^{-4}$ *M* dinitrophenol | DL-alanine-1-$^{14}C$<br>,, | 72<br>11 |
| *D.* Nuclei without added dinitrophenol<br>Nuclei in 1 × $10^{-4}$ *M* dinitrophenol | DL-alanine-1-$^{14}C$<br>,, | 154<br>58 |
| *E.* Nuclei without added cyanide<br>Nuclei in 0·001 *M* sodium cyanide | DL-alanine-1-$^{14}C$<br>,, | 64<br>13 |
| *F.* Nuclei without added metabolite<br>Nuclei + 40 *μM* glucose<br>Nuclei + 40 *μM* α-ketoglutarate | glycine-1-$^{14}C$<br>,,<br>,, | 86<br>99<br>109 |

The synthetic activity of the isolated nucleus can be readily destroyed either by heating, or by freezing and thawing. Nuclei stored at 2° C. gradually lose their ability to incorporate $^{14}C$-amino-acids. The rate of decline in activity with storage varies considerably in different preparations; but in most cases activity is well retained for 4–6 hr. and almost entirely lost after 24 hr. at 2°. Nuclei prepared in hypertonic sucrose solutions (for example, 1 *M*) are inactive. Nuclei prepared in 0·25 *M* sucrose and afterwards placed in 1 *M* sucrose solution also lose their activity.

## Nature of the Incorporation Process

There are several experiments now to be described which make it clear that the uptake of labelled amino-acids into nuclear proteins represents protein synthesis and is not simply a random or non-specific exchange reaction.

The first of these experiments is the demonstration that only the L-enantiomorph of the administered DL-alanine-1-$^{14}C$ is incorporated into nuclear protein. The ability of the nucleus to distinguish between

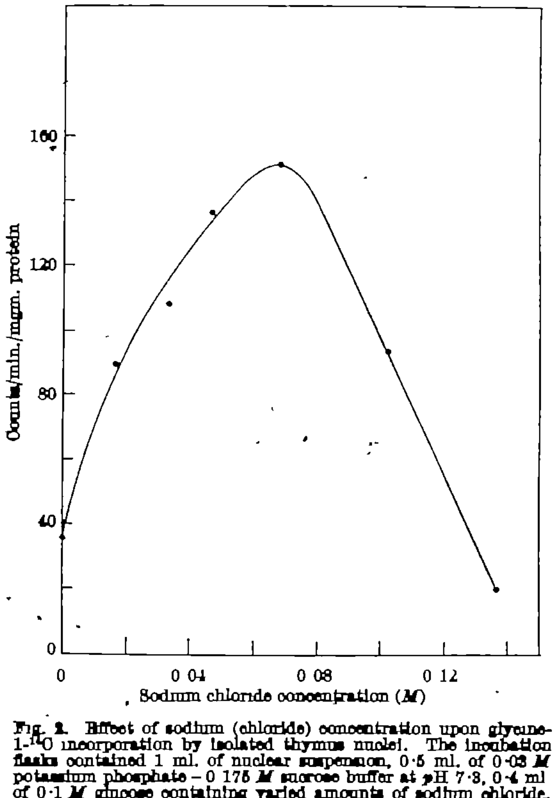


Fig. 2. Effect of sodium (chloride) concentration upon glycine-1-$^{14}C$ incorporation by isolated thymus nuclei. The incubation flasks contained 1 ml. of nuclear suspension, 0·5 ml. of 0·03 *M* potassium phosphate – 0·175 *M* sucrose buffer at *p*H 7·3, 0·4 ml of 0·1 *M* glucose containing varied amounts of sodium chloride, and 0·1 ml. of glycine-1-$^{14}C$ solution containing 1·0 mgm. = 0·018 mc. per ml. The incubation period was 60 min.

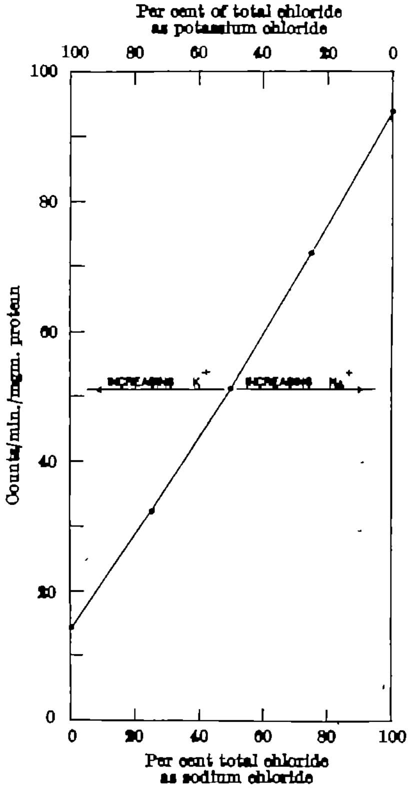


Fig. 3. Effect of varying sodium : potassium ratio upon glycine-1-$^{14}$C incorporation by isolated thymus nuclei. The incubation flasks contained 1 ml. of nuclear suspension, 0 5 ml of 0 03 *M* potassium phosphate – 0·175 *M* sucrose buffer at *p*H 7·3, 0·4 ml. of 0 1 *M* glucose containing 0 187 m*M* of total chlorides, the ratio of sodium to potassium being varied as indicated in the chart, and 0·1 ml. of glycine-1-$^{14}$C solution containing 1·0 mgm. = 0·018 mc. per ml. The incubation period was 60 min.

D and L forms of the amino-acid is readily indicated by the experiments summarized in Fig. 4. In these tests increasing amounts of unlabelled D-alanine or unlabelled L-alanine were added to the incubation medium together with the DL-alanine-1-$^{14}$C. If both the D and the L forms of the $^{14}$C-alanine were utilized by the nucleus then both unlabelled isomers should compete with isotopic molecules for acceptance by the nucleus, and the carbon-14 activity of the nuclear protein should be correspondingly lowered. Actually, the addition of unlabelled D-alanine has no such effect; only the L-isomer competes for incorporation. It follows, therefore, that only the L-form of the $^{14}$C-alanine administered is utilized for protein synthesis by the nucleus.

A second experiment was designed to test whether the incorporated amino-acid is in constant exchange with other amino-acid molecules in the medium. If the uptake of amino-acids is indeed reversible then $^{14}$C-alanine once incorporated into nuclear proteins should be exchanged with unlabelled L-alanine added to the medium after incorporation has occurred. This was tested in the experiments summarized in Fig. 5. Incorporation of $^{14}$C-alanine was allowed to proceed for 45 min. At that time a large excess of unlabelled L-alanine was added to the incubation medium. In 'control' experiments an equal amount of unlabelled D-alanine was added. Samples of the nuclei were removed at 15-min. intervals and the carbon-14 activity of the nuclear protein measured in the usual way. It is evident from the curves that adding an eightfold excess of unlabelled D-alanine has no effi on the normal time course of carbon-14 incorporatio The addition of unlabelled L-alanine acts to suppr further incorporation of alanine-$^{14}$C, as could ha been predicted from the previous experiment; b the specific activity of the nuclear protein contin to rise. It follows that $^{14}$C-alanine once incorporat into protein is not constantly being replaced unlabelled alanine in the medium. Similar expe ments have been performed using a 200-fold exc of unlabelled L-alanine. No exchange was noted to 180 min. after addition of the unlabelled amin acid, although 'control' experiments showed that t nuclei were still actively incorporating $^{14}$C-alani over the entire period. Thus the incorporation labelled amino-acids represents a synthetic rath than an exchange reaction.

## Role of Deoxyribonucleic Acid in Protein Synthesis

The notion originally suggested by Brachet[6] a Caspersson[7] that ribonucleic acids play a part in pr tein synthesis is now widely accepted as demonstrate The most direct evidence in its favour comes fro the work of Gale and Folkes on protein synthes in bacterial cell residues[8], and from studies amino-acid incorporation by a ribonucleoprote complex of the liver[9]. In both cases ribonuclea acts to suppress amino-acid incorporation.

The isolated cell nucleus affords a unique oppo tunity to test the role of the deoxyribonucleic acids the process of protein synthesis, and the results ha a special interest because they ultimately bear the mode of action of the gene, and on the chemic relationships between the nucleus and the cytoplas

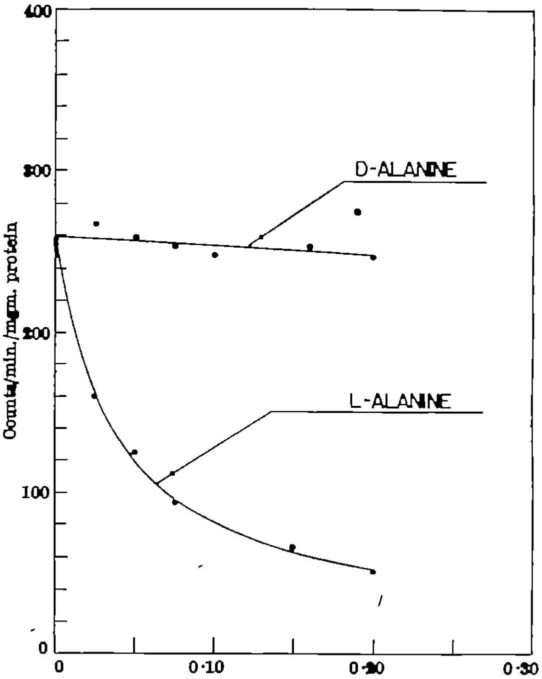
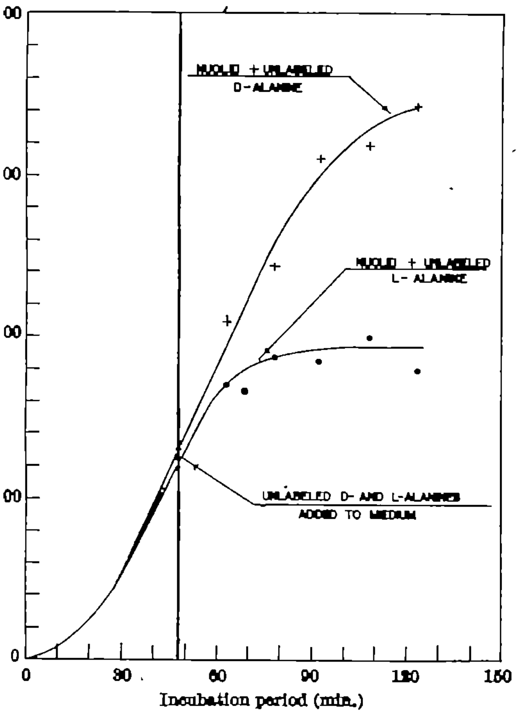


Fig. 4. The effect of unlabelled D- and L-alanines upon incorporation of DL-alanine-1-$^{14}$C by isolated thymus nuclei. The incubation vessels contained 1 ml. of nuclear suspension, 0·6 ml. of 0·1 *M* sodium phosphate – 0·25 *M* sucrose buffer (*p*H 7·3) containing varied amounts of either D- or L-alanine, as indicated in the chart, 0·4 ml. of 0·1 *M* glucose containing 6·25 mgm. NaCl per ml. and 0·1 ml. of DL-alanine-1-$^{14}$C solution containing 0·5 mgm. = 0·008 mc. per ml. The incubation period was 60 min.



ig. 5. The retention of incorporated alanine-1-$^{14}C$ following ddition of a large excess of unlabelled D- or L-alanine after ptake has occurred. The incubation vessels contained 1 ml. of uclear suspension, 0·5 ml. of 0·1 *M* sodium phosphate – 0·25 *M* ucrose buffer at pH 7·3, 0·4 ml. of 0·1 *M* glucose containing ·25 mgm. NaCl per ml. and 0·1 ml. of DL-alanine-1-$^{14}C$ solution ontaining 0·5 mgm. = 0·008 mc. per ml. The latter solution upplies 0·025 mgm. of labelled L-alanine. Samples were ncubated for 45 min., at which time 0·2 mgm. of unlabelled - or L-alanine was added. Samples were then withdrawn at 5-min. intervals, and the activity of the nuclear proteins determined in the usual way

A number of experiments which relate deoxyribo- cleic acid to the process of protein synthesis in the cleus will now be described. Several of these periments deal with the effect of deoxyribonuclease the uptake of labelled amino-acids. When isolated lei are treated with crystalline pancreatic deoxy- onuclease before adding $^{14}C$-amino-acids, the incorporation of the latter is markedly impaired. The results in Table 2 show that the degree of impairment becomes more serious as more and more of the deoxyribonucleic acid is degraded. Removal of practically all the deoxyribonucleic acid leaves only 15 per cent of the activity observed in appropriate 'controls'. These findings suggest a direct role of deoxyribonucleic acid in nuclear protein synthesis.

Additional support for this conclusion arises from experiments which test whether the synthetic activity of nuclei treated with deoxyribonuclease can be restored by the addition of supplementary calf thymus deoxyribonucleic acid. In these experiments the nuclei were treated with deoxyribonuclease under the conditions summarized in Table 3. The activity of the enzyme was then blocked by the addition of citrate, and a deoxyribonucleic acid supplement was added. The isotopic amino-acid was then supplied, and incorporation allowed to proceed for 60 min. The specific activity of the protein in nuclei which had received a deoxyribonucleic acid supplement was then compared with the protein activities in 'control' nuclei which had been treated with the enzyme in the same way but which had not received any additional deoxyribonucleic acid. The results of such experiments all agree in demonstrating that added calf thymus deoxyribonucleic acid does in fact restore a part of the original activity of the nucleus.

It is a matter of considerable interest to determine whether nucleic acids other than calf thymus deoxyribonucleic acid can restore the synthetic capacity of deoxyribonuclease-treated thymus nuclei. Several such experiments are now in progress, and it has been very tentatively concluded that the thymus nucleus can distinguish between thymus deoxyribonucleic acid and that prepared from wheat germ.

Since deoxyribonucleic acid is required for nuclear protein synthesis, the question naturally arises as to how the deoxyribonucleic acid participates in amino-acid incorporation. Several experiments were performed to test whether the action of deoxyribonucleic acid requires the active participation of its free phosphate groups. The results of these experiments are summarized in Table 4. The procedure used was to add varying amounts of basic compounds which are known to combine with the free phosphoric acid

Table 2. EFFECT OF DEOXYRIBONUCLEASE AND RIBONUCLEASE ON $^{14}C$-AMINO-ACID INCORPORATION BY THYMUS NUCLEI

| Conditions of experiment* | Isotope administered as | Nucleic acid removed (per cent) | Specific activity of protein (c.p.m./mgm.) | Decrease in $^{14}C$ incorporation (per cent) |
|---|---|---|---|---|
| 1. Nuclei preincubated with 0·13 mgm. DNase for 15 min. before adding isotopic amino-acid<br>'Control' nuclei (preincubated without DNase) | glycine-1-$^{14}C$<br>" | 47<br>— | 144<br>205 | 30<br>— |
| 3. Nuclei preincubated with 1·0 mgm. DNase for 15 min.<br>'Control' nuclei | glycine-1-$^{14}C$<br>" | 81<br>— | 33<br>84 | 61<br>— |
| 7. Nuclei preincubated with 0·5 mgm. DNase for 30 min.<br>'Control' nuclei | DL-alanine-1-$^{14}C$<br>" | 91<br>— | 62<br>183 | 66<br>— |
| ). Nuclei preincubated with 0·5 mgm. DNase for 30 min.<br>'Control' nuclei | DL-alanine-1-$^{14}C$<br>" | >95<br>— | 2·3<br>15·3 | 85<br>— |
| 7. Nuclei preincubated with 0·1 mgm. DNase for 30 min.<br>'Control' nuclei | DL-alanine-1-$^{14}C$<br>" | —<br>— | 54<br>92 | 41<br>— |
| '. Nuclei preincubated with 0·3 mgm. DNase for 15 min.<br>'Control' nuclei | DL-alanine-1-$^{14}C$<br>" | —<br>— | 51<br>109 | 54<br>— |
| '. Nuclei preincubated with 0·125 mgm. RNase for 15 min.<br>'Control' nuclei | glycine-1-$^{14}C$<br>" | 34<br>— | 199<br>205 | 3<br>— |

* In all experiments the incubation flasks contained 1·0 ml. of nuclear suspension, 0·5 ml. of 0·1 *M* sodium phosphate – 0·25 *M* sucrose r (pH 7·3) and 0·4 ml. of 0·1 *M* glucose containing 6·25 mgm. NaCl and 4·10 mgm. $MgCl_2.4H_2O$ per ml. One-tenth ml. of nuclease solution ining the indicated amount of enzyme was then added and incubation allowed to proceed for the indicated time. The isotopic amino-acid mgm.) was then added and incubation continued for 60 min. 'Control' experiments were performed in the same way without adding DNase.

Table 3 EFFECT OF SUPPLEMENTARY CALF THYMUS DNA on $^{14}$C-ALANINE UPTAKE BY DNASE-TREATED NUCLEI

| Conditions of experiment* | Calf thymus DNA added (mgm.) | Specific activity of nuclear proteins (c.p.m./mgm.) | Increase in uptake due to added DNA (per cent) |
|---|---|---|---|
| *A.* 'Control' nuclei (preincubated without DNase) | 0 | 183 | — |
| ,, ,, ,, ,, ,, | 2 | 181 | 0 |
| ,, ,, ,, ,, ,, | 4 | 183 | 0 |
| Nuclei treated with 0·5 mgm. DNase for 30 min. before adding $^{14}$C-alanine + citrate | 0 | 62 | — |
| ,, ,, ,, ,, ,, ,, ,, ,, | 2 | 71 | 15 |
| ,, ,, ,, ,, ,, ,, ,, ,, | 4 | 81 | 31 |
| *B.* 'Control' nuclei (preincubated without DNase) | 0 | 92 | — |
| Nuclei treated with 0·1 mgm. DNase for 30 min. before adding $^{14}$C-alanine + citrate | 0 | 54 | — |
| ,, ,, ,, ,, ,, ,, ,, ,, | 10 | 80 | 48 |
| *C.* 'Control' nuclei (preincubated without DNase) | 0 | 166 | — |
| Nuclei treated with 0·1 mgm. DNase for 40 min. before adding $^{14}$C-alanine + citrate | 0 | 74 | — |
| ,, ,, ,, ,, ,, ,, ,, ,, | 10 | 101 | 36 |
| *D.* 'Control' nuclei (preincubated without DNase) | 0 | 15 | — |
| ,, ,, ,, ,, ,, | 10 | 13 | — |
| Nuclei treated with 0·5 mgm. DNase for 30 min. before adding $^{14}$C-alanine + citrate | 0 | 2·3 | — |
| ,, ,, ,, ,, ,, ,, ,, | 10 | 4·8 | 108 |

* In these experiments the incubation flasks contained 1·0 ml. of nuclear suspension, 0·5 ml. of 0·1 *M* sodium phosphate – 0·25 *M* suc buffer (pH 7·3) and 0·4 ml. of 0·1 *M* glucose containing 8·16 mgm. NaCl and 4·19 mgm. $MgCl_2.4H_2O$ per ml. 0·1 ml. of DNase solut containing the indicated amount of enzyme was then added and incubation allowed to proceed for the indicated time. Then 1 ml. of D solution containing the indicated amounts of calf thymus DNA and 20 *μM* of sodium citrate was added, followed by 0·1 ml. (= 0·05 mg of DL-alanine-1-$^{14}$C solution. Incubation was continued for 60 min. 'Control' experiments were performed in the same way without adding DN

groups of deoxyribonucleic acid. The compounds selected included the basic dye, methyl green, and two basic proteins, protamine, and a lysine-rich histone prepared from calf thymus[10]. It is clear that the addition of small amounts of methyl green, protamine or histone to the nuclei before adding the isotopic amino-acid has little effect upon the uptake. Larger amounts lead to a partial impairment of carbon-14 incorporation; but the impairment may reflect osmotic or other damage to the system, since large amounts of added serum albumin also decrease the uptake.

A few other observations are included in Table The first deals with the effect of chloramphenic which has been shown to block protein synthesis bacterial systems[11]. This compound had little eff on amino-acid incorporation by isolated thym nuclei. A second observation is concerned with t effect of added cortisone, which has been shown cause involution of the thymus *in vivo*[12]. The additi of this steroid diminishes amino-acid uptake by t isolated nuclei.

Since deoxyribonucleic acid is required for prot synthesis in the nucleus, and ribonucleic acid is need

Table 4 EFFECTS OF BASIC SUBSTANCES, CORTISONE AND CHLORAMPHENICOL ON $^{14}$C-AMINO-ACID INCORPORATION BY ISOLATED THYMUS NU

| Conditions of experiment | Isotope administered as | Specific activity of protein (c.p.m./mgm.) | Change in $^{14}$C uptake due to added compound (per cent) |
|---|---|---|---|
| *A.* 'Control' nuclei | DL-alanine-1-$^{14}$C | 154 | — |
| Nuclei + 0·125 mgm. methyl green | ,, | 167 | + 8 |
| ,, + 0·25 ,, ,, ,, | ,, | 162 | + 5 |
| ,, + 0·50 ,, ,, ,, | ,, | 116 | −25 |
| *B.* 'Control' nuclei | glycine-1-$^{14}$C | 205 | — |
| Nuclei + 0·25 mgm. methyl green | ,, | 251 | +22 |
| *C.* 'Control' nuclei | glycine-1-$^{14}$C | 89 | — |
| Nuclei + 0·50 mgm. methyl green | ,, | 64 | −28 |
| *D.* 'Control' nuclei | DL-alanine-1-$^{14}$C | 154 | — |
| Nuclei + 0·375 mgm. protamine | ,, | 168 | + 9 |
| ,, + 0·75 ,, ,, | ,, | 159 | + 3 |
| ,, + 1·50 ,, ,, | ,, | 164 | + 6 |
| *E.* 'Control' nuclei | glycine-1-$^{14}$C | 79 | — |
| Nuclei + 1·5 mgm. protamine | ,, | 70 | −11 |
| ,, + 3·0 ,, ,, | ,, | 31 | −61 |
| ,, + 1·5 mgm. histone (lysine-rich) | ,, | 76 | − 4 |
| ,, + 3·0 ,, ,, ,, ,, | ,, | 62 | −21 |
| ,, + 2·63 ,, arginine | ,, | 63 | −20 |
| ,, + 3·0 ,, bovine serum albumin | ,, | 66 | −16 |
| *F.* 'Control' nuclei | glycine-1-$^{14}$C | 75 | — |
| Nuclei + 0·5 mgm. protamine | ,, | 73 | − 3 |
| ,, + 1·0 ,, ,, | ,, | 70 | − 7 |
| ,, + 2·0 ,, ,, | ,, | 45 | −40 |
| ,, + 1·75 ,, arginine | ,, | 62 | −17 |
| ,, + 2·0 ,, bovine serum albumin | ,, | 62 | −17 |
| *G.* 'Control' nuclei | glycine-1-$^{14}$C | 21 | — |
| Nuclei + 0·1 mgm. chloramphenicol | ,, | 19 | −10 |
| *H.* 'Control' nuclei | DL-alanine-1-$^{14}$C | 217 | — |
| Nuclei + 0·063 mgm. cortisone | ,, | 138 | −36 |
| ,, + 0·125 ,, ,, | ,, | 122 | −54 |

r protein synthesis in the cytoplasm, the question turally arises as to the role of ribonucleic acid within e nucleus. Attempts to relate the ribonucleic acid the thymus nucleus to nuclear protein synthesis ve not so far been successful. Treatment of the lated nuclei with ribonuclease before adding $^{14}$C-nino-acids has no effect on the uptake of the latter. owever, this result does not permit the conclusion at ribonucleic acid has no part in nuclear protein nthesis, because in the experiments mentioned only per cent of the nuclear ribonucleic acid was released the action of the enzyme.

One difficulty which should be mentioned in this nnexion is the problem of nuclear variability. uclei prepared from different thymus glands at fferent times of the year may vary considerably their properties. One way in which they vary is their susceptibility to ribonuclease. Several eparations (made during the winter months) re-ased all their ribonucleic acid when treated with e enzyme, whereas nuclei prepared more recently ere relatively resistant. The nuclear variability is ident in other properties as well: in osmotic operties, as evidenced by the tendency to form gels, d in the ability to retain the complement of acid-luble nucleotides.

*Which nuclear proteins become labelled?* The answer this question depends at the outset upon the istence of a dependable and meaningful scheme of actionating the proteins of the nucleus. This is a eld of endeavour which is now in its earliest stages development, though it promises to become a ajor topic of biochemical investigation.

We have developed a provisional fractionation ocedure which is applicable to the proteins of ymus 'sucrose' nuclei, and which permits the paration of several classes of proteins of different operties, and considerable biological interest. In s essentials the procedure is as follows. (See flow-eet in Fig. 6.) The nuclei are first extracted with H 7·1 potassium phosphate buffer. The extractable otein (Fraction 1) is about 10 per cent of the hole nuclear mass and contains about one-third of e ribonucleic acid of the nucleus. The nuclei are en suspended in 1 *M* sodium chloride, in which they swell and largely dissolve. The opalescent solution is centrifuged at 26,000 *g* to sediment the undissolved protein. This residue (Fraction II) also comprises about 10 per cent of the nuclear mass and contains one-third of the total ribonucleic acid. The supernatant after high-speed centrifugation contains the bulk of the protein of the nucleus and all the deoxyribonucleic acid. This solution is saturated with sodium chloride and brought to *p*H 10·9. The resulting precipitate is treated with acetate buffer at *p*H 4·1 to extract a histone fraction (Fraction III), leaving a gelatinous protein residue (Fraction IV). This gelatinous protein constitutes about 8 per cent of the nuclear mass. Its amino-acid composition and other properties show that it is not a histone. After removing the salt from the saturated sodium chloride supernatant, arginine-rich and lysine-rich histones[14] are removed in dilute acid. The residue contains all the deoxyribonucleic acid of the nucleus and a firmly attached protein fraction (Fraction V) the amino-acid composition of which shows that it is not a histone.

ACTIONATION OF THE PROTEINS OF ISOLATED CALF THYMUS NUCLEI

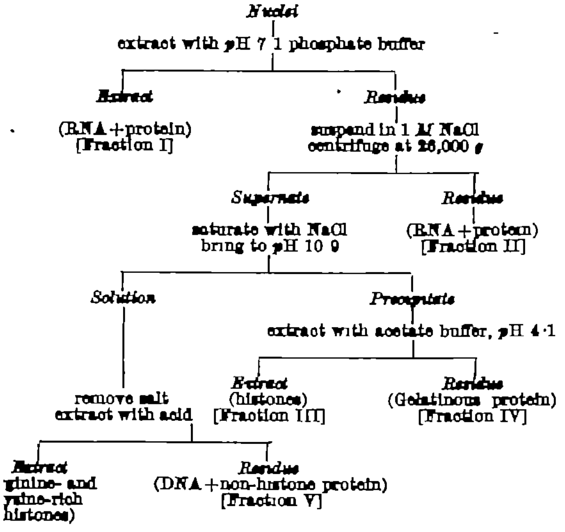


Fig. 6. Flow-sheet for the fractionation of the proteins of calf thymus 'sucrose' nuclei

Table 5. ALANINE-1-$^{14}$C INCORPORATION INTO DIFFERENT PROTEIN FRACTIONS OF THYMUS NUCLEI

| Protein fraction | Specific activity (c.p.m./mgm.) |
|---|---|
| Total nuclear protein | 107 |
| Fraction I (protein soluble in *p*H 7·1 buffer) | 179 |
| Fraction II (residue after extraction in *M* sodium chloride) | 117 |
| Fraction III (histones) | 36 |
| Fraction IV (gelatinous protein) | 157 |
| Fraction V (non-histone protein associated with DNA) | 243 |

When nuclei are incubated in the presence of $^{14}$C-alanine and afterwards fractionated according to the above scheme, wide variations in specific activity are observed in the different protein fractions. (It should be mentioned that the total alanine contents of the protein fractions are very similar, so that differences in carbon-14 concentration reflect differences in the metabolic activity of the various proteins.) The results of such an experiment are presented in Table 5. Several of the findings are of particular interest. First is the observation that the protein (Fraction V) which is most closely associated with the deoxyribonucleic acid is by far the most 'active' protein of the nucleus. This result lends further support to the conclusion drawn from deoxyribonuclease experiments that the deoxyribonucleic acid plays a direct part in protein synthesis. A second point of interest is the fact that the level of isotope incorporation into the histone protein (Fraction III) is relatively low. This result agrees with earlier *in vivo* experiments[15] in which it was noted that the incorporation of glycine-$^{15}$N into the histones of mouse liver, pancreas and kidney is much lower than the uptake into the residual proteins of the chromosome. Finally, it may be noted that the ribonucleoprotein complex which is extracted in *p*H 7·1 phosphate buffer has a high level of activity. It is tempting to speculate that this high activity in a protein fraction of the nucleus which is diffusible indicates a role of this protein in the mechanism by which the nucleus interacts with the cytoplasm.

Since a protein component of ribonucleoprotein can be synthesized in the isolated nucleus the question arises as to whether the isolated nucleus can also synthesize ribonucleic acid, and whether the ribonucleic acids in different fractions are synthesized at different rates. (It has already been reported that pig kidney nuclei isolated in sucrose can incorporate $^{32}$P-orthophosphate into their ribonucleic acid[14].) The ability of thymus and lymphoma nuclei to utilize glycine-$^{14}$C for ribonucleic acid synthesis, and the role of deoxyribonucleic acid in this process are currently being investigated. Preliminary experiments show that $^{14}$C-glycine is actively incorporated into the purines of the nucleic acids of isolated thymus nuclei.

## Energy-yielding Mechanisms in Isolated Nuclei

As considerable energy should be required for the active synthesis of protein in the nucleus, one would expect nuclei to contain an energy generating system, possibly involving energy-rich compounds such as adenosine triphosphate and related nucleotides. It has already been pointed out that the incorporation of $^{14}$C-amino-acids is an aerobic phenomenon, inhibited by both cyanide and dinitrophenol.

To determine the overall concentration and distribution of the nucleotides in thymus nuclei, analyses were first performed on the 'standard', that is, nuclei prepared in non-aqueous media by the Behrens' procedure. The cold acid extract of Behrens' type nuclei was fractionated by ion-exchange chromatography[15], and it was found that these nuclei contain mononucleotides of adenine, cytosine, uracil and guanine, together with several uridine diphosphate derivatives, the adenine nucleotides predominating in amount. The nucleotide analyses of the Behrens' type nuclei are in close agreement both quantitatively and qualitatively with similar analyses performed on whole tissue, indicating that in this respect at least no gross differences exist between nucleus and cytoplasm (Table 6).

When similar analyses are performed on thymus nuclei isolated in sucrose solutions it is found that they retain 60–80 per cent of their original acid-soluble nucleotide content. These nucleotides are well retained after repeated washings with cold sucrose – calcium chloride solution. From the analyses of the nucleotides found in thymus nuclei, a surprising observation came to light. During tl preparation of 'sucrose' nuclei in the cold, tl nucleotide monophosphates characteristic of tl excised tissue are largely converted back to tl energy-rich triphosphate forms which predomina in the living tissue. This synthesis of high-ener phosphate bonds is presumably the result of extensi aeration of the nuclear suspension during the isolati procedure.

Table 6. ADENINE NUCLEOTIDE CONTENTS OF ISOLATED CALF THYMUS NUCLEI

| Material analysed | Per cent of total $E_{260}$ present as AMP | ADP | ATP |
|---|---|---|---|
| *A.* Nuclei prepared by Behrens' method*<br>Whole thymus tissue* | 19·0<br>20·6 | 4·5<br>5·7 | 2·2<br>2·4 |
| *B.* Nuclei prepared in 0·25 *M* sucrose (isolation requiring 45 min.) | 9·3 | 7·7 | 14·0 |
| *C.* 'Sucrose' nuclei after rapid isolation (25 min. at 2° C.)<br>Above nuclei stirred gently at 2° for 60 min. after isolation | 19·0<br>3·5 | 10·5<br>5·7 | 7·6<br>24·5 |
| *D.* 'Sucrose' nuclei prepared in $10^{-4}$ *M* sodium cyanide<br>'Control' nuclei prepared without cyanide | 21·5<br>8·5 | 4·9<br>6·3 | 2·5<br>19·1 |
| *E.* 'Sucrose' nuclei prepared in $2 \times 10^{-4}$ *M* dinitrophenol<br>'Control' nuclei prepared without DNP | 20·1<br>8·6 | 8·0<br>5·6 | < 1·1<br>15·0 |

* The predominance of nucleotide monophosphate in thymus tissue and in thymus nuclei prepared by the Behrens' procedure should not be taken to indicate the actual conditions *in vivo*. It is probable that the predominance of these low-energy forms is simply a reflexion of anoxia resulting from the death of the animal. Evidence to support this conclusion stems from the nucleotide analyses of rat thymus which was frozen in liquid nitrogen immediately upon removal. In this instance the nucleotide triphosphates predominate over di- and mono-phosphates.

To test whether the synthesis of compounds lil adenosine triphosphate is an intranuclear phenomeno or whether it requires the participation of the cyt plasm, the following experiment was performe Nuclei were isolated as quickly as possible (25 mi at 2° C.). At this time, most nucleotides are st present as monophosphates (see Table 6). Tl isolated nuclei were then stirred gently in the co for an additional 60 min. At the end of the expe ment almost all the nucleotides had been convert to the triphosphate form. Since the conversion tak place in isolated nuclei, and occurs regardless of tl volume in which the nuclei are suspended, it appea that this is an intranuclear synthesis of high-ener phosphate. Only intranuclear adenosine monoph phate seems to be involved because added adenosi monophosphate is not acted upon. The results Table 6 also make it clear that the process is complete inhibited in the presence of $10^{-3}$ *M* sodium cyani or $2 \times 10^{-4}$ *M* dinitrophenol. However, it should l noted that certain reagents which block oxidati phosphorylation in mitochondria, namely, jan green *B* ($2 \times 10^{-4}$ *M*), methylene blue ($2{\cdot}5 \times 10^{-4}$ *M* and dicumarol ($10^{-4}$ *M*), have no effect on tl synthesis of adenosine triphosphate by isolat thymus nuclei. Synthesis of adenosine triphospha does not occur in the absence of oxygen. Tak together, the results indicate that nuclei are equipp with energy-generating systems which presumab operate via some type of oxidative mechanism. T relationship of this to the mitochondrial system being considered.

## Amino-Acid Incorporation by Lymphoma Cell Nuclei

The procedures described for the study of prote synthesis in isolated thymus nuclei have recent been extended to include another test syste Nuclei have been prepared from the cells of a tra plantable mouse lymphoma [*AKR* lymphoma *L* (This material was very generously given to us l Dr. John G. Kidd, of Cornell University Medic College.) The time-course of incorporation of $^{14}$ alanine by the lymphoma nuclei is included in Fig.

In summary, nuclei prepared from calf thymus a sucrose medium actively incorporate $^{14}$C-labell amino-acids. It has been shown that this is a sy thetic reaction which requires the participation the deoxyribonucleic acid of the nucleus. Therefo a biochemical function of deoxyribonucleic acid the synthesis of protein in the chromosome. The fr phosphate groups of the deoxyribonucleic acid do n seem to be involved in the process. When the protei of the nucleus are fractionated and then classifi according to their specific activities, one finds t histones to be relatively inert. The protein fracti most closely associated with the deoxyribonucle acid has the highest activity. A diffusible rib nucleoprotein complex is also active. Together wi earlier observations on the incorporation of ami acids by cytoplasmic particulates, these results sh at protein synthesis can occur in both nucleus and toplasm. It also follows that the nucleus can meet e energy requirements of protein synthesis. In this nnexion it has been found that the isolated thymus ıcleus is endowed with systems which generate gh-energy phosphate bonds. [July 26

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# THE VENEZUELAN INSTITUTE FOR NEUROLOGY AND BRAIN RESEARCH

By DR. GEOFFREY H. BOURNE

London Hospital Medical College

ITUATED in the beautiful mountains surrounding Caracas, the capital of Venezuela, and only 12 km. vay from the centre of the city, is an Institute hich represents the first stage of a great scheme for urological research.

On January 1, 1955, the 5,000-ft. mountain on hich this Institute has been placed was virgin rritory; since then, the prodigious efforts of Dr. umberto Fernandez-Moran have resulted in the ıttening of the top of the mountain, the building an 800-kW. electric power station with specially ntrolled voltage, a water-supply system which cludes an artificial lake of some 6 million litres pacity, and what is described as the 'Pilot' unit of e Institute, together with residences for the staff. n December 2 this first section of the new Institute as being opened by the President of Venezuela, eneral Marcos Perez Jimenez, less than a year from the arrival of the first bulldozer on the mountain top.

This first stage of the plan has already cost three million dollars, but much more will be spent before the entire project is completed. This first part contains laboratories for research into nerve ultrastructure, neurophysiology, biophysics, biochemistry and biomathematics. In addition, there are a large library, several workshops and ten residential units for scientific personnel and assistants. A guest house for visitors from abroad is also incorporated into the design. Further development of the Institute envisages a large building for the Neurotropic Virus Research Unit, a large radiation laboratory which will be equipped with a nuclear reactor for medical research, and further buildings for biochemistry, biomathematics and experimental neuropharmacology. It is proposed ultimately to have a hospital of two

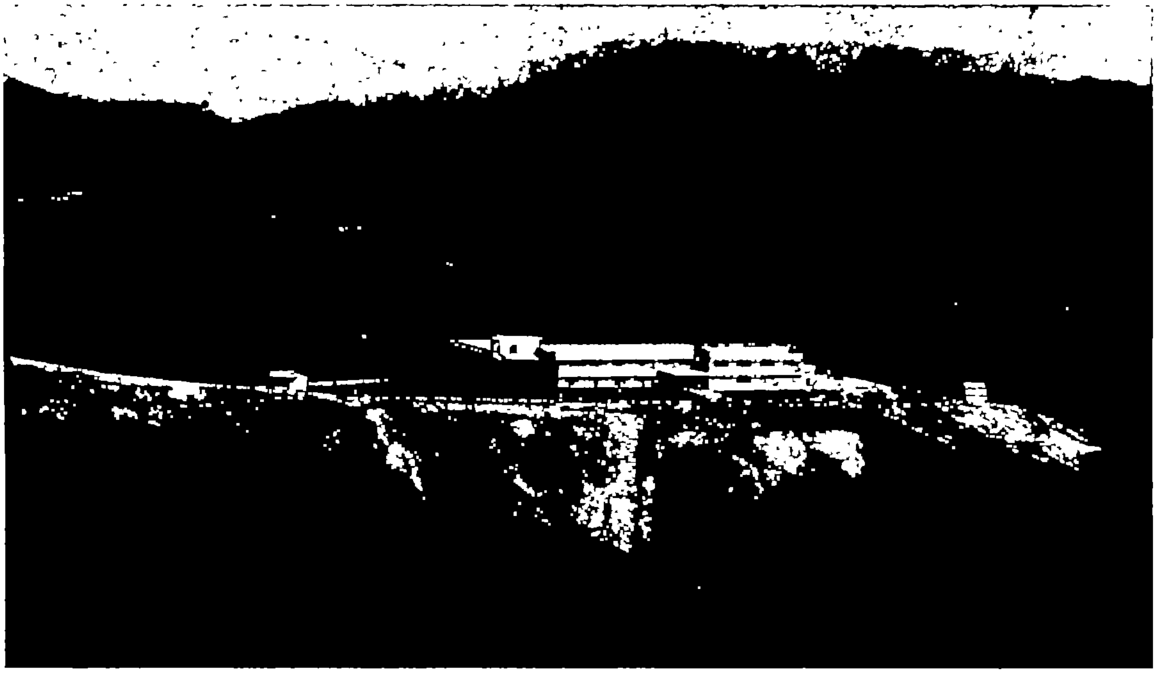

Fig. 1. The Venezuelan Institute for Neurology and Brain Research

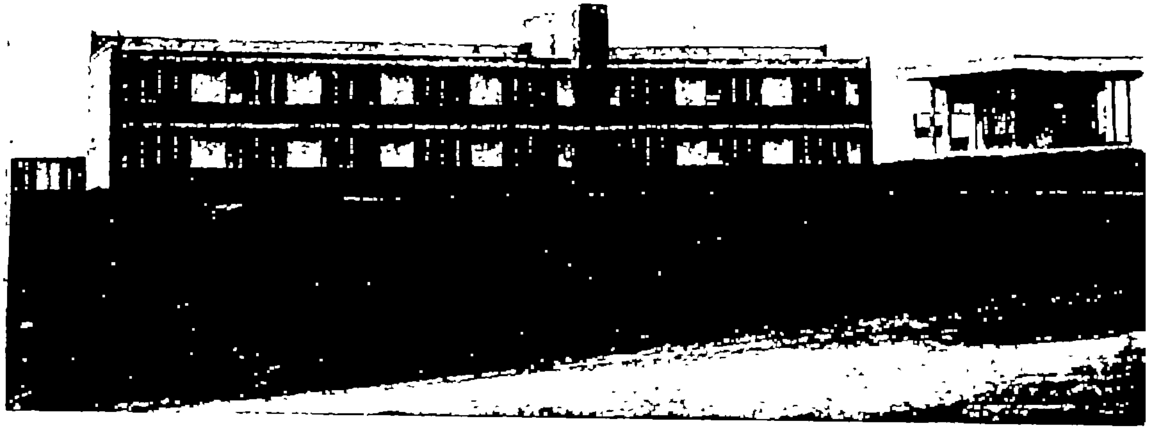

Fig. 2. First building of IVNIC (Venezuelan Institute for Neurology and Brain Research) containing: (1) Department of Nerve Ultrastructure (equipped with three electron microscopes); (2) Department of Neurophysiology; (3) Neurotropic Virus Research Unit; (4) Department for Nuclear Magnetic Resonance Studies; (5) Department of Biophysics; (6) Department of Biomathematics

hundred beds similar to the Research Hospital at the National Institutes of Health in Bethesda, U.S.A. In fact, the Institute was founded last year (April 29, 1954) by decree of the President of Venezuela as an autonomous government agency similar in status to the National Institutes of Health, and in many respects to the National Institute for Medical Research in Great Britain.

The object of the Institute goes beyond being simply a national institution; it is hoped that it will become a regional research centre in neurology in South America and eventually an international research and training centre in this field. In many respects it is strategically situated for this purpose, being only seven to eight hours away by aeroplane from New York and fifteen to eighteen hours away from Britain and Western Europe. Close contact with the United States has already been established by the signature on June 14 last of an agreement between the two countries under the terms of which the United States will furnish Venezuela and the Institute with certain radioactive materials and will supply information on the design, construction, operation and use of nuclear reactors for research. The U.S. Atomic Energy Commission, under the terms of this agreement, has also agreed to lease the Venezuelan Government up to 6 kgm. of contained uranium-235 in uranium enriched up to a maximum of 20 per cent uranium-235.

The proposed international character of the Institute has been emphasized by the first staff appointments: Dr. Gunnar Svaetichin, of the Karolinska Institute in Sweden, has already arrived in Caracas to take charge of the Department of Neurophysiology, which has been organized and equipped especially to work with the refined micro-electrode techniques with which Dr. Svaetichin carried out pioneer work in Sweden. In addition to this, a department devoted to the application of nuclear magnetic resonance technique to the study of para-crystalline biological components like the myelin sheath of nerves is being organized with the c laboration of Dr. P. Dennis, of the University Geneva. Full staffing of the various departments the Institute will be a slow process, and will obvious have to be carried out with care. Those who do to the new Institute may well find that the perpetu springlike climate of the mountain-top, on which t Institute lies, the feeling of peaceful detachme from the world engendered by a mountainous habita the congenial colleagues and lack of financial worr provided by a generous salary, will provide a uniq atmosphere in which their hypotheses and theori can be thought over, discussed and finally put the test.

Providing an adequate library for the staff is problem which the Institute will need to solve. Ba numbers of many journals would be difficult obtain; but it is proposed for this purpose to bu up a collection of microfilms of back numbers. T policy of the library will also be to invest in curre journals rather than books, since books are stat rapidly becoming out of date, whereas journals a the life-stream of advancing knowledge. The equi ping of the Institute will also be important; b donors have been generous for this purpose, and t researches on fine structure of nerves will have t benefit, for example, of three electron microscopes.

A description of this remarkable new Institu would be incomplete without some reference to i initiating genius and first director, Dr. Fernande Moran. Dr. Fernandez-Moran graduated in medici in Munich and later re-qualified at the Centr University, Caracas. Afterwards he took a Ph.D. physics in the University of Stockholm. He was fellow in neurology at George Washington Universit Washington, D.C., assistant in neurosurgery at t Serafimerlas Clinic, Stockholm, and Research Fello at the Institute for Cell Research, Karolinsk Institute, Stockholm, and assistant professor of c research in the same Institute. As well as being t first director of the new Institute, he holds the cha biophysics at the Central University, Caracas. is electron microscope studies have established his putation as an authority on the sub-microscopic ganization of vertebrate nerve fibres. Much of this ork was due to his development of a microtome for tting sections of nervous and other tissues (in- uding undecalcified bones and teeth) at thicknesses 100 A. or less, which are necessary for good elec- on microscope investigations. For this machine he so designed a diamond knife which could be made om industrial diamonds. In the Institute, Dr. ernandez-Moran will take charge of the work on ne structure of nervous tissue, and he has estab- ished a special department to continue the develop- ent work on the diamond knife and on microtomes use with them.

During my visit to the Institute last summer, it as a revelation to see the energy and speed with hich Dr. Moran tackled and coped with the in- umerable details of equipping and starting the istitute in time for the opening.

Venezuela is in an extremely fortunate financial osition due to the exploitation of her oil and other atural resources, and she is extremely fortunate hat she has at such a moment someone like Dr. ernandez-Moran, who was able to conceive and to recute such a remarkable scheme, and an enlightened inister of Health and President, who were far- ghted enough to see that money invested in this ay would benefit not only Venezuela itself but ltimately the rest of the world as well. The Vene- elan Institute for Neurology and Brain Research a practical step forward in international scientific search.

# OBITUARIES

## Dr. J. W. Nicholson, F.R.S.

DR. J. W. NICHOLSON, an outstanding mathe- atician and man of science, died on October 10, ged seventy-three. He was the eldest son of the te J. W. Nicholson, of Redcar, Yorkshire, and egan the serious study of mathematics and physical ience at the University of Manchester. Later, he itered Trinity College, Cambridge, where his rilliant career began. He was 12th Wrangler in 904 and Isaac Newton Student in 1906. In 1907 he as Smith's Prizeman. He was Adam's Prizeman wice—in 1913 and 1917. He lectured at the avendish Laboratory and later at The Queen's niversity, Belfast.

In 1912 he was appointed professor of mathe- atics in the University of London, King's College, nd occupied this chair until 1921, when he became itor at Balliol College, Oxford, where he was irector of studies in mathematics and physics until rious illness forced him to retire in 1930.

Nicholson was one of the most brilliant mathe- aticians and astrophysicists of his time. In 1917 e was elected into the Royal Society. He was also Fellow of the Royal Astronomical and the London athematical Societies, past president of the Röntgen ociety, a former vice-president of the Physical ociety and a member of the Société de Physique. e was an excellent lecturer and teacher, and prob- bly no teacher in King's College in his time was so uch appreciated and admired by his students and olleagues as he was.

Nicholson's scientific achievements are much more nportant than is generally realized in these days: the elucidation of the electronic structure of atoms owes as much to Nicholson as to any other one man. Before his appointment to King's College, he became interested in certain nebular spectra (the nebula in Orion among others) and the spectrum of the solar corona; and the first of a most remarkable sequence of papers on this subject appeared in the *Monthly Notices of the Royal Astronomical Society* (72, 49; 1912), entitled "The Spectrum of Nebulium". In this he attributed certain nebular spectral lines to a primitive type of atom which he named nebulium. This he imagined to consist of a small central massive positively charged nucleus with four electrons travelling around it on the same circular orbit. He was thus enabled to account for certain spectral lines which, it seemed, could not be ascribed to hydrogen or helium. His work was inspired by Clerk Maxwell's famous paper on Saturn's rings. He was, in fact, able to identify a large number of nebular spectral lines with those which his nebulium would be expected to emit. Indeed, he *predicted* a nebular spectral line the wave-length of which he calculated to be 4352·9 A. before it was observed. It was later observed and measured by Prof. F. J. M. Stratton, who estimated it to be 4353·3 A.

Perhaps the most remarkable feature of Nicholson's work was the discovery that angular momentum is an integral multiple of $h/2\pi$. There is no doubt that this work inspired his pupil, Niels Bohr, to explore the consequences of assuming the hydrogen atom to have a single electron travelling in a circle around a massive nucleus, and it was certainly part of the inspiration of the $\int pdq = nh$ condition enunciated by one of his colleagues at King's College and which was later adopted by Bohr.

One must not omit to mention the important work in which Nicholson collaborated with the distinguished spectroscopist, Sir Thomas Merton, and which was published in the *Philosophical Transactions of the Royal Society* (A, 216, 459; 1916; A, 217, 237; 1917; and A, 220, 137; 1919). It dealt with the distribution of intensity in broadened spectral lines and with intensity relations in the spectra of hydrogen and helium.

Nicholson was a friendly and generous man who took great pleasure in being helpful to both students and colleagues. He was a man of high character and in that respect reminded me of our colleague, H. Stanley Allen, and of the great Max Planck. All of us who knew him were deeply distressed by his tragic illness. As a mathematician he impressed me as very sound, and I learned more from him than from any other man, with the exception, perhaps, of the German mathematician, Carl Neumann. I shall always treasure his memory.

Nicholson married Dr. Dorothy Wrinch, Fellow of Girton College, Cambridge, in 1922, and had one daughter; the marriage was dissolved in 1938.

WM. WILSON

## Mr. Alexander Keiller

ALEXANDER KEILLER, who died at the end of September at the age of sixty-five, was one of the long line of distinguished amateur British archæologists which goes back to Aubrey and Stukeley. Of these perhaps the greatest was Pitt-Rivers, on whom Keiller, like him with leisure and abundant means at his disposal, admittedly modelled his own work.

While still in his early thirties, Keiller carried out a systematic survey of stone circles and allied monuments in north-east Scotland, making accurate plans and detailed descriptions of each site. A summary account of this work was presented as a paper to the British Association at its Aberdeen meeting in 1934.

In 1925, however, he embarked on the programme of excavation and field-work with which his name will be inseparably associated. He acquired and began excavations on Windmill Hill, near Avebury in north Wiltshire, and continued these annually until 1929, revealing in detail the first extensive Neolithic settlement to be explored in Britain. The material was housed in a museum in his London house, where it was at the disposal of students, and as a result the earliest Neolithic culture of southern Britain, taking its name from the type-site, was defined and clarified.

From Windmill Hill to the Avebury monuments themselves was an inevitable step, and in 1933 Keiller began a systematic excavation programme with the examination of the northern part of the West Kennet Avenue, continuing until 1938 within the Great Circle itself. He moved his residence to Avebury Manor, and re-housed his museum within its grounds, making it and the excavated portions of the monument available to the public. He adopted a policy of imaginative but judicious conservation and restoration of the Avebury monuments, and systematically purchased land to preserve these and their surroundings; as a result it was eventually possible for the whole area to be acquired by the National Trust and the Ancient Monuments Department of the Ministry of Works.

Keiller's outstanding contribution to contemporary British archæology was his insistence on high standards of discipline and accuracy in excavation and field-work, and his realization from the first of the value of scientific techniques as applied to archæological material. He early appreciated the potentialities of air photography, collaborating with Crawford in the "Wessex from the Air" survey, and even discussing with Eckener the possibility of using the *Graf Zeppelin* for a similar but even more ambitious scheme. At Windmill Hill he insisted on a full study of the faunal and floral remains in their archæological context. But above all it is to Keiller that we owe the inception of the systematic study of British prehistoric stone artefacts by petrographical means, which, following his lead, is now yielding information of the highest importance on manufacture and trade in the early second millennium B.C. Alec Keiller was an enthusiast in the best sense; full of ideas, stimulating and highly individual. Archæology, like other academic disciplines, can only benefit from the impact of such men.

STUART PIGGOTT

## Dr. E. J. Delporte

DR. E. J. DELPORTE, who died at Uccle on October 19, was honorary director of the Royal Observatory at Brussels, where he had continued to work since his retirement from the directorship in 1947.

Eugène Joseph Delporte was born in Brabant in 1882, and after studying mathematics and physics at the University of Brussels, obtained the degree of D.Sc. with distinction in 1903, entering the Observatory in the same year. In 1923 he took charge of the equatorial instruments and began that p gramme of minor planet observations which was become his main interest. It was during this peri that Delporte proposed that new boundaries shou be adopted for the constellations, defined in terms hour circles and parallels of declination. The propo was accepted by the International Astronomi Union in 1928, and the work was completed in 19 Originally intended to apply only to constellatio north of 12·5° south declination, the scheme fina covered the sky from pole to pole, the northe boundaries merging well with those which Gould h previously defined for the southern hemisphere.

In 1936 Delporte was appointed director of t Royal Observatory at Brussels, and pursued vigorous policy of systematic observations of t minor planets. It is impossible to estimate t number of new discoveries that were made duri these years, but some dozens of these minor plane have received permanent numbers. Planet 12 carries Delporte's name, as does the comet 1941 VI but he will probably be best remembered as t discoverer of the two remarkable asteroids Am (1221) and Adonis, the orbits of which are st exceptional in a list of more than 1,600.

Delporte worked enthusiastically for the Inte national Astronomical Union from its first meeti in Brussels in 1919, and played a prominent part Commission 20 (minor planets, comets and satellites of which he was president during 1938–48. H received many decorations from the hands of h countrymen, and was an active member of man scientific societies with astronomical interests. H was a corresponding member of the Bureau d Longitudes and of the Paris Academy of Science and in 1946 was elected an associate of the Roy Astronomical Society.

Conscious always of the needs of his Observator Delporte was mainly responsible for the improv ments which were effected in 1930, on the occasio of the centenary of the independence of Belgium when a 1-metre reflector, a double astrograph and new meridian circle were added to the equipmen Always ready to praise the scientific success of h colleagues, he gave every encouragement to th younger members of his staff, who will long rememb him as a remarkable observer and a wise and friendl counsellor.

J. G. PORTER

## Prof. Robert P. Bigelow

THE death occurred on September 6 of Pro Robert P. Bigelow, who retired in 1933 after fort years service in the Biology Department of th Massachusetts Institute of Technology; he wa ninety-two years old. A native of Baldwinsville, Ne York, Dr. Bigelow graduated from Harvard Unive sity and received the degree of doctor of philosoph at Johns Hopkins University before joining th staff of the Massachusetts Institute in 1893 as a instructor. He was appointed assistant professor zoology and parasitology in 1912, associate profess in 1915, and professor in 1922. Following his retir ment, Dr. Bigelow served as honorary lecturer in th Biology Department; and, in 1944, returned as special lecturer. He was librarian of the Institut during 1895–1925. Dr. Bigelow was also the form librarian of the Marine Biological Laboratory Woods Hole, and editor of the *American Naturali* and the *Technology Quarterly*.

# NOBEL PRIZES FOR 1955

THE following awards of Nobel Prizes to scientific men have been announced:

## Physics: Profs. P. Kusch and W. E. Lamb

The joint award of the Nobel Prize for Physics for 955 to Prof. P. Kusch, of Columbia University, and rof. W. E. Lamb, of Stanford University, recognizes common feature in their contributions to physics. oth have applied the methods of high-precision dio-frequency spectroscopy to atomic phenomena, which the effect on the electrons of their own diation field, though very small, is significant.

Prof. Kusch has applied the methods of radio-equency resonance in atomic and molecular beams determine, with the highest achievable precision, e magnetic moment of atomic nuclei, and of the ectron. In this way he has shown that the spin-oment of the electron is not precisely one Bohr agneton, but (1·001146 ± 0·000012) Bohr mag-etons. Modern theories, developed at about the ame time, and greatly stimulated by the experi-ental work of Kusch and of Lamb, predict the alue $1 + e^2/\hbar c - 11{\cdot}89\, e^4/\hbar^2c^2 + \ldots = 1{\cdot}00114536$. usch's measurements of nuclear magnetic moments, om nuclear resonance, and from atomic hyperfine tructure, show small but significant discrepancies hich throw light on the structure of atomic nuclei.

Prof. Lamb, while primarily a theoretical physicist, as turned to experiment to test the prediction of odern theories of quantum electrodynamics, that he fine structure of the hydrogen spectrum is odified by the reaction of the electron with its adiation field. According to the simple Dirac wave quation, the energy of the metastable $2s_{\frac{1}{2}}$ level of ydrogen is exactly equal to the energy of the $2p_{\frac{1}{2}}$ vel. In an experiment where transitions are induced etween these two levels in an atomic beam, Lamb emonstrated that they are separated by 1057·77 ± ·10 Mc./s. Modern theories predict 1057·19 ± ·16 Mc./s.

Prof. Lamb has recently accepted appointment to he chair of theoretical physics in Oxford.

## Physiology and Medicine: Prof. Hugo Theorell

The Nobel Prize for Physiology and Medicine for 955 has been awarded to Prof. Hugo Theorell, irector of the Biochemical Department of the edical Nobel Institute of Stockholm, for his work n flavoprotein enzymes and hæmoproteins such as ytochrome *c*, peroxidase, catalase and myoglobin. he study of the "old flavoprotein enzyme", the rosthetic group of which is flavin mononucleotide FMN), was carried out by him when he was holding Rockefeller Foundation Fellowship at the Kaiser Vilhelm Institute (now Max Planck Institute) for ell Physiology (Berlin-Dahlem). It is the electro-horetic separation of this enzyme from a poly-accharide, which accompanied it, that enabled him o purify this enzyme and to determine its main roperties. Of special interest, however, is his exten-ive study of cytochrome *c*, the extractable and oluble component of the cytochrome system which onstitutes the intracellular respiratory chain of atalysts linking the dehydrogenase systems with molecular oxygen, thus providing the essential path for hydrogen or electron transfer from the activated molecules of substrates to oxygen. To the study of the physico-chemical properties of cytochrome *c* and other hæmoproteins, the mechanism of the reactions in which they are involved and the nature of the links between their prosthetic groups and protein, Prof. Theorell has applied great technical skill and a variety of modern physico-chemical and biochemical methods.

More recently, Prof. Theorell and his co-workers studied the properties of alcohol dehydrogenase extracted and purified from liver, and they were able for the first time to follow spectrophotometrically the kinetics of reactions between the enzyme and the reduced co-enzyme I (diphosphopyridine nucleotide). From this work emerged a method for the precise estimation of minute amounts of alcohol, which is of great value for medico-legal work. Prof. Theorell has established a very active centre of research which attracted many workers from different countries to his department which, in 1948, was transferred to the new building of the Medical Nobel Institute, where it is provided with all facilities for the study of a great variety of biophysical and biochemical problems.

## Chemistry: Prof. Vincent du Vigneaud

This year's Nobel Prize for Chemistry goes to Prof. Vincent du Vigneaud, professor and head of the Department of Biochemistry, Cornell University Medical College, New York. Prof. du Vigneaud had many achievements to his name before his recent outstanding work on the structure and synthesis of oxytocin and vasopressin. His researches on the chemistry of insulin were a valuable early contribution in this difficult subject, and were naturally related to his studies on intermediary metabolism and sulphur-containing substances. A distinguished series of investigations on the mechanism of transmethylation and the biosynthesis of choline were based on his substantial experience of both chemical and biochemical methods and greatly added to our knowledge of the metabolism of methionine and of cystine. During the Second World War, Dr. du Vigneaud turned his attention to the chemistry of penicillin, and his synthesis of this substance was a significant contribution to this subject. More recently his activities, and those of his colleagues, have been largely directed to the isolation, chemistry and synthesis of the posterior pituitary hormones, oxytocin and vasopressin. The demonstration that these substances are closely related octapeptides, each containing a disulphide bond spanning six amino-acid residues (a type of structure also found in insulin by Sanger), and the fact that, as long ago as 1935, du Vigneaud had shown that oxytocin can be reduced and reoxidized without obvious inactivation, paved the way to the synthesis of both of these hormones. Each step in a series of complex investigations has been checked with the utmost care, and the complete synthesis of these two related substances has opened wide the door to vast new developments in the pharmacology of peptide hormones and their chemical relations.

# NEWS and VIEWS

## Wellcome Laboratories of Tropical Medicine, London : Brigadier J. S. K. Boyd, O.B.E., F.R.S.

Brigadier J. S. K. Boyd has resigned his position as director of the Wellcome Laboratories of Tropical Medicine as from January 1, 1956, on his appointment as a Wellcome trustee in place of Prof. T. R. Elliott, who has retired. Brigadier Boyd joined the Royal Army Medical Corps in 1914 and served in France, Macedonia and India. In 1929 he carried out researches in India on a variety of pathological problems. Returning to England, he was principally responsible for the official adoption of immunization with tetanus toxoid in the Army, a practice which was almost to eliminate casualties from tetanus during the Second World War. During the War he was deputy director of pathology to the Middle East Forces in Egypt, where he was concerned with the organization of blood transfusion services and the many pathological problems arising in a subtropical climate. Among these problems the introduction of sulphaguanidine, in collaboration with Sir Neil Hamilton Fairley, for the treatment of bacillary dysentery was outstanding. He became deputy director of pathology to 21 Army Group in 1944 and served in that capacity in Western Europe until 1945, when he became director of pathology to the War Office. In 1946 he resigned this position to accept appointment as director of the Wellcome Laboratories of Tropical Medicine, where he has since organized chemotherapeutic research in the tropical field. In spite of the heavy administrative work of an army pathologist, Brigadier Boyd always found time to carry out his own particular research and has continued to do the same in his recent appointment. His most important work has dealt with the analysis of the multiplicity of antigens in the group of the dysentery bacilli, and with bacteriophages, particularly with the problems arising from the existence of symbiotic phages. In both these fields he has gained an international reputation. He was elected F.R.S. in 1951 and F.R.C.P. soon afterwards. It is fortunate that his new appointment will not prevent him from continuing his researches.

## Dr. R. S. F. Hennessey, C.M.G.

Dr. R. S. F. Hennessey, who succeeds Brigadier Boyd, recently retired from the Colonial Medical Service, in which he has spent twenty-five years. He received his medical education at Trinity College, Dublin. Primarily a pathologist, he was employed as such by the Uganda Government from 1929 until 1944, and during most of that time he was lecturer in pathology and forensic medicine at Makerere College Medical School. From 1944 he served for three years with the Palestine Government, first as deputy director of medical services (laboratories) and later as deputy director of medical services (health). Thereafter he became assistant medical adviser to the Colonial Office in London and a member of the Colonial Medical Advisory Committee. His most recent appointment, during 1949–55, was as director of medical services, Uganda Government, in which capacity he was a member of several research committees. Dr. Hennessey thus takes with him to his new appointment a sound background of administrative experience and a wide knowledge of the outstanding problems of tropical medicine.

## U.S. National Science Foundation

Dr. Alberto F. Thompson has been appointe head of the Office of Scientific Information of th U.S. National Science Foundation, and Mr. Clyde C Hall, public information officer of the Foundation Dr. Thompson goes to the foundation from the United States Atomic Energy Commission, where h has served for the past seven years as chief of technical information. He was in charge of the Unite States exhibit at the International Conference on th Peaceful Uses of Atomic Energy at Geneva. Befor the War, he was an assistant professor of chemistr at the Massachusetts Institute of Technology, an earlier, a member of the faculty of the University o Minnesota. Mr. Hall was special placement representative in the Civil Service Commission, with majo responsibility for the identification and placing o top management specialists in the Federal service During the War, he served as assistant to the Directo of Public Information for the Foreign Economi Administration and, earlier, as an informatio specialist with the U.S. Department of Agricultur Before that he was a staff writer for the *Nationa Geographic Magazine* and the Washington Bureau o the Associated Press.

## Nuclear Energy Committee of the Institute o Metals

The Council of the Institute of Metals has appointe a Nuclear Energy Committee, with the object o stimulating interest in metallurgical problems arisin in connexion with the industrial and scientific aspect of the use of nuclear energy. It is proposed that among its activities, the new Committee shall arrang special meetings, discussions and symposia ; invit the writing of papers or articles for publication ; an arrange the publication of books or other literatur to attain the objects for which it was formed. Th Committee hopes to arrange an exhibition of nuclea energy products, of interest to metallurgists, in connexion with the Institute's Spring Meeting in Apri 1956. The constitution of the Committee is : Mr G. L. Bailey (British Non-Ferrous Metals Researc Association), Mr. E. W. Colbeck (Hadfield, Ltd.), Dr Maurice Cook (Imperial Chemical Industries, Ltd. Metals Division), Dr. S. F. Dorey (Lloyd's Registe of Shipping), Dr. H. M. Finniston (United Kingdo Atomic Energy Authority), Dr. Ivor Jenkins (Th General Electric Co., Ltd.), Prof. A. G. Quarrel (University of Sheffield), Mr. L. Rotherham (Unite Kingdom Atomic Energy Authority), Mr. S. S. Smit (Imperial Chemical Industries, Ltd., Metals Division), and Major P. L. Teed (Vickers-Armstrongs (Aircraft), Ltd.). Anyone interested in the activities o the Committee should communicate with Lieut. Colonel S. C. Guillan, Secretary, Institute of Metals 4 Grosvenor Gardens, London, S.W.1.

## An Electronic Computer for the Meteorologica Office

This is the centenary year of the Meteorological Office, and through its long record meteorologists have been confronted with dynamical problems of such complexity that their solution has sometimes seemed beyond hope. In recent years, however, nothing less than a revolution has taken place. The analysis of regular upper-air observations has revealed much about the physical processes, and the invention of electronic computers has opened the way to numerical solutions to problems the analytical solutions of which are

hibitively difficult. The staff of the Napier Shaw
search Laboratory of the Meteorological Office
ve already made a major contribution in this new
vance and, confirming work in other countries,
ecially the United States and Sweden, have
wn that weather maps, giving isobars and upper
contours, may be predicted for 24 hr. ahead by
sic hydrodynamical methods and with promising
curacy. The numerical computations are extremely
avy and hitherto have been performed by arrange-
nt on digital electronic computers available in
ndon and Manchester. The requirement for a
achine for the sole use of the Meteorological Office
s, happily, now been recognized, and it is expected
at one of most modern type will be installed at
nstable within a year or so. Whatever may be
e future success of weather prediction, this step
ay be taken as marking a turning point in the
ience of meteorology. Other problems, not only
ose of forecasting, will no doubt yield ground to an
tack by quantitative methods, and the recent
aims made by the director, Sir Graham Sutton, for
eteorology as an exact science must more and more
realized.

## ience Service

SCIENCE Service was founded in America in 1921
a non-profit corporation with trustees nominated
the National Academy of Sciences, the National
esearch Council, the American Association for the
lvancement of Science, the E. W. Scripps Estate,
d the journalistic profession. In the original state-
ent of aims its task was defined as "to take science
the people . . . to conduct, operate and furnish
ess service for the collection, preparation, dis-
ibution and sale of scientific matter and information,
rrent events and fundamental conceptions or topics
interest to general readers, to newspapers, period-
als, journals, magazines, educational institutions
d government". One of its developments has been
e Science Clubs of America, an organization in
hich about 350,000 boys and girls are affiliated to
teen thousand clubs in the United States and
her countries. The clubs vary in size from three
seven hundred members, and programmes are
anned to suit the age and science interests of the
oup. Each year two national events are held for
embers of Science Clubs of America. The annual
ational Science Fair was started in 1950 and is held
ch spring in a different city. The host city in 1956
Oklahoma City and, in 1957, Los Angeles. The
her national event was started in 1942 and, as the
nnual National Science Talent Search, is held each
ear for seniors in high school who wish to compete
r 11,000 dollars in Westinghouse Science Scholar-
ips for their college education. The winners receive
free visit to Washington to attend the Science
alent Institute. All the brochures produced by
ience Service are set out attractively and may be
tained from 1719 N. Street, N.W., Washington 6,
.C.

## niversity of Birmingham

THE University of Birmingham has conferred the
tle of reader in mathematical physics on Dr. R. H.
alitz. The following have been appointed lecturers
the University: Dr. P. H. Rose (physics), S. W.
reen (botany), Dr. J. S. M. Botterill (chemical
gineering), J. W. R. Griffiths and J. C. Cluley
lectrical engineering), and Dr. H. Y. Yeung (electron
hysics). The following have been appointed to fellowships: Dr. C. B. B. Bull (geophysics), Dr. A. M. Bolsterli and Dr. E. Vogt (mathematical physics), D. B. Idle (botany), Dr. R. A. James and S. Markowitz (physics), Dr. Eleanor H. Slifer (zoology), and Audrey Todd (chemistry).

Gifts have been made to the University as follows: to the Department of Chemistry, £550 from the Electrical Research Association, for one year in the first instance, for research on the fundamental characteristics of the oxidation of certain liquid hydrocarbons, and £700 rising to £850 over three years from S. C. Johnson and Co. for a research fellowship to be devoted to research on waxes; to the Department of Civil Engineering, two grants from the Highway Engineering Education Trust, one for establishing a lectureship in highway engineering for a period of three years and the other, amounting to £250 a year for two years, for the organization of a summer school to give advanced training in road construction, traffic engineering and highway soil mechanics; to the Department of Electrical Engineering, £800 from the Central Electricity Authority to continue research work on electrostatic precipitation of dust; to the Department of Chemical Engineering, £935 for one year from the Ministry of Supply for research on the low-temperature properties of esters, £600 a year for two years from Whiffen and Sons, Ltd., for research in liquid-phase corrosion, £3,675 over a period of three years from the United Kingdom Atomic Energy Authority for research on the characteristics of 'Spraypak', and £775 from the Ministry of Supply for research on the design of distillation towers; and to the Department of Physical Metallurgy, a total grant of £3,225 for three years from the United Kingdom Atomic Energy Authority for research on the properties of ionic crystals.

## University of Leeds: Recent Gifts

THE following gifts have been made to the University of Leeds: £1,000 from Glover and Main, Ltd., London, for North Block I (Fuel Science) of the University; 6,000 dollars from the Dow Chemical Co., Michigan, to the Department of Physical Chemistry for further research in paramagnetic resonance; £6,627 from the Wool Textile Research Council to the Department of Textile Industries for research under the direction of Prof. J. B. Speakman and £3,340 for 1955–56 for research under the direction of Prof. A. H. Nissan; £900 from the Wool Textile Research Council to the Department of Colour Chemistry and Dyeing for research; and £900 for 1955–56 from the Cement and Concrete Association to the Department of Civil Engineering for the salary of a lecturer.

## National Institute of Sciences in India: Proceedings

THE National Institute of Sciences in India, since its inception in 1935, has published regularly every year the *Proceedings of the National Institute of Sciences in India*, containing miscellaneous articles on physical and biological sciences, as well as important official proceedings of the Institute. The Council of the Institute has decided that, with effect from Vol. 21 (1955), the *Proceedings* are to be published in two parts—*A*, physical sciences; *B*, biological sciences—and they are to be issued bi-monthly in alternate months. In addition, the official proceedings are to be published in a "Year Book", an annual publication on the lines of the publications of the Royal Society. The volume and year numbers will be the same for the two parts of the *Proceedings*, and each will contain its own title page, page numbering and index.

## Science Masters' Association : Annual Meeting

THE annual meeting of the Science Masters' Association will be held in the Royal College of Science, Imperial Institute Road, South Kensington, London, S.W.7, during December 28–30, the annual business meeting of the Association being on the last day. The president this year is Sir Edward Salisbury, director of the Royal Botanic Gardens, Kew, and he will deliver his presidential address in the Courtauld Hall, Queen Elizabeth College, on the evening of December 28, his subject being "Science and Education". Two special discussions will be held: one on December 30 at which science teaching in secondary modern schools will be considered; and one on December 31 on first-year failures in the universities, which will be introduced by Dr. E. R. Roberts, of the Department of Inorganic Chemistry, Royal College of Science, and by Prof. F. A. Vick, of the Department of Physics, University College of North Staffordshire. On the morning of December 29 a lecture-demonstration of experiments with radioactive isotopes suitable for schools will be given by the members of the Radioactivity Subcommittee of the Association, and in the afternoon there will be a demonstration of ciné and cinémicrography in the teaching of natural history, given by K. A. Murch, of the Chichester High School for Boys. In the afternoon of December 30 the Science and Religion Group of the Association will hold a discussion, and in the evening Mr. T. D. Bourdillon, a member of the 1953 Everest Expedition, will lecture on the successful conquest of Mount Everest and on the use of oxygen during the climb, which was his special responsibility. As in the past, manufacturers and publishers who advertise in the *School Science Review* will exhibit at the meeting, and the usual exhibition by members of apparatus and teaching aids which they have found useful will also be held. In addition, special displays will be given in the Royal College of Science by the Civil Defence Department of the Home Office, and in Queen Elizabeth College by members of the Science Departments there. Further information can be obtained from the annual meeting secretary of the Association, W. H. Dowland, 93 Westbourne Road, West Hartlepool, Co. Durham.

## British Institute of Radiology : Annual Congress

THE annual congress and exhibition of the British Institute of Radiology will be held in Caxton Hall, Victoria Street, Westminster, London, S.W.1, during December 8–9. On the morning of the first day, an opening address will be given by Sir John Cockcroft, director of the Atomic Energy Research Establishment, on the future role of atomic energy in industry, science and medicine, and this will be followed in the afternoon by a symposium on the hazards from the increasing use of ionizing radiations, at which three papers will be read. In the evening Dr. Gwen Hilton (University College Hospital, London) will deliver the Mackenzie Davidson Memorial Lecture and will speak on the role of radioiodine in the treatment of carcinoma of the thyroid. The second day will be devoted to papers on the clinical applications of image intensification, and three symposia as follows: pulmonary fibrosis and collagen diseases of the lungs; the influence of histological structure on radiosensitivity; the introduction of the rad in radiotherapy practice. The fee for the congress is 1 guinea (10s. 6d. f members of the Institute). Further information c be obtained from the Honorary Secretary of t Institute at 32 Welbeck Street, London, W.1.

## Christmas Lectures for School Children

A CHRISTMAS lecture for older school childre arranged by the Institution of Electrical Enginee will be given at the Institution (Savoy Place, Londo W.C.2) on December 29 at 3 p.m., and again on t following day, by Mr. R. Brooks, his subject bei "Electric Traction". The lecture will outline t principal features and methods of operation of t different systems of electric traction now in u particular reference being made to the equipment the locomotives and motor-coaches used on mai line and suburban services. The main principles electric railway signalling will also be considere together with a demonstration of full-size apparat including searchlight-type signals. Admission to t lecture is free, and application for tickets, stating f which afternoon they are required, should be ma to the Secretary of the Institution at the abo address. The Royal Institution's Christmas lectur this year will be the 126th such "Course of six lectur adapted to a Juvenile Auditory". The course w be given by Prof. H. W. Melville at 3 p.m. c December 27, 29 and 31 and January 3, 5 and 7, h subject being "Big Molecules". The topics to be di cussed at the six lectures will be, respectively, t making of big molecules, the size of a big molecul rubber and the rubber-like state, man-made fibre and plastics from big molecules (two lectures). F non-members of the Royal Institution, the fees f the course are: children (10–17 years) £1, adul £2. Application for tickets should be made to t Royal Institution, 21 Albemarle Street, London, W.

## Announcements

SIR GEORGE LLOYD-JACOB, one of Her Majesty' Judges of the High Court of Justice, has accepte appointment as a Trustee of the Ciba Foundation f the Promotion of International Co-operation i Medical and Chemical Research.

THE University of Sheffield has conferred the titl of emeritus professor of engineering on Prof. H. W Swift, and that of emeritus professor of glass technology on Prof. H. Moore, both of whom have recentl retired from their respective chairs.

THE Department of Scientific and Industri Research has appointed Sir Walter Drummon formerly chairman of the National Coal Board, an Prof. N. F. Mott, Cavendish professor of physics i the University of Cambridge, to be the Department' visitors to the Electrical Research Association, i succession to Dr. P. Dunsheath and Prof. J. T Randall, whose period of service has been completed.

THE Mond Nickel Co., Ltd., has appointed D G. L. J. Bailey to be superintendent of its Platinu Metals Research Laboratory at Acton, London N.W.10, in succession to Dr. E. C. Rhodes. D Bailey, who is a graduate of the Imperial College o Science and Technology, London, was on the staff o the Admiralty Engineering Laboratory, West Drayton, throughout the Second World War, and sinc 1945 he has been a member of the British Non Ferrous Metals Research Association, where he is a present deputy research manager.

# CONFERENCE OF COMMONWEALTH SURVEY OFFICERS

THE Commonwealth Survey Officers' Conference was held in London and Cambridge during .ugust 15–26. It was opened by Lord Lloyd, Under-ecretary of State for the Colonies, in the Depart-ent of Geography at Cambridge, and was attended y about two hundred representatives of Home and ommonwealth surveying departments and allied terests, including the directors of survey or sur-eyors-general of nearly all the Commonwealth rritories, with observers from the United States of merica, France, Holland, Belgium, Ireland and the udan. Between August 15 and 23, twenty-six apers were read on a wide variety of technical and dministrative subjects, after which the Conference oved to London for visits to neighbouring govern-ent survey establishments. Brigadier M. Hotine, irector of Colonial surveys, was president of the onference. Delegates were mostly accommodated Pembroke and Downing Colleges, a very con-enient arrangement. A valuable adjunct was an xhibition of surveying instruments by eighteen ritish manufacturers.

Of the papers read, eight dealt with administration, ducation and land registration; three with the esign of new instruments; eight with the routine f field surveying, nearly all from the point of view f air survey; three with the geodetic framework; ne with variations of sea-level; and three with lectronic aids to surveying. The list of titles might uggest that an aircraft and a box-full of electronics now a good substitute for hard work on the ground; ut in one of the discussions it was well agreed that most circumstances the best map could still only e made by a fairly equal combination of both pro-esses. The following notes give a short summary of he papers most likely to be of interest to readers of *ature.*

In a paper on the use of automatic plotting achines for 1/1,250 air survey, Major D. V. Hutchin-on described the combination of air and ground urvey now being used for the city survey of Oxford, hich will probably serve as a model for similar plans hroughout Great Britain. The air-photo plotting achine requires less dense ground control than the ld method of chain survey on the ground, but does ot, of course, provide a map which can be accepted ithout ground verification and amplification. Clear iagrams of a sample plan show the amount of detail about half) which is confidently identified on the hotograph and plotted by the machine, and how uch is left to be verified and amplified by the round surveyor: at this scale, buildings with over-anging eaves come into the latter category. The ut-turn of the ground surveyor has been increased rom 0·28 sq. km. a month without preliminary air urvey to 0·48 sq. km. with it. Total costs, including hat of flying, are substantially lower than when round survey alone is employed.

Prof. E. H. Thompson's new air-photo automatic lotting machine, of which the first model has just een completed by Messrs. Hilger and Watts, was on iew and was the subject of a paper.

A paper by Major I. E. Sleep analysed the accuracy f a 1 : 25,000 map made by multiplex equipment rom 1/90,000 vertical photography, supplemented by 1/30,000 obliques, taken from an aircraft at 45,000 ft., an altitude at which flying may be convenient in time of war. With ground control-points about 11 miles apart, errors of height were found to average 16 ft. and of position 12 metres, a standard which is adequate for a military 1/25,000 map with 20-metre contours, and which is indeed remarkable considering the scale of photography and scarcity of control. A typical 1/25,000 map sheet made in this way accompanies the paper, with the Ordnance Survey version (errorless in plan, but not in contouring) printed in grey, and the air-survey version in brown.

Surveyors will be interested to learn from a paper by E. W. Taylor that the designers of the new small Tavistock theodolite have changed over to the coincidence system of reading, and that both circles are now read in a single eyepiece alongside the main telescope. In the geodetic model, a similar coincidence system is also being adopted; but the separate micrometers and eyepieces for the horizontal and vertical circles are retained.

Commander W. I. Farquharson read a paper containing interesting descriptions of tidal bores, seiches, surges and secular changes of sea-level. From British tidal records, which are regrettably scanty, he has analysed the secular rises of sea-level during 1835–95, 1895–1925 and 1925–50, and finds them to be zero, 0·4 ft. per century and 0·5 ft. per century, respectively. He quotes rises of 0·4 and 1·2 ft. per century for the two later periods from American records at Halifax, New York and Baltimore, and a similar value from Holland. He suggests that port engineers should be prepared for a further rise of 1 ft. during the coming century.

Capt. C. C. Lowry's paper on radio aids to hydrographic surveying described the uses and limitations of radio distance, depth and direction measuring apparatus as applied to hydrographic survey, and a paper by C. Powell gave details of the construction, use and accuracy of the Decca equipment.

A paper by D. L. Mills, of the United States Army Map Service, described the completion of the African Arc of the 30th meridian. This great piece of geodetic triangulation, which was begun about seventy years ago, has been finally completed since 1952 by a party from the U.S. Army Map Service observing the section between latitudes 1° and 10° north. This section includes 300 miles of the flat Sudd region, where triangulation is difficult and has only been made possible by using 100-ft. portable Bilby steel towers. Three base-lines were measured by the Sudan Survey Department, and Laplace azimuth stations were observed at appropriate intervals.

One paragraph in this report answers a question which has often troubled surveyors, namely, what happens when a Bilby tower collapses. One such accident occurred, a tower collapsing with five men at the 100-ft. level. One broke a bone in his foot and the others were at work again after a day's rest. The ground was hard-baked clay. The Sudanese are evidently resilient.

The completion of the African arc, coupled with the radar connexion recently observed between Crete and Egypt, makes it possible (if desired) to compute

South African triangulation in terms of the European Datum. Russian triangulation, known to exist but not published, could carry the same datum to Vladivostok, and a gap of 1,000 miles in Persia is all that prevents it extending to Singapore. Radar measures, of geodetic accuracy, between Europe, Greenland and America will link the European and American datums within a few years, and triangulation from the latter already extends well into South America. The days of separate, isolated national surveys are passing.

A paper by H. A. Stamers Smith gave a useful summary of the present state of geodetic triangulation in Nigeria, where primary traverse has in places been very successfully used as a substitute for triangulation. The misclosures of ten such traverses are given, averaging about 1 in 100,000 in distances of 100–200 miles.

A paper by Col. R. C. A. Edge described work done by the Ordnance Survey with electronic computing. Traverse and levelling computations are a heavy item in the ordinary work, but, varying much in detail, require a high proportion of 'arranging' for pure computation. They are therefore more suited to punch-card methods using a small calculator (such as the *I.B.M.* 626) than to a large storage computer. An *I.B.M.* 626 has recently been installed at the Ordnance Survey. Photogrammetric computations, another heavy item, are more uniform but mathematically more complex. They are suitable for a large computer, and for some time they have been programmed for, and successfully computed by, *ACE*. They are now being programmed for *DEUCE*.

Space does not admit mention of the remaining papers, but all are of value in their own spheres. These Survey Conferences are held at four-yearly intervals, and provide a most welcome opportunity for surveyors from all over the Commonwealth to exchange ideas and to renew friendships. The papers presented at previous conferences, and the resulting discussions, have been published by H.M. Stationery Office, and it is hoped that a 1955 volume will soon be published also. G. BOMFORD

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# INTERNATIONAL BIOMETRIC SYMPOSIUM IN BRAZIL

THE Biometric Society, which now forms the Biometric Section of the International Union of Biological Sciences, is endeavouring to stimulate the teaching and use of good statistical practices in biology in many parts of the world. As part of this programme, an international biometric symposium was held in Campinas, Brazil, during July 4–9. The University of São Paulo was host to the symposium, and a committee of the University Seminario de Estatistica, with Dr. C. G. Fraga (Institute of Agronomy, Campinas) as secretary, handled local arrangements; financial assistance was received from ten different governmental and non-governmental organizations. The ninety-eight statisticians and biologists attending included sixty-two from Brazil, eight from other Latin American countries, fourteen from the United States, five from Great Britain, seven from other European countries, and two from Asia. The foreign visitors will long remember the hospitality of their Brazilian hosts.

The president of the Society, Prof. W. G. Cochra (Johns Hopkins University), took as the subject his address the 1954 trial of the Salk poliomyelit vaccine in the United States, focusing attention o the design of the investigation rather than upon th outcome. He said that in 'placebo areas' childre who received the vaccine were matched by contro receiving a similar injection of a placebo, while i other parts of the country the only controls wer younger and older uninoculated children. Th difference between case-rates in inoculated an control children was apparently greater in th placebo areas. His suggested explanation was the natural immunity was lower in the homes of childre whose parents consented to their inclusion i the trial, a consent necessary in the placebo area for all participators but elsewhere only for th inoculated.

In the afternoon, Sir Ronald Fisher (University c Cambridge) described the contribution of biometr to plant improvement, with special reference t experimental design, the analysis of genetic model involving large numbers of Mendelian factors tha cannot be individually identified, and classical Mendelian genetics. Prof. E. R. Dempster (Universit of California) then discussed genetic models i animal breeding. Shorter papers on biometrica genetics by Prof. F. G. Brieger (Agricultural College Piracicaba) and Dr. H. Kalmus (University College London) related to autogamic populations an heterotic genes in plant genetics and to cyclomorphosis, respectively.

Two sessions on experimental design were held o July 5. Dr. S. C. Pearce (East Malling Researc Station) showed that difficulties of adequate replication with perennial crops restrict the experimenter t very simple designs. A compensation is that relationships between many concomitant measurements ca be studied. He illustrated the balancing of treatments so that one set of trees can be used for tw or more consecutive investigations. E. Amara (Institute of Agronomy, Pelotas) discussed missin yields and other problems in the analysis of sugar-cane experiments. The design and analysis o coffee experiments at the Campinas Institute o Agronomy were reviewed by Dr. A. Conagin and Dr Fraga, who showed how modern design had improved the quality of information obtainable in research on this crop. In a more theoretical paper, Dr. F. Pimentel Gomes (University of São Paulo) spoke of the use o the Mitscherlich equation in analysing fertilize experiments on sugar-cane. In the afternoon, Mis G. M. Cox (University of North Carolina) surveyed recent work in the theory of experimental design; her paper was of particular interest for its mention of special designs for estimating optimal conditions, including the new category of rotatable designs. Dr. W. J. Youden (Bureau of Standards, Washington, D.C.) then gave a graphic account of how types o design developed by biologists are now assisting research on physical problems. With remarkable clarity and humour, he illustrated the adaptation of designs to situations in which the block size i predetermined; or, at most, two replications are wanted; or some treatments are to be chosen afte part of the experiment was complete; or in which instrumental drift is a serious factor. On the following day, during a visit to the Agricultural College a Piracicaba, members held a discussion on experimental design for perennial crops.

On July 7, Prof. P. G. Homeyer (Iowa State College) summarized experience on sources of variation in feeding experiments with chicken, cattle and pigs, and its use in designing new experiments; he emphasized particularly the danger of neglecting variation between pens. Dr. G. L. Rocha (Brazil) and Dr. G. O. Mott (Purdue University) reviewed the technique and interpretation of pasture experiments in Brazil and the United States, respectively, after which Prof. A. Linder (University of Geneva) described an experiment on the grazing times of cows permitted to choose between differently treated plots. In the afternoon session, on sampling techniques, Dr. M. H. Hansen (United States Bureau of the Census) discussed the control of errors of response in sample surveys. Recent work on the theory and practice of estimating fish catches around the Indian coast was then described by Dr. P. V. Sukhatme (Food and Agriculture Organization). Prof. J. Nieto de Pascual (Bureau of Statistics, Mexico) described a survey of national morbidity in Mexico, and Prof. W. L. Stevens (University of São Paulo) presented an account of recent work on the sample estimation of the coffee harvest, a problem complicated by a biennial cycle of bearing. The session ended with a paper from Dr. E. Cansado (Interamerican Statistical Centre, Santiago, Chile) on new proofs of theorems on sampling from a finite population.

After a morning visit to the State Institute of Agronomy at Campinas, the afternoon of July 8 was given to papers on bioassay. Dr. C. I. Bliss (Connecticut Agricultural Experiment Station) showed general methods for obtaining confidence intervals for estimates of relative potency, and then illustrated how these could be adapted to various assay techniques in the "U.S. Pharmacopeia". Dr. D. J. Finney (University of Aberdeen) presented five models relating to correlations of residual error and residual effects of previous doses in cross-over and single-subject assays, and explained the statistical analysis appropriate to various designs. Dr. P. Mello Freire (Institute of Biology, São Paulo) described the analysis and interpretation of three 'complement fixation' assays. Finally, several questions on bio-assay, with special reference to the assay of snake venom, were submitted to a panel for discussion.

The first of four papers on medical statistics on July 9, that by Dr. J. O. Irwin (London School of Hygiene and Tropical Medicine), related to an experiment conducted in Singapore with human subjects to assess the influence of air movement, temperature, humidity, clothing and other factors on sweat-rate and other physiological measurements. An interesting application of covariance analysis was shown by Dr. J. N. Manceau (Public Health Service, Pará) in his account of a comparison between two antihelminthics for the control of nematode parasites in seventy-four Belém children. Dr. A. E. Brandt (United States Atomic Energy Commission) described briefly an investigation into the clinical effects of two different very high-voltage sources proposed for the treatment of cancers that are frequently incurable by conventional radiotherapy; he then considered the problems of performing a clinical trial on one type of cancer, with adequate random allocation of patients to the two treatments yet within the limits imposed by medical ethics. The final paper, by Prof. A. Vessereau (Sorbonne), consisted of an interesting application of discriminant function analysis to the diagnosis of medical and surgical cases of jaundice from electrophoretic analysis of serum proteins.

One of the most satisfactory features of the symposium was the lively discussion that followed almost every paper: the variety of questions and comments, and the number of people taking part, proved that the holding of the symposium was fully justified. Moreover, Brazilian science will continue to benefit from this venture, for it provided the impetus for the immediate formation of a Brazilian Region of the Biometric Society (which already has more than fifty members) and also of a Brazilian Genetical Society.

D. J. Finney

# DESIGN OF ELECTRONIC DEVICES FOR PRODUCTION

A SUMMER school on the role of the trained scientist in the design of electronic devices for production was held at the Services Electronics Research Laboratories in Baldock and Harlow during September 20–23. More than sixty university and technical-college professors and lecturers attended. Accommodation was provided by Emmanuel College, Cambridge, and transport to and from the Laboratories was by motor coach.

The first speaker was Mr. A. J. Young (English Electric Valve Co.), who surveyed the recent developments in special valves. He directed attention particularly to one of the functions of management in the device industry, namely, to decide to pursue a particular line of development. The scientific judgment required to execute this function to the best advantage is an increasing need in the industry, and it should be the object of the universities and technical colleges to bring forward scientists having good understanding of their subject and, as a result, good judgment regarding device development. The next speaker was Mr. D. S. G. Lewis (officer in charge of the extension of the Services Electronics Research Laboratory at Harlow), whose subject was magnetrons, and he gave a résumé of the problems facing the designer after fifteen years of development. In particular, he directed attention to the complicated nature of the device, in which the variation of any one parameter alters the effect of every other one. Mr. Lewis sketched the problems arising in the manufacture of magnetrons, giving special attention to the close limits imposed at very high frequencies. The final speaker on the first day was Dr. J. M. Dodds (Metropolitan-Vickers Electrical Co., Ltd.), his subject being high-power klystrons. He explained why the klystron is preferred to the magnetron for certain purposes, and described the design and manufacture of a klystron suitable for driving a very high-power linear accelerator. During this first day examples of modern valves were exhibited, many valve firms contributing samples of their latest designs. In the afternoon, Dr. H. A. H. Boot, one of the inventors of the multi-cavity magnetron, supervised a demonstration of micro-wave valve-making techniques.

The second day of the school opened with a discussion of methods of generation of millimetre waves, given by Mr. P. O. Hawkins (Services Electronics Research Laboratory). Mr. Hawkins, in addition to surveying the field, gave special attention to a floating drift tube klystron capable of delivering 10–20 W. at a wave-length of 8 mm. He was followed by Dr.

R. Q. Twiss (also of the Services Electronics Research Laboratory), who illustrated forward thinking by discussing the prospects of developing and detecting sub-millimetre waves; he gave special attention to the use of electrons travelling at approximately the speed of light. Mr. G. Knott (Mullard Research Laboratories) described the action of travelling-wave amplifiers and of backward-wave oscillators. In the first part of his discourse he referred particularly to the problem of noise in signal amplifiers and to the yet unsolved problems of mechanical design; in the second part he sketched the theory of backward-wave valves and described results achieved at a wave-length of about 2 cm. which may lead to a new generation of low-power micro-wave oscillators.

The school then turned its attention to the important subject of reliability in electronic devices, and on this subject an address was given by Mr. E. G. Rowe (Standard Telephones and Cables, Ltd.). Mr. Rowe explained what steps had been taken since 1945 to improve the general reliability of valves and described the problems which still remained to be solved. He was followed by Mr. G. H. Metson (Research Station of the General Post Office), who dealt specifically with the problem of designing valves for lives of the order of a hundred thousand hours (more than eleven years) and gave a scientific explanation of the factors determining long life in cathodes. In the morning a demonstration was given of millimetre-wave generators, and in the afternoon Mr. P. Gurnell superintended a demonstration of receiving-valve manufacturing techniques. The day closed with a lively discussion of how best to teach at university standard so as to obtain industrial scientists having a real understanding of scientific problems.

On September 22 the school transferred to Harlow, where it was addressed by Dr. D. A. Wright (Research Laboratories of the General Electric Co., Ltd.) and later by Mr. C. P. Lea-Wilson (Harlow) on the subject of thermionic cathodes. Dr. Wright described all types of thermionic emitter, dealing particularly with the limitations of the oxide-coated cathode, while Mr. Lea-Wilson paid special attention to high-temperature sintered cathodes used in magnetrons and high-power klystrons. Mr. J. Pollard (Services Electronics Research Laboratory) then discussed methods of obtaining high vacua and explained that the needs of the valve engineer are not yet adequately met either as regards speed of pumping or as regards ultimate vacua. In the afternoon Mr. J. E. Stanworth (British Thomson-Houston Research Laboratory) described the problems arising in the manufacture of glass and ceramic valve envelopes. In the second part of his address he dealt specifically with some of the new and interesting glasses developed recently. In the evening Mr. A. Monk (Harlow) supervised a demonstration of the use of new materials in valve making.

The final day of the school was devoted to problems arising in connexion with solid-state devices. The introductory discourse was given by Mr. I. M. Ross (Services Electronics Research Laboratory), who surveyed the whole field, giving examples of entirely new solid-state devices which have come to light during the past few years. He was followed by Mr. E. H. Cooke-Yarborough (Atomic Energy Research Establishment), who described the properties of transistors and some of the uses to which they are being put. He emphasized that the transistor is a new type of electronic device in many ways utterly dissimilar to a valve and demonstrated some of the surprising circuits in which transistors can be used. Mr. E. B. Callick (Royal Naval Scientific Service) then discussed the problems encountered in manufacturing transistors and emphasized that these represent an entirely new development in manufacturing methods, where extremely minute traces of impurity are of primary importance and where the physical magnitudes involved are very small indeed. In the afternoon Mr. A. F. H. Thomson (Harlow) described the various types of memory or storage devices which are coming into use, taking the view that magnetic materials will play an ever-increasing part in this field. He was followed by Mr. P. E. Trier (Mullard Research Laboratories), who dealt more specifically with magnetic switching devices. He showed how these can be built up into a full-scale computer and gave special attention to the difficult scientific problems which have yet to be solved in connexion with the use of ferro-magnetic materials and ferrites. During the afternoon a demonstration was given of solid-state devices in use in various ways.

In the short time which remained for discussion it was suggested that the proceedings of the school should be made available, at least in an abridged form, and it is hoped to publish these in the *Journal of Electronics* early next year. J. THOMSON

## ANIMAL MOVEMENT

DURING the British Association meeting at Bristol, Sections D (Zoology) and I (Physiology) held a joint session on September 6, at which the subject of "Animal Movement" was discussed. The first paper was by M. A. Sleigh, speaking on ciliary movement, and in it he gave an account of his own work on the movement of the peristomial cilia of *Stentor*. He suggested that the frequency of beat is a measure of the mechanical activity and that wave velocity is a measure of the metachronal co-ordination. Experiments have shown that the beat frequency and wave velocity have different temperature coefficients. Also it can be demonstrated that changes in the viscosity of the medium and in the viscosity of the protoplasm affect only the frequency and not the wave velocity, while the wave velocity can be substantially altered by digitoxin without appreciably affecting the frequency. The conclusion to be drawn is therefore that the two parts of the system are separate and have very different properties. Mr. Sleigh holds the view that the frequency might be maintained by the first cilium in a row acting as a pace-maker, while the excitation pathway of the wave velocity might be neuroid.

The second paper, by Dr. T. Weis-Fogh, was on the flapping flight of insects, and was illustrated by a slow-motion film on the flight of the desert locust. He described the wing movements in detail, and explained how the film was made and how his co-worker, Dr. Martin Jensen, had used it for estimating the changes both in magnitude and direction of the aerodynamic forces during the beat cycle. It has become clear that the wing cycle can be treated as a series of stationary flow situations and that the torques set up at the wing base can be estimated. When these torques are considered in detail, it is possible to subdivide them into aerodynamic and inertial torques, and to relate them to the torque-producing components within the body. From this lysis, it is evident that the inertial torques are most balanced by elastic torques arising from ormations of the body cuticle. When the various ques are summed for different phases of the beat, result equals the torque which the flight muscles st produce. It appears that some two-thirds of work is being expended against aerodynamic ces, and that the mechanical efficiency of the scle system is 17–18 per cent.

The third speaker, Dr. R. H. J. Brown, discussed flapping flight of birds. He pointed out that re are several different types of flapping movements, and that these are found either in different ds or in the same bird in different situations. The ious types of flapping cycle were illustrated by tern slides, and the functional differences between various phases were described. It is clear that reas the down-strokes are almost the same for birds, the up-strokes may be entirely different h in path and function. These various types of -stroke are found, with few exceptions, to be ated to the size of the bird. The small birds up the size of a pigeon usually fold their wings irely during the up-stroke in slow flight. The eon and birds of similar size use a propulsive -stroke in slow flight and a passive one in fast ht; and in the large species the up-stroke is sive except perhaps just before landing. Individual ht habit makes the transition point from one type the other indefinite. It can be shown that these ferences are to be expected from considerations of scle weight, wing area and wing mass (inertia). ile the qualitative picture is fairly clear, there is le information from which any quantitative imates of aerodynamic or overall efficiency can be de.

The last paper was given by Dr. O. C. J. Lippold, o considered fatigue in human voluntary muscle. suggested that the fatigue may be attributable one or more of four factors: first, the voluntary ve may be diminished; secondly, the nerve conction may be impaired; thirdly, the neuroscular junction may be fatigued; and finally, the ntractile mechanism may itself become weaker. It probable that three of these factors are responsible the diminished activity in fatigue, and that the in effect is due to one or other in different cirnstances. For example, prolonged work, not of a enuous nature, undoubtedly gives rise to central igue; but if a strong enough motive arises, the scle activity can be restored to the unfatigued el. To what extent the occurrence of a neuroscular block is important has not been settled, hough experiments described by Dr. Lippold lead n to believe that such fatigue does not occur. He o holds the view that fatigue of the neural pathy is not a factor. On the other hand, under conions of strenuous exercise it is clear that the igue can be predominantly muscular, and that the set of fatigue is accelerated and the recovery layed by impairment of the blood supply to the scle. Finally, Dr. Lippold suggested methods by ich the blood supply to the muscle might be reased, and thus postpone the onset of fatigue.

During the short discussion which followed, Mr. igh was questioned on his suggestion of a neuroid ntrol in ciliary movement and pointed to the uctures associated with cilia as supporting his ws, and then Dr. Weis-Fogh explained some of his imates of internal work and power losses in locust ht.

# STANDARDS IN BRITISH INDUSTRY

IN two recent broadsheets (Nos. 381 and 382, July 11, 1955) Political and Economic Planning reviews the various types of standards in use in British industry, examines the arguments for and against their use and scrutinizes the work of the British Standards Institution; in particular, the method of preparing standards and the extent to which they are adopted are considered, and whether the Institution, as at present constituted, is capable of doing justice to its growing responsibilities at home and overseas.

Industrial standards fall into two broad categories: functional standards, or the tools used in doing a job; and dimensional standards which, by laying down dimensions and tolerances for finished and semi-finished goods, secure interchangeability and simplification. Frequently there are combinations of both types. Britain's leadership in aircraft design has been helped considerably by the many standards relating to production, drawing-office practice and engineering construction, and objections to the use of standards in industry are often based on misconceptions of what standards imply. The first of these two broadsheets indicates the vital contribution which standardization can make to efficiency in industry by cutting out waste of machine-time, materials, power and labour, and also the importance of standards in foreign markets. Many problems are involved in the formulation of standards both technically sound and commercially practicable, and the resolution of these difficulties in Great Britain falls to the British Standards Institution, which is the subject of the second broadsheet.

Essentially the British Standards Institution is a co-ordinating body bringing together the technical knowledge of those engaged in industry, professional associations, technical colleges, universities and government departments, and the practical and commercial knowledge of producers, distributors and consumers in an endeavour to produce standards acceptable to all interests concerned. Until 1931, its activities were mainly confined to the engineering industry; but in that year a Supplemental Royal Charter enlarged its terms of reference to user industry as a whole and its name was changed from British Engineering Standards Association to British Standards Institution. By 1939 it had grown to something like its present size and published nearly a thousand standards for a wide range of engineering and chemical, building and like materials. It has always worked for the promotion of British standards abroad, and continues to take an active part in the movement for internationally accepted standards. Between the two World Wars it became concerned with the standards since known as Codes of Practice, of which more than a hundred and fifty have been issued, ranging from the planning of buildings for ensuring adequate sunlight to the use of electronic valves.

The broadsheet suggests that the Institution could take a wider view of the whole question of standards, and that its work at home should follow some order of priority more closely related to the productive efficiency of the country as a whole. Closer co-operation between the Institution and the British Productivity Council in an effort to introduce standards, where they are likely to be of most benefit, is suggested; and with the growing adoption of standards overseas, the Institution must turn its attention increasingly to securing international agreement, aligning British standards to the requirements of overseas customers, and promoting British Standards in other countries. Some expansion of the publicity and information services of the Institution is desirable, and surveys are suggested which could indicate an order of priorities by showing where its work is most and least effective, particularly with regard to the smaller firm. The need for solid financial basis is emphasized. The governm contribution for 1955–56 should be of the order £120,000; but the present arrangements termin after 1956–57, and it is pointed out that it is import that the Institution's income must be assured fo sufficient period ahead to allow it to plan w confidence, possibly by means of a quinquenn government grant and equivalent longer-term s scriptions from industry.

# THE POLYPEPTIDE CHAIN CONFIGURATION OF COLLAGEN

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THE complete determination of the structure of collagen presents two major problems: first, that of discovering the configuration of the individual polypeptide chains by the application of X-ray diffraction data; second, the understanding and significance of the larger-scale structure seen in the electron microscope. We reserve a discussion of the larger structure and its relation to that of the individual chains for a later communication. This communication deals with the polypeptide configuration and is an elaboration of earlier remarks[1,2] on the relationship between the structures of poly-L-proline and of collagen.

A consideration, in fact, of the recent work on this synthetic polymer[1,2] and on collagen itself[3-4] has clarified the principles on which the structure of collagen must be based, and shows that an approximate solution can now be arrived at with reasonable certainty. The determination of the exact atomic positions within a single chain will require a much closer study and may ultimately rest on the possibility of an improvement in the experimental data.

The main features of the collagen polypeptide chain configuration are, we think, indicated by the joint consideration of the following: (1) the high-angle X-ray diffraction pattern; (2) the amino-acid composition and sequence analysis; (3) the structure of poly-L-proline.

The configuration must also account for physical properties such as density and infra-red absorption.

## High-Angle X-Ray Diffraction Pattern

The general features of the high-angle X-ray pattern are consistent with a system of hexagonally packed rods, 12 A. apart in dry material, the separation increasing with hydration. Each rod contains a set of atoms, which may be one or more amino-acid residues, repeated at axial intervals of 2·86 A. in the unstretched material. On stretching the fibre the axial repeat increases to 3·1 A. or more, and the improved X-ray pattern suggests that the atom sets are repeated on a helical structure. From the X-ray spacings, the dimensions of possible alternative helical systems can be derived[3-4]. Theoretically, a very large number of helical systems can be devised which fit the observed high-angle X-ray diagram, but it seemed to us that the actual model would be one of a comparatively small number of simple alternatives[3-4], namely: (*a*) a single helix with a period of 28·6 A., containing either three or sev turns and ten atom sets; (*b*) two concentric helic related by a diad axis, each helix repeating exact after 57·2 A. with three or seven turns and twen atom sets; (*c*) three concentric helices related by triad axis, each helix repeating exactly every 85·8 Each chain would contain thirty atom sets and thr or seven turns in its repeat. For three turns, sin the atom sets and turns are both multiples of there would be a complete repeat after 28·6 A.

Examination of the general form of the intensi distribution to be expected from such systems[5], and comparison with the observed high-angle X-r pattern shows that, in collagen, the single helic form (*a*) is the most likely, as illustrated in Fig. In the following discussion, this form is assumed be correct.

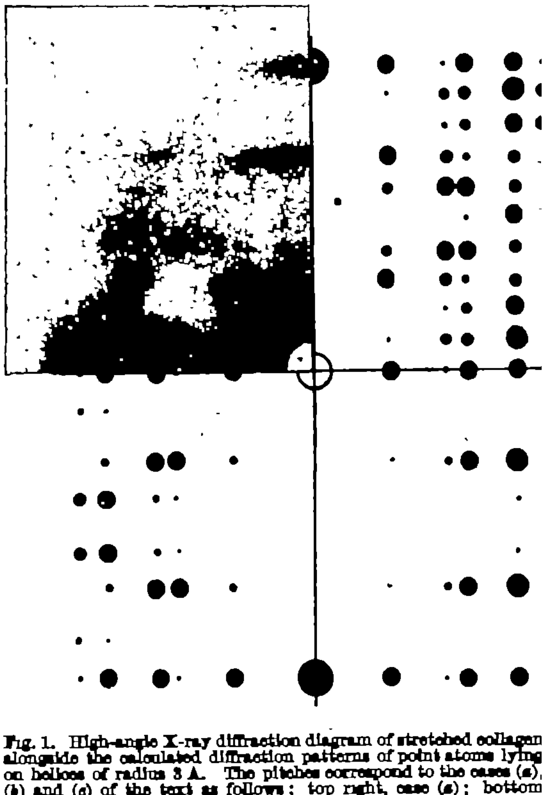

Fig. 1. High-angle X-ray diffraction diagram of stretched collagen alongside the calculated diffraction patterns of point atoms lying on helices of radius 3 A. The pitches correspond to the cases (*a*), (*b*) and (*c*) of the text as follows: top right, case (*a*); bottom left, case (*b*); bottom right, case (*c*)

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The measured density of dry collagen fibres shows at there are probably three amino-acid residues in e 2·86 A. atom set. The single-helix form (*a*) could en itself arise in one of several probable alternative ays: (i) a single polypeptide chain with three sidues in 2·86 A.; (ii) a unit of three similar arallel chains, each with one residue in 2·86 A.; i) a unit of three chains, each with one residue in 86 A., so related that the complete system is ecified by a single helical array of the dimensions (*a*).

We have investigated a large number of structures type (i), but have found none to be satisfactory. he difficulties of joining straight non-integral lices, as in (ii), by an adequate number of hydrogen nds, have already been pointed out[2–4]. It is possible at these difficulties may be overcome if, instead of system of three straight helices, we have a comound system of coiled coils, corresponding to case (iii). The intensity distribution given by a compound elical system involving several single helices wound lically around one another is, as pointed out by rick[10], more complex than for the simple cases, and is not easy to formulate by inspection all the mbinations of minor and major helix pitches which ould produce a given intensity distribution. A articular case, however, is suggested by the poly-L-roline and collagen data. In this, three chains, each ith three residues per turn relative to the major elix, slowly coil around each other so that the umber of residues per turn, relative to the common xis, becomes 3⅓. Such a system may be shown to orrespond to case (iii), and is, therefore, of a form onsidered favourable from the analysis of the X-ray iagram. Further, the number of residues per turn each chain relative to the other chains in the unit integral, so that a regular form of hydrogen bonding feasible.

Of the models proposed for the structure of colagen, only three[11–13] put forward since the helical nalysis of the X-ray diagram was first described[6,7] ave the required basic dimensions. The first two of hese involve *cis* residues, which seems very unlikely view of the infra-red spectrum of collagen[14,15] and f the structures of other peptides, particularly poly-proline; the third, that of Ramachandran and artha[13], is discussed below.

## Amino-Acid Composition and Sequence Analysis

Although the complete amino-acid sequence in llagen has not yet been determined, some sequence udies have been made[16,17] and we can reach certain ntative conclusions. Examination of the small eptides which have been identified suggests that, if ere is a repeated short sequence, it is not a rigid ne (or is not maintained throughout the protein aterial), but is rather of the form —$R_1$—$R_2$—$R_3$—, here $R_1$ may be proline, $R_2$ may be hydroxyproline, nd $R_3$ is, probably, nearly always glycine. The most teresting result is the isolation of the peptides glycyl rolyl hydroxyprolyl glycine and glycyl prolyl ydroxyproline. All three residues occur in sequences ther than the above, with the exception that hydroxyroline always appears to be followed by glycine. lthough glycine is about one-third of the total umber of residues, proline is only one-eighth and ydroxyproline one-tenth in bovine collagen[18], so that most the sequence —prolyl—hydroxyprolyl—lycyl— could only account for about one-third of e total structure. While glycine, the other non-polar residue, and the polar residues each account for about one-third of the total, the evidence does not suggest a rigid (—non-polar—polar—glycine—) sequence.

It may be that the sequence —prolyl—hydroxyprolyl—glycyl—, or a similar sequence, is largely concentrated in one of the three chains of a structure such as that discussed above, so conferring on this chain a special configuration. The other two chains can be pictured as crystallizing about this one. In any event, it is probable that a high proportion of these residues inserted into the α-helix[19] or β-pleated sheet[20] would make these structures unstable as a result of distortion and the reduced number of possible hydrogen bonds, and that a distinct type of chain might be the most stable. In the limit, a structure consisting entirely of proline residues might be expected to take up such a new configuration; this was in fact found to be the case.

## Structure of Poly-L-Proline

An X-ray study of poly-L-proline[1,2], synthesized recently by Berger, Kurtz and Katchalski[21], shows the polymer to have a helical structure in which the amino-acid residues are related by an exact threefold screw axis. The residue repeat along this axis is 3·12 A., and the similarity of this spacing to that of stretched collagen suggests strongly that the two chains have very similar configurations.

Poly-L-proline, like collagen, has a high specific *lævo* optical rotation[21]. It has been suggested that this rotation in collagen is due to the special type of helical configuration[22]. A left-handed sense is imposed sterically on the poly-L-proline chain, and it seems highly probable that the minor helices of a three-chain collagen structure would also be left-handed.

We now wish to consider ways in which three poly-L-proline type chains may be bonded together to form this compound system. The work described below was briefly referred to at the Third International Congress of Biochemistry, Brussels, 1955.

If one in three of the residues of the threefold chain has a secondary amide-group, then three chains can be imagined to be joined together by hydrogen bonds in two simple ways corresponding to the two trigonal positions in the poly-L-proline structure. In either system the individual left-handed chains are themselves related by a threefold left-handed screw. Looking in the —αC—NH—CO—αC— direction of the chains and taking the NH . . . O direction as the direction of hydrogen bonds, then the latter are alternately pointing clockwise or anti-clockwise. When the side-chain interactions are taken into consideration, the following results emerge. In the anti-clockwise system there are a number of short van der Waals contacts which would force the chains to take up a non-integral screw configuration. If a second proline ring is replaced by any side-chain, *R*, in the sequence —glycyl—*R*—prolyl—, there is a single short contact, which would cause distortion, whereas if two residues in three are glycine, there are no short contacts. In all cases the system might be stabilized with a three-and-a-third-fold screw-axis by additional hydrogen bonds. In the clockwise system, there do not appear to be any seriously short contacts, nor can such additional hydrogen bonds be readily made, and, although a three-and-a-third-fold structure can be built, there seems little reason for the chains to depart from the exact three-fold configuration. A preliminary investigation suggests that in the anti-clockwise arrangement there may be two simple ways of making these extra hydrogen bonds: first, by replacement of a second proline in the three-residue sequence by another secondary amide residue, so that by slight distortion of the chains a second set of NH . . . O hydrogen bonds can be formed between peptide backbones; or second, by using the polar groups of side chains. One of the remaining proline residues could be replaced by hydroxyproline or by other hydroxy, acidic or basic residues, which might allow formation of an OH . . . O or NH . . . O bridge to an unbonded carbonyl group. The work of Gustavson[23], which shows a correlation between thermal stability and hydroxyproline content of various collagens, is in favour of an O—H . . . O hydrogen bond, in the case of hydroxyproline at least, although there does not at the moment appear to be any correlation with the proportion of other polar residues.

While this work was in progress, we became aware that very similar lines of thought were being pursued by other workers in the field. Ramachandran and Kartha[13] have been the first to propose a structure, having the superhelical configuration described above, in which the basic NH . . . O bonding is in an anti-clockwise direction with the structure additionally stabilized in the first of the ways mentioned above. A rigid —prolyl—glycyl—*R*— sequence is required, so that the structure as it stands cannot accommodate a number of known sequences, particularly —prolyl—hydroxyprolyl—. The hydrogen-bond angles are rather greater than is normally considered permissible, although this may be consistent with the abnormally high NH-stretching frequency. The optical transform of this model, however, is in good general agreement with the observed diffraction data; while not correct in every detail, this strongly suggests that the general form of the backbone configuration is correct.

In conclusion, it seems to us highly probable that the collagen structure consists of three chains of the poly-L-proline type modified to give 3⅓ residues per turn. These three chains are bound together by a system of NH . . . O hydrogen bonds between residues approximately on the same axial level, and the structure is further stabilized and the 3⅓ residues per turn maintained by additional hydrogen bonding. It would seem that X-ray methods alone may not provide sufficient data to distinguish between differe structures of this general type, and it is possible th the actual structure might be a complex of slight different arrangements resulting in the maximu possible stability.

We are grateful to Prof. J. T. Randall for l continued advice and encouragement throughout tl course of this research. Two of us (P. M. C. and McG.) are indebted to the Nuffield Foundation f research fellowships during the tenure of which th work was carried out. [Nov. 9

*Note added in proof.* Since this paper was su mitted for publication a communication has appear by Rich and Crick[24], in which they propose tw alternative structures for collagen of the kind di cussed above. They have called these collagen I an II. Each has a single system of NH . . . O hydroge bonds, respectively in the anti-clockwise and clock wise arrangements.

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# QUANTITATIVE SEPARATION OF B VITAMINS BY ELECTROPHORESIS ON AGAR PLATES

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We have already described the determination of components of a mixture of vitamin derivatives after chromatographic separation on circular paper[1]. This method makes a fairly exact estimation possible, but is not sufficiently sensitive for direct use with some biological material, owing to the limited quantity of material that can be placed on the paper. The lower limit of sensitivity of 0·05 μgm. for thiamine and 0·15 μgm. for nicotinic acid and derivatives requires a certain minimum concentration of these substances. The assay is, moreover, complicated by the difficulty of estimating microbiologically active derivatives not clearly separable by chromatography Siliprandi and his collaborators[2] have applied electro phoresis on paper to the separation of derivatives c thiamine, riboflavin, pyridoxin and nicotinic aci which they later measured chemically. The sensitivit of their procedure (approximately 10 μgm.) can b greatly increased if electrophoresis is combined wit a microbiological assay by applying the dried pape to a suitable medium. It is nevertheless limited b the fact that only about 10 mm.$^3$ of the solution ca be applied to the paper.

We have developed a more suitable method b carrying out electrophoresis directly in thin layers c agar jelly as used in macro-electrophoresis[4]. Washe

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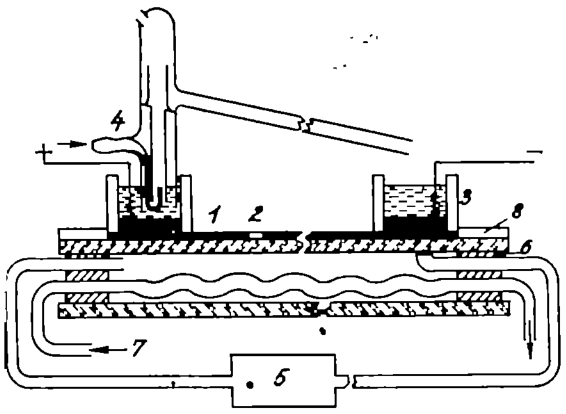

Fig. 1. Section of the apparatus for agar electrophoresis
1, agar (black); 2, starting hole; 3, electrode vessel; 4, pump; 5, thermostat; 6, rubber gasket; 7, cooling device; 8, glass frame

ilms of silica gel or polyvinyl alcohol have been ised; possibly other transparent jellies could be ised, but agar is to be preferred as a medium as it an be easily handled. High-voltage electrophoresis up to 10,000 V.) is carried out in silicon films. After eparation in the electric field, another layer of agar elly is placed on the first. This second layer contitutes a medium containing all the substances equired by the test organisms seeded into the agar xcept that to be determined. Zones of growth ppear in those spots corresponding to the presence f the vitamin or its active derivative in the lower ayer of the agar jelly. As in all diffusion tests, the ogarithm of the dose is directly proportional to the liameter of the growth zone.

The vitamins can also be demonstrated by chemical eaction in the agar in the same way as on paper see middle part of Fig. 2). Quantitative chemical letermination is possible after cutting out and iquefying the appropriate portions of the agar jelly. For the separation of the thiamine roup (shown in Fig. 2) the lower ayer of agar should have a pH of ·3. The warm, fluid agar is thereore diluted with phosphate buffer o a final concentration of 0·05 *M*. The most suitable concentration of gar must be determined for each ystem, and in general varies beween 1 and 2 per cent. We use lass plates up to 60 cm. × 80 cm. ramed by glass strips (2 cm. in readth) which are caulked with gar to hold the liquid agar film on he previously warmed plate (Fig. 1, 8). Without appreciable warmng of the agar film, 1–3 mm. thick, a current of 100–150 m.amp. can be put through it at a potential lrop of 7 V./cm. Distilled water an be sprayed on the film should it lry up with prolonged use. Under hese conditions the separation of hiamine and its derivatives is chieved in about four hours and an be controlled by the use of visible indicators such as acid uchsin, methyl green or riboflavin. The test substances are placed in oles, 5–10 mm. in diameter, punched in the jelly with a cork borer along a starting line at intervals of 2–4 cm. (Fig. 1, 2). If necessary, another layer of agar may be added along the starting line to increase the thickness. In this way 0·2 ml. or more of substrate can be placed on the agar, the grading of the doses being preferably logarithmic. Glass cups or filter-paper disks can be used instead of the punched holes for accommodating the substrate. Even solid substances such as minced organs, fæces and also blood can be placed directly on the agar, after denaturation of protein, without previous extraction.

In certain instances, increased separation of the active growth factors can be achieved by a combination of paper chromatography and electrophoresis in agar jelly, strips of the chromatogram being placed either singly or packed along the starting line. A frame 3 cm. in diameter composed of glass strips which are fixed by clamps is set on the solid agar plate and filled with liquid agar to a height of about 5 mm. and serves as an electrode vessel (Fig. 1, 3). With narrow electrophoretic plates up to 10 cm. wide, two sintered glass filters (Eintauchnutsche Schott *G4*) can be used for the purpose with two carbon rods inserted to serve as electrodes. If the pores in the sintered glass filters are too big, they can be covered with agar. The apparatus includes a heating and cooling device and a pumping system for the electrolyte solution. Before the agar is poured on the glass plate, the plate is warmed by pumping water at 55° C. into a chamber formed by two glass plates and a soft rubber gasket (Fig. 1, 6). For cooling, cold water is passed through the chamber (Fig. 1, 7). Incubation of the test organisms is carried out overnight after the requisite adjustment of temperature in the thermostat (Wobser Ultrathermostat) (Fig. 1, 5). During long runs, the electrolyte solution is repeatedly transferred by a blower from the anode to the cathode vessel and vice versa (Fig. 1, 4) to keep the hydrogen-ion concentration around the electrodes reasonably constant.

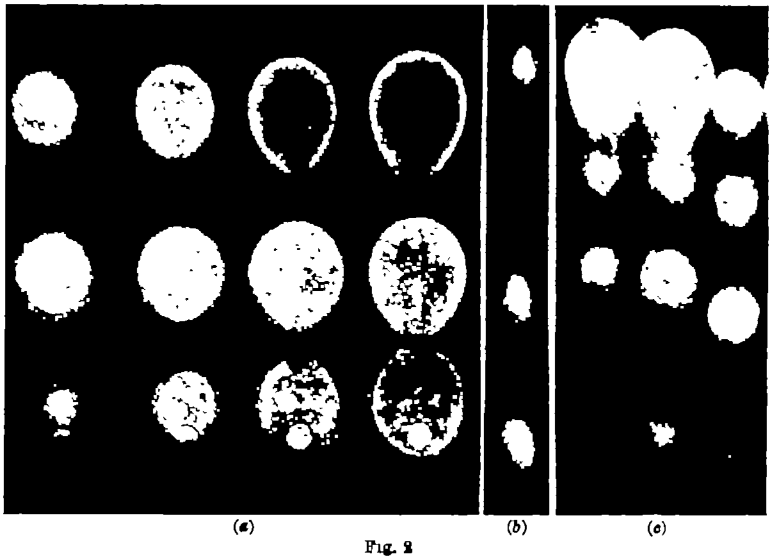

Fig. 2

(*a*) Growth zones with *Lactobacillus fermentum*. Standard mixture, 0 008–0 064 μgm Bottom row, pyrophosphoric acid ester of thiamine; middle row, monophosphoric acid ester of thiamine Top row, thiamine itself

(*b*) Chemical development to thiochrome (in ultra-violet light)

(*c*) Left: urine after a loading-test with thiamine. Centre: the same urine, but with added standard mixture of thiamine pyro- and mono-phosphoric acid ester, thiamine disulphide and thiamine. Right: the standard mixture alone

The growth zones shown in Fig. 2 were obtained with *Lactobacillus fermentum* ATCC 9338, by means of which as little as 0·002 μgm. of thiamine can be demonstrated. The diameter of growth zones is directly proportional to the logarithm of the dose within the limits 0·008–0·512 μgm. of thiamine (see Fig. 2). The pyrophosphoric acid and the monophosphoric acid esters of thiamine, thiamine itself and its disulphides and disulphide phosphates migrate to the cathode. For this reason the starting point for the thiamine group is placed near the anode. The speed of migration is in certain circumstances influenced by the ions present in the test solution. If necessary, the growth zones are identified by the use of an internal standard (see Fig. 2). We were able to demonstrate by such means the presence of thiamine disulphide in all the organs and excreta examined.

It is preferable to use for these tests organisms responding to as many factors as possible rather than the organisms of high specificity used for microbiological tests. It is by the different requirements of different organisms that a new factor can b identified and its chemical constitution inferred. Fo example, *Lactobacillus fermentum* requires the intac thiamine molecule, whereas *Rhodotorula mucilaginosa* is satisfied with the pyrimidine component alone *Phycomyces blakesleeanus* responds to higher concentrations of the thiazole moiety but not to pyrimidine. However, in the presence of small quantitie of thiazole, the mould develops a mycelium on those spots containing pyrimidine, or conversely forms i with small amounts (4 mgm./100 ml. medium) o pyrimidine on spots containing thiazole.

A detailed account of this work will be publishe elsewhere[4]. [June 14

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# VALENCY CHANGES OF MOLYBDENUM DURING THE ENZYMATIC REDUCTION OF NITRATE IN *NEUROSPORA*

By Dr. D. J. D. NICHOLAS and Dr. H. M. STEVENS

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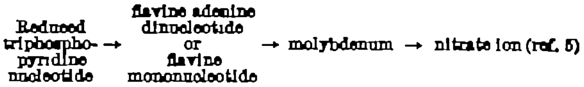
MOLYBDENUM has been identified as a constituent of nitrate reductase in *Neurospora crassa*[1,2], *E. coli*[3] and in higher plants[4]. The micronutrient undergoes oxidation-reduction changes during nitrate reductase action in the following sequence:



Reduced triphosphopyridine nucleotide → flavine adenine dinucleotide or flavine mononucleotide → molybdenum → nitrate ion (ref. 5)

This communication reports that, during the enzymatic reduction of nitrate, the valence change undergone by molybdenum involves $\text{Mo}^{6+}$ and $\text{Mo}^{5+}$. Paper chromatography was used to prepare pure solutions of salts with molybdenum in various valency states, and for identifying $\text{Mo}^{3+}$, $\text{Mo}^{5+}$ and $\text{Mo}^{6+}$. Sodium molybdate reduced with sodium dithionite, which acts as an electron donor for the enzymatic reduction of nitrate, was shown to contain $\text{Mo}^{5+}$ as the most reduced valence state of the micronutrient. Further, $\text{Mo}^{5+}$ prepared free from molybdenum in the other valence states acts as an effective donor for nitrate reductase action, but $\text{Mo}^{3+}$ is without effect. $\text{Mo}^{3+}$ will reduce nitrate non-enzymatically.

## Determination of Valence States of Molybdenum present in Dithionite-reduced Sodium Molybdate

*$\text{Mo}^{6+}$ and $\text{Mo}^{5+}$.* The molybdate solution reduced with sodium dithionite was spotted on acid-washed Whatman No. 1 paper, and run in the following solvent mixture: water 100, glacial acetic acid 10, potassium thiocyanate 10 gm. The chromatograms were dried and developed in one of three ways: (*a*) spraying with 0·2 per cent dithiol in 2 *N* hydrochloric acid; (*b*) spraying with a mixture of 10 per cent stannous chloride and 10 per cent potassium thiocyanate; (*c*) exposure to hydrogen chloride vapour.

$R_F$ values (which had been checked with standard solutions of molybdenum of the two valencies) are: $\text{Mo}^{6+}$ 0·3–0·4; $\text{Mo}^{5+}$ 0·8.

An alternative method is the addition of 8-hydroxyquinoline in 50 per cent chloroform–ethanol to the dithionite-reduced molybdate solution. The chloroform layer containing the oxinates was spotted on Whatman No. 1 paper, dried and run in ethyl alcohol. The oxinate spots of $\text{Mo}^{6+}$ and $\text{Mo}^{5+}$ were observed in daylight or in ultra-violet light:

$\text{Mo}^{6+}$ oxinate (yellow), $R_F = 0$, maxima 250, 370 mμ; minimum 280 mμ.

$\text{Mo}^{5+}$ oxinate (reddish purple), $R_F$ 0·9, maxima 243, 540 mμ; minimum 480 mμ.

These values had been determined using standard solutions of the molybdenum of the two valencies.

*$\text{Mo}^{5+}$ and $\text{Mo}^{3+}$.* The dithionite-reduced solution of molybdate in hydrochloric acid was separated on paper using an ether–thiocyanic acid solvent prepared by adding 10*N* hydrochloric acid (40 ml.) to a solution of potassium thiocyanate (40 gm. in 40 ml. water) (the mixture was cooled to 15° and extracted with 150 ml. redistilled ether; the ethereal layer was filtered, and stored in a refrigerator). After drying, the paper was sprayed with 10-vol. hydrogen peroxide, then dried and sprayed again with a mixture of 10 per cent potassium thiocyanate and 10 per cent stannous chloride. No molybdenum valency less than 5 was detected in the reduced molybdate solution. Using standard solutions of $\text{Mo}^{5+}$ and $\text{Mo}^{3+}$, $R_F$ values in this solvent are 0·8 and 0·0, respectively.

$\text{Mo}^{3+}$ is readily oxidized to $\text{Mo}^{5+}$ in the presence of $\text{Mo}^{6+}$, so that the separation of $\text{Mo}^{3+}$ in the presence of $\text{Mo}^{6+}$ was not feasible. It has not been ssible to prepare and determine Mo$^{4+}$ in solution cause of its instability.

## eparation and Determination of Mo$^{6+}$, Mo$^{5+}$ and Mo$^{3+}$

Mo$^{6+}$ was prepared by acidifying sodium molybdate th $2N$ hydrochloric acid, and Mo$^{5+}$ by dissolved olybdenum pentachloride in acetone. A chloride lution of Mo$^{3+}$ was made by reducing a mixed lution of sodium molybdate (0·5 gm./5 ml. water) d $10N$ hydrochloric acid (10 ml.) with zinc dust til the solution ceased to give a red colour when iquots were tested with 10 per cent potassium thioanate. The valency state of molybdenum in such mixture was checked by reducing 1 ml. of a sodium olybdate solution containing 12·5 mgm. molybmum per ml. as described. When all the zinc had ssolved, the solution was diluted with water to 0 ml.; 40–50 ml. aliquots were mixed with 50 ml. V sulphuric-acid and titrated with standard tassium permanganate.

Exp. 1. 5,625 μgm. of reduced molybdenum quired 3·5 ml. 0·05$N$ potassium permanganate. lculated for Mo$^{3+}$ → Mo$^{6+}$ + 3e, 3·51 ml.; for o$^{4+}$ → Mo$^{6+}$ + 2e, 2·34 ml.

Exp. 2. 5,000 μgm. of reduced molybdenum quired 15·6 ml. 0·01$N$ potassium permanganate. lculated for Mo$^{3+}$ → Mo$^{6+}$ + 3e, 15·62 ml.; for o$^{4+}$ → Mo$^{6+}$ + 2e, 10·4 ml.

The zinc and traces of Mo$^{5+}$ were removed from e solution as follows: 5 ml. of the mixture was aced on a cellulose column (15 cm. × 1·5 cm. ternal diameter). When the solution had soaked , the inner glass wall above the cellulose was wiped ith filter paper to remove any adhering liquid. The lumn was then eluted with thiocyanic acid in her, and this was continued for at least 15 min. ter the red band of Mo$^{5+}$ CNS had passed through e column. Ether was then passed through the lumn to remove thiocyanic acid, followed by dislled water to elute Mo$^{3+}$. The final eluate was armed to 45° and carbon dioxide passed through expel ether. The Mo$^{3+}$ solution was diluted to 0 ml. with water and stored in the refrigerator.

The molybdenum concentrations in the solutions ere determined as follows:

*Mo$^{6+}$*. To 5 ml. of sodium molybdate solution ntaining 2·5 mgm. molybdenum were added 5 gm. tassium thiocyanate and 10 ml. $5N$ hydrochloric id; the mixture was kept at 50° for 15 min. and as diluted to 100 ml. with 10 per cent potassium thioanate in $2N$ hydrochloric acid. The solution was tered through a No. 42 Whatman paper, and –20 ml. aliquots were extracted with 40–50 ml. distilled ethyl acetate. The ethyl acetate extracts ere measured at 490 mμ on a Spekker absorptioeter (blue-green filters). The concentration range ed was 1–12 μgm. molybdenum per ml. ethyl acetate.

*Mo$^{5+}$*. To 1 ml. of molybdenum pentachloride in etone containing approximately 500 μgm. molybmum per ml. was added 10 ml. of 10 per cent tassium thiocyanate in $2N$ hydrochloric acid and e solution kept at 50° for 15 min. to reduce any o$^{6+}$ to Mo$^{5+}$. Aliquots were extracted with 40–50 ml. hyl acetate and determined as described previously.

*Mo$^{3+}$*. To 0·5 ml. of Mo$^{3+}$ solution containing proximately 500 μgm. molybdenum per ml. was ded 10 ml. of 10 per cent potassium thiocyanate $2N$ hydrochloric acid followed by 10-vol. hydrogen roxide until the red colour produced started to fade. Then 10 per cent stannous chloride in $2N$ hydrochloric acid was added until the restored red colour no longer deepened. The mixture was then shaken with 40–50 ml. of ethyl acetate; the ester layer was filtered, and the colour measured at 490 mμ.

Table 1. Mo$^{5+}$ AS AN ELECTRON DONOR FOR THE ENZYMATIC REDUCTION OF NITRATE

Millimicromoles of nitrite formed in the reaction mixture

| Exp. | Reduced triphos. pyr. nucleotide Enzyme Flavin mono-nucleotide Pot nitrate | Mo$^{5+}$ Enzyme Pot. nitrate | Mo$^{5+}$ Pot. nitrate | Mo$^{5+}$ Boiled enzyme Pot. nitrate | Mo$^{6+}$ Enzyme Pot. nitrate |
|---|---|---|---|---|---|
| 1 | 35 5 | 36 | 0 | 2 | 0 |
| 2 | 24 | 22 | 0 | 1 | 0 |

0·5 ml. of enzyme containing approximately 400 μgm. of protein, 0·20 ml. reduced triphosphopyridine nucleotide (2 μmol./ml.), 0 20 ml. flavin mononucleotide (0 09 μmol. per ml.), 0·6 ml. 0·1 $M$ potassium nitrate and 50 μgm. Mo$^{5+}$ or Mo$^{6+}$ contained in 0 01 ml., each checked for purity by paper chromatography. The reaction mixtures were made to 2 ml. with 0·1 $M$ phosphate buffer $p$H 7 5. After 10 min. at room temperature the mixtures were assayed for nitrite using sulphanilamide and N-(1-naphthyl) ethylenediamine reagents.

## Enzymatic Reduction of Nitrate by Nitrate Reductase

Nitrate reductase was prepared from *Neurospora crassa* (Wild type 146, microconidial; kindly supplied by Dr. William D. McElroy, Johns Hopkins University, Baltimore) as described elsewhere[5]. Mo$^{5+}$ and Mo$^{6+}$ solutions, the valency purity of which was previously checked by paper chromatography, were tried as electron donors in the presence of the purified enzyme. The results are given in Table 1.

The results in Table 1 show that Mo$^{5+}$ is as effective as reduced triphosphopyridine nucleotide as an electron donor for the enzymatic reduction of nitrate. Mo$^{6+}$, however, is without effect. In the absence of nitrate reductase or in the presence of the boiled enzyme, Mo$^{5+}$ does not reduce nitrate. The very small amount of nitrite formed with the boiled enzyme is attributed to a release of bound nitrite from the denatured protein.

## Non-enzymatic Reduction of Nitrate by Mo$^{3+}$

Mo$^{3+}$ reduces nitrate non-enzymatically, whereas Mo$^{5+}$ or Mo$^{6+}$ is without effect. Thus it is possible to determine Mo$^{3+}$ in the presence of Mo$^{5+}$ by measuring reduction of nitrate. The rate of chemical reduction of nitrate by Mo$^{3+}$ is approximately twice that of nitrate reductase action. Over the range 0·1–20 mμ $M$ nitrate, 2 mμ $M$ Mo$^{3+}$ will reduce 1 mμ $M$ nitrate chemically.

It is unlikely that the chemical reduction of nitrate by Mo$^{3+}$ is important for the reduction of nitrate in *Neurospora*, because Mo$^{3+}$ has not been detected in the felts and the enzymatic reduction involves Mo$^{5+}$ and Mo$^{6+}$ only.

It has not been possible to effect a non-enzymatic reduction of either Mo$^{6+}$ to Mo$^{5+}$, or Mo$^{5+}$ to Mo$^{3+}$, using reduced di- or tri-phosphopyridine nucleotide as an electron donor. Reduced triphosphopyridine nucleotide does not appear to reduce Mo$^{5+}$ to Mo$^{3+}$ in the presence of nitrate reductase. [July 8

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Function of Krause's Membrane

A. V. Hill[1] has shown that ordinary diffusion of a chemical substance is too slow to explain the rapidity with which the contraction in the interior of a striated muscle fibre is set off by the action potential, which is a change in the potential difference across the surface membrane; some more rapid link must therefore exist. Krause's membrane (*Z* line, telophragma) is a possible anatomical basis for such a link[2], since it extends continuously across the fibre and is attached to the interior of the sarcolemma[3,4].

We have tested this possibility by depolarizing very small areas of the surface of fresh fibres isolated from frog muscles. A micropipette with a squared-off tip, diameter about 2 microns, filled with isotonic sodium chloride, was firmly applied to the fibre surface and fed with pulses of current of $\frac{1}{4}$-sec. duration, making the interior of the tip about 20–40 mV. negative with respect to the Ringer bath. Fig. 1 shows that, when this was done opposite an *A* band, there was no contraction, while if the pipette was opposite an *I* band (with *Z* at its centre), that *I* band alone shortened, the contraction spreading only a short way in. In neither case was it possible to initiate shortening with pulses which hyperpolarized the membrane. Greater inward spread was obtained with a 4-micron pipette (Fig. 2), which is the largest that could be used without overlapping more than one *Z* line. The *I* band to which this pipette was applied now shortened for a distance of about 10 microns inward from the surface, while neighbouring *I* bands (1·5–3 microns from the central *Z* line) did not shorten and were, in fact, passively stretched.

The fibres had ceased to give propagated electrical activity by the time we made these observations, but were still capable of powerful local twitches in response to depolarization of a larger area membrane. The current applied with the micr pipette would not be expected to set up a propagate action potential even in an excitable fibre, becaus of the smallness of the area depolarized.

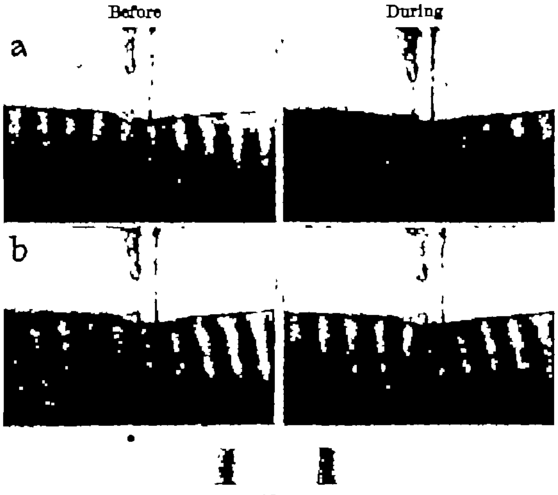

Fig. 1. Micropipette applied to edge of an isolated fibre from the semitendinosus muscle of the frog. Polarized light, compensated so that *A* bands appear dark. In (*a*), pipette is applied opposite an *A* band, in (*b*) opposite an *I* band. Left, before, and right, during, a pulse of current depolarizing the membrane opposite the tip. Contraction in (*b*) only, and then affecting only one sarcomere. In other experiments which were not recorded photographically, the contraction spread about 4 microns inwards

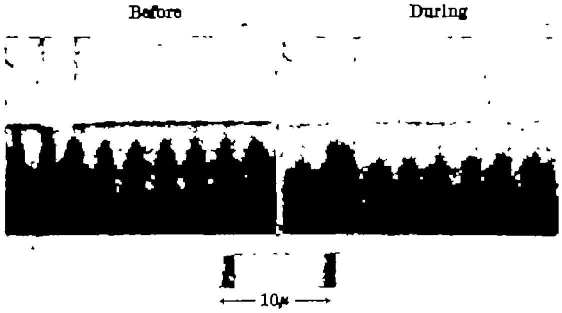

Fig. 2. As in Fig. 1*b*, but with larger pipette. Contraction spreads about 10 microns inwards, but there is no spread to the adjacent sarcomeres, where the *I* bands are, in fact, stretched

We consider that these results are strong evidenc that the influence of membrane depolarization is con veyed to the interior of the fibre by spread along som structure in the *I* band; from the anatomical situatio this must almost certainly be Krause's membrane.

This work was done during the tenure of a fellowshi by one of us (R. E. T.) from the National Institute Neurological Diseases and Blindness, U.S. Publi Health Service.

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Sept. 14.

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## Reaction of Starfish Spermatozoa to Histidine and Certain Other Substances considered in Relation to Zinc

Starfish spermatozoa are generally immobile i sea-water suspension. However, Metz[1] has reporte that they become intensely active when they ar suspended in egg albumin – sea water. His exper ments were chiefly concerned with the agglutinatio reaction, and further it was shown (Metz and Donc van[2]) that most of the amino-acids and peptides wer also capable of agglutinating the sperm, whe fertilizin was added. Apart from the problem agglutination, we were interested in the induce motility of these spermatozoa in albumin – sea wate and have examined the effects of various amin acids on their motility and metabolism.

It was found that L-histidine exerts a marke effect on the motility of these spermatozoa. It very striking to take a small amount (0·5 ml.) the diluted sperm (1 : 20) of the starfish, which ar almost motionless, and observe instantly active move ments on addition of 0·5 ml. of histidine – sea wate ($2 \times 10^{-2}$ *M*, *p*H 8·0). At the same time the effec of histidine on the initial oxygen uptake of thes spermatozoa was examined by the usual Warbur technique, at 20° C. and with air in the gas phas As shown in Fig. 1, histidine sharply increases th oxygen uptake, the effect being progressively i creased when sea water containing $10^{-4}$, $10^{-3}$

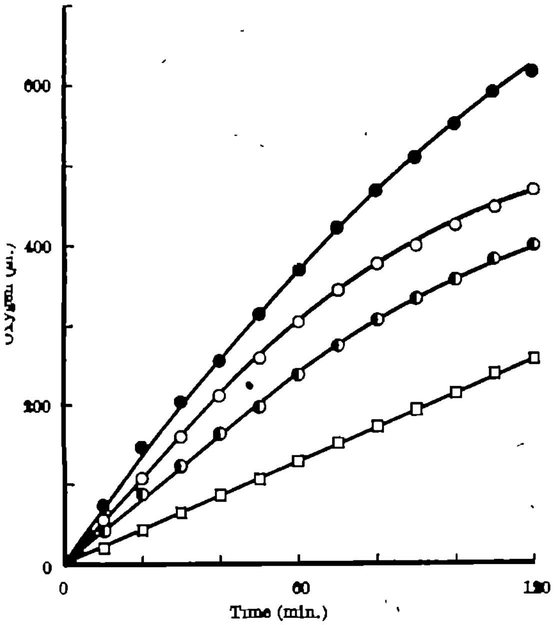

Fig. 1. Effect of histidine on the oxygen uptake of starfish spermatozoa in sea water with different concentrations of histidine: □—□—, control; ◐—◐—, $10^{-4}$; ○—○—, $10^{-3}$; ●—●—, $10^{-2}$ *M* histidine – sea water

$0^{-2}$ *M* histidine is added to sperm suspensions. The otility of spermatozoa is also greatest in $10^{-2}$ *M* istidine – sea water.

Further experiments showed that cysteine and lycine are also effective, the motility and the rate f the respiration of the spermatozoa in cysteine – sea rater being about the same as in histidine – sea water. 'he effect of glycine was very small. Also the helating agents ethylenediaminetetraacetic acid and iethyldithiocarbamate proved to be effective, but he spermatozoa swim less actively in sea water containing these agents than in histidine – sea water. Iowever, it is to be noted that no such effects were roduced when sea water containing other aminocids (alanine, leucine, serine, glutamic acid, arginine, ethionine, cystine, tryptophan, tyrosine) was dded to sperm suspensions.

The question immediately arises whether the xtraordinary effect of histidine is essentially brought bout by the liberation of zinc from the sperm, ince there is evidence that the imidazole group of istidine has a strong zinc-binding capacity (Gurd nd Goodman[3]) and since it has been shown (Fujii[4]) hat zinc is present in considerable amount in some arine sperm, especially in the middle-piece and crosome. That zinc occurs in high concentration n human spermatozoa has also been reported by Iawson and Fischer[5]. Therefore, the zinc content f *Asterias* spermatozoa was determined polarographically and a comparison was made between 1) sperm suspended in sea water for 30 min. and 2) sperm suspended for 30 min. in sea water containing $10^{-2}$ *M* histidine. It was found that the zinc ontent of the spermatozoa was greatly reduced after he treatment with histidine, suggesting that zinc r some zinc compound had passed from the sperm o the external solution. On the average, the zinc ontent of the former (1) was 0·21 μgm./mgm. dry reight, while that of the latter (2) was 0·10 μgm./gm. dry weight. The external medium, which had contained histidine-treated sperm, was found to give a positive dithizone reaction after centrifugation.

The evidence so far obtained suggests that, at least in the starfish, the release of zinc in minute quantities from the sperm is responsible for the initiation of the sperm's activity, both as regards motility and respiration. It is likely that the sperm middle-piece or the acrosome loses zinc to histidine or other metal-chelating substances, and that the liberation of zinc itself represents the sudden release of a state of stress in the spermatozoa. It appears difficult for the present to discuss these results in relation to the dilution effect (Rothschild and Tyler[6]) or the anaerobic motility induced by glycine (Tyler and Rothschild[7]) in sea-urchin sperm. It is interesting, however, to note that the effect of histidine was scarcely observable in a very dilute suspension of the starfish sperm. Could zinc release be normally involved in the basic mechanism of the motility of the spermatozoa?

These experiments described form part of a wider investigation on the physiological role of zinc. One of us (Fujii[8]) has already indicated that zinc is present in appreciable amount in the nucleoli of starfish oocytes, and is possibly involved in the mitotic processes.

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June 1.

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## Role of Photochemical Processes in the Reduction of Nitrate by Green Algae

Experiments have been described supporting the idea that reduction of nitrate in the light by green algae is a photochemical process[1]. However, a strong argument against this assumption is the fact that, without carbon dioxide, a really significant reduction of nitrate in the light has never been found[2,3]; only several hours after the addition of glucose can a strong evolution of oxygen due to nitrate reduction be observed[3]. This indicates an indirect influence of light via the formation of photosynthetic products rather than a direct photochemical reduction of nitrate. In the following we show that it is necessary to distinguish between the effect of light on the reduction of nitrate and nitrite, respectively (cf. also Harvey's results with diatoms[4]). The latter is the first intermediate in the reduction of nitrate by green algae[5].

When nitrate is added to *Ankistrodesmus braunii* suspended in nitrogen-free culture medium in the absence of carbon dioxide, only a minute amount of oxygen is evolved (Fig. 1). This result, obtained manometrically under a variety of experimental conditions (*p*H 6·5 and 4·5, under pure nitrogen and air, with $4 \times 10^{-4}$ to $9 \times 10^{-3}$ *M* potassium nitrate,

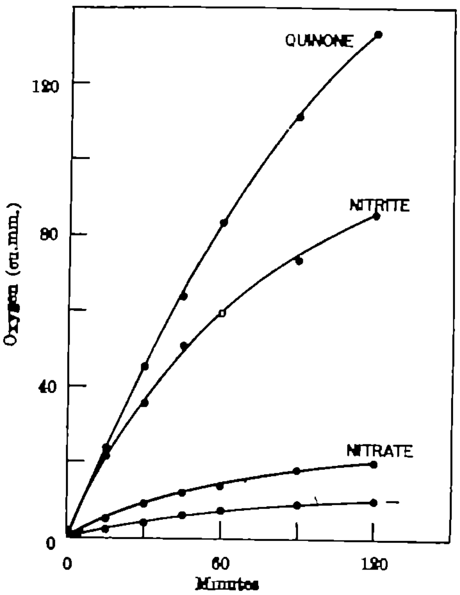

Fig. 1. Oxygen evolution after addition of quinone, sodium nitrite, and potassium nitrate (no addition as control) to *Ankistrodesmus* suspended in nitrogen-free culture medium ($p$H 6·5) in the absence of carbon dioxide. Gas phase, nitrogen (potassium hydroxide in the centre well); light intensity, 1,200-foot candles; temperature, 15° C.; 21 mm.³ cells (6·5 mgm. dry weight) per vessel. Concentrations of oxidants: quinone, 3·3 × $10^{-3}$ *M*; sodium nitrite, 1·1 × $10^{-3}$ *M*; potassium nitrate, 3·3 × $10^{-4}$ *M*. Theoretical yield: 179 mm.³ oxygen in each case. Pretreatment of the algae: 4 hr. in nitrogen-free medium at moderate light intensity (400 ft.-candles); gas phase, air

at 15° and 25° C.), is in excellent agreement with earlier findings[3,4]: The rate of reduction of nitrate under these conditions is approximately the same as that normally occurring in the dark. On the other hand, reduction of nitrate in the presence of carbon dioxide, or in the absence of carbon dioxide with added glucose[5], proceeds about ten times as fast as reduction in the dark[5]. By contrast, an addition of nitrite in non-toxic concentrations produces an immediate strong evolution of oxygen in the light. (Pressure changes are negligible in the presence of alkaline pyrogallol as an oxygen-absorbing agent.) Per mole of nitrite reduced, 1·5 moles of oxygen are formed. The rate of this reaction at $p$H 6·5 is somewhat smaller than that of the quinone–Hill reaction under the same conditions (Fig. 1). But at $p$H 4·5 reduction of nitrite in the light proceeds much faster, the rate of the reaction being nearly identical with that of the quinone–Hill reaction at $p$H 6·5. It is of interest in this connexion to note that the influence of $p$H on the dark-nitrite reduction is also strong but in the opposite direction[5]. Furthermore, it should be mentioned that an addition of nitrite in the dark under aerobic conditions leads to a strong increase in respiratory oxygen uptake[5], whereas under anaerobic conditions no gas exchange occurs.

In order to inhibit enzymatic processes effectively without influencing photochemical reactions possibly involved in the reduction of nitrite, the rate of the reaction under different conditions was studied at low temperatures. Comparison of the results obtained in a series of experiments performed at 4° C. and at 15° C., respectively (Table 1), shows that: (1) the reduction of nitrite at 15° C. in the light proceeds about twice as fast with concomitant photosynthesis as it does in the absence of carbon dioxide; (2) at 4° C. the favourable influence of carbon dioxide and

Table 1. Nitrite (*M* × $10^{-6}$) Reduction by 25 mm.³ *Ankistrodesm* Cells in 1 hr. at $p$H 4·5. Sodium Nitrite (5·5 × $10^{-4}$ *M*) added Algae in Nitrogen-free Culture Medium. Nitrite Concentration measured Colorimetrically. Experimental Conditio otherwise as indicated in Fig. 1

| | Light | | Dark | |
|---|---|---|---|---|
| | $N_2$ + 4% $CO_2$ | $N_2$ | Air | $N_2$ |
| 15° C. | 212 | 108 | 40 | 20 |
| 4° C. | 110 | 90 | 20 | 8 |

photosynthesis on reduction of nitrite largely di appears; (3) the rate of reduction in the light wit out carbon dioxide is only slightly decreased at 4° C (4) light under anaerobic conditions in the absen of carbon dioxide is much more effective in nitri reduction than is respiration[5] in the dark; this hol true especially at 4° C., where the rates of enzymat reactions are strongly decreased.

Considering these results, one might at first l inclined to conclude that the reduction of nitrite is simple photochemical process with nitrite acting lik quinone as a Hill reagent. There are, howeve some fundamental differences between the reductio of nitrite and a typical Hill reaction. Isolate chloroplasts, able to reduce quinone and other Hi reagents, are unable to reduce either nitrate[6] (unle nitrate reductase and triphosphopyridine nucleotid are added[7]) or nitrite[6,7]. Furthermore, the rate c nitrite reduction in the absence of carbon dioxid by whole *Ankistrodesmus* cells decreases faster tha that of quinone reduction (Fig. 1). Upon a secon addition of quinone, oxygen evolution immediatel starts again at a high rate; with nitrite, howeve only a small increase in oxygen formation is observe The rate of nitrite reduction is apparently determine by the supply of carbon compounds necessary for th further assimilation of the products of nitrate an nitrite reduction[8].

Accordingly, the influence of light upon nitrat reduction in green algae might be explained in th following way. The first step (nitrate → nitrite) which proceeds rapidly only in the presence of carbo dioxide or of glucose[5], seems to be indirectly acceler ated by light via the formation of photosyntheti products. On the other hand, the reduction c nitrite, which goes on at a high rate even at ver low temperatures and in the absence of carbo dioxide, seems to be more closely connected wit photochemical processes.

A full account of these and other results wi be published later. My thanks are due to the U.S National Academy of Sciences and to Foreig Operations Administration for a research scholarship

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# Respiratory Increase and Phosphorus and Nitrogen Metabolism in Sweet Potato Infected with Black Rot

IN the black rot of sweet potato caused by *eratostomella fimbriata* we found a respiratory inrease—a characteristic of plant tissues infected with athogens. We have investigated the rate of respiraory increase in the sound part next to the infected issues during a week after the inoculation of the athogen, the effect of 2,4-dinitrophenol on the espiration and the changes in the amount of phoshorus and nitrogenous compounds present.

In contrast to the constant respiration in the ontrol and the equal rate of respiratory increase about 80–90 per cent) caused by addition of dinitrohenol, the increase of respiration in tissue affected y black rot reached a maximum (about 90–100 per ent increase) at 48–72 hr., and gradually decreased hereafter; the respiratory increase due to addition f dinitrophenol dropped to c. 30 per cent at 48–72 hr., ut recovered again at a later stage.

able 1. RESPIRATION OF THE BLACK-ROT TISSUE OF SWEET POTATO AND THE EFFECT OF DINITROPHENOL

wenty slices (7 mm. in diameter and 0·5 mm. thick) were put into he Warburg vessels containing 85 µmoles of phosphate buffer (pH 5·5) nd 162 µmoles of sucrose in a total volume of 2·0 ml. Gas phase, air; emperature, 30°; 20 min. equilibration; dinitrophenol was added in a final concentration of 5 × $10^{-5}$ *M*

| (hr.) | 0 | 24 | 48 | 72 | 168 |
|---|---|---|---|---|---|
| Control (µl.) | 77·3 | 88·0 | 80·5 | 77·6 | 93·7 |
| Control + DNP | 138·7 | 156·0 | 143·0 | 149·0 | 178·0 |
| Increase (%) | 80 | 77 | 78 | 92 | 90 |
| Black rot (µl.) | | 132·7 | 147·0 | 177·0 | 120·0 |
| Black rot + DNP | | 208·0 | 186·0 | 232·0 | 231·0 |
| Increase (%) | | 56 | 26 | 31 | 93 |

Since the respiratory increase due to dinitrophenol s dependent on the acceleration of the reaction ATP → ADP + $P_i$), its effect indicates the speed of he above reaction in tissues. It is supposed that, herefore, the decrease of the effect in one stage may e caused by the promotion of breakdown and/or tilization of adenosine triphosphate by some bioogical process. To clarify this point the tissues were nalysed for inorganic phosphate and acid-soluble rganic phosphate. Both phosphate fractions of the ontrol remained almost constant, whereas inorganic hosphate in black rot tissue decreased at first, ncreased in the second stage, and then dropped gain; a concomitant increase of acid-soluble rganic phosphate was observed. Occasionally was observed that the level of inorganic phoshate in the secondary stage was not raised but emained constant. There was no measurable hange in the alcohol-soluble phosphate fraction conaining phospholipid and the phosphate fraction xtractable with cold perchloric acid and containing ibonucleic acid. The accumulation of acid-soluble rganic phosphate may indicate the activation of a hosphate system by which the energy of adenosine riphosphate is utilized and the rate of generation f adenosine diphosphate is increased; thus the ncreased respiration in the black-rot tissue of sweet otato may be linked to the activated phosphate ystem.

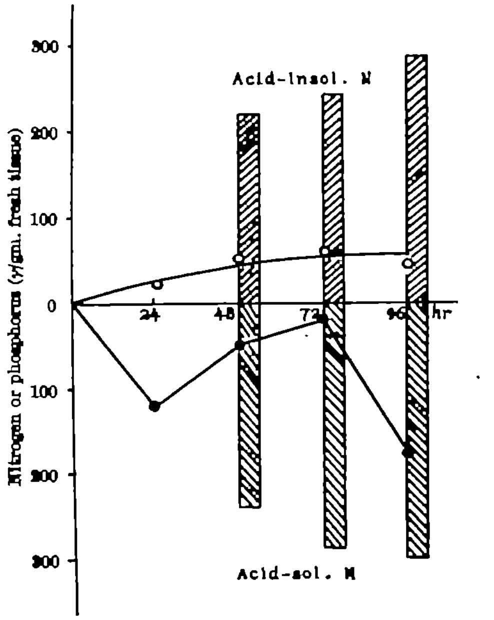

Fig. 1. Change of the amounts of phosphorus and nitrogenous fractions in the sweet potato infected with black rot. Inorganic phosphate, —●—, is expressed as the difference between the control and that of black-rot tissue; acid-soluble organic phosphate, ○—○, as the difference between that in black-rot tissue and that in the control. In the same way, acid-soluble nitrogen shows the decrease and acid-insoluble nitrogen the increase over the control. The values for the controls scarcely changed through the experimental stage

To elucidate the anabolic process such as the ctivation of the phosphate cycle in the black-rot issues, we have examined the nitrogenous metaolism. Compensating the consumption of the acid-soluble nitrogenous fraction (such as amino-acids), a concomitant increase of the acid-insoluble nitrogenous fraction (such as protein) was observed; in further experiments, the synthesis of functional protein such as mitochondrial protein was observed.

The mechanism of the respiratory increase in the black-rot tissues is thought to be as follows: by the penetration of *Ceratostomella fimbriata*, the protoplasm of the sound part next to the infected tissue is activated to synthesize organic phosphate, functional proteins such as mitochondria, and simultaneously accelerates the adenosine phosphate reaction (ATP → ADP + $P_i$); this results in an increase of respiration. P. J. Allen[1] believed that the respiratory increase in wheat infected by powdery mildew could be explained by the mildew toxins acting as uncouplers and accelerating the production of adenosine diphosphate. We have put forward the view that a part of the respiratory increase might be caused by the uncoupling effect of ipomeamaron, a sesquiterpene $C_{15}H_{22}O_3$, and related substances accumulated in the infected sweet potato tissues[2]; but from the above results it is thought that the effect of uncouplers such as ipomeamaron may be only partly responsible for the respiratory increase. As these uncouplers acted as inhibitors of the phosphate metabolism and protein synthesis of *Ceratostomella fimbriata*, they were presumed to take part in the resistance of sweet potato against the pathogen[3].

The metabolites (essential oils (such as ipomeamaron), polyphenols (for example, chlorogenic acid), coumarin substances (for example, umbelliferon and scopoletin)) were accumulated in the sound tissue, paralleling the respiratory increase[4], and offered resistance to infection by the pathogen. In addition, a thermolabile and non-dialysable fraction containing an inhibitor is produced in the black-rot tissues[5].

Those effects were also observed in white potato tissue, which shows strong resistance against *Ceratostomella fimbriata* infection[3]; the acid-soluble organic phosphate and acid-insoluble nitrogenous compound were synthesized, and at the same time the respiration was increased (c. 40 per cent). In the white potato rot-tissue, the thermolabile, non-dialysable fraction inhibited germination of the fungal spores. K. Tomiyama *et al.* have described a similar effect in the white potato infected with *Phytophthora infestans* and offered a similar explanation, independently, before a meeting of the Phytopathological Society of Japan (April 6, 1955).

We wish to express our thanks to Dr. Yusuke Sumiki, University of Tokyo, for his advice.

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# Molecular Weight of Insulin in N,N-Dimethylformamide

The detailed investigations of Sanger and co-workers have established the molecular weight of insulin as some multiple of about 6,000[1]. It is not clear, however, whether the fundamental covalently bonded unit is the 6,000 or 12,000 species. (The determination of the positions of the S—S linkages in insulin[1] does not establish the fundamental unit as the 6,000 species. The methods of analysis do not preclude the possibility of a staggered arrangement of the S—S linkages such that the 12,000 species is covalently bonded together.) Several workers using a variety of techniques—osmotic pressure, sedimentation and light-scattering—achieved results indicating that the minimum molecular weight of insulin in aqueous solution is 12,000[2]. However, other work has indicated a value of 6,000. Harfeneist and Craig[3], by counter-current distribution methods in 2-butanol-dichloracetic acid systems, Fredericq[4] by sedimentation-diffusion studies in alkaline solutions, and Kupke and Linderstrøm-Lang[5] by osmotic pressure determinations in aqueous guanidine chloride solutions, have all recently contributed data consistent with the value of 6,000. Osmotic pressure studies of insulin in N,N-dimethylformamide in this laboratory also indicate a molecular weight of 6,000 for the fundamental unit.

Amorphous insulin (lot 200-1*B*-11*J*) was a gift of the Eli Lilly Company. N,N-Dimethylformamide (DuPont) was purified by distillation at reduced pressure through an activated charcoal column. Although it has a relatively low dielectric constant of 26·6, the osmotic pressure studies were made in 0·2 *M* potassium iodide solutions of N,N-dimethylformamide in order to minimize an possible Gibbs–Donnan effect. Zimm–Myerso osmometers[6] were used with suitably permeab membranes prepared from Visking cellulose casin by a treatment which included an 18-hr. soak i 80 per cent ethanol. The osmometers were place in solvent inside closed glass jars to prevent al sorption of water. Equilibrium was attained i about two days and measurements were made f at least three days longer. The temperature wa 13·8° C. and was regulated to ± 0·01° C.

Table 1

| Insulin conc. (gm./L.)* | $\pi$ (cm. $H_2O$) | $\bar{M}_n \times 10^{-3}$ |
|---|---|---|
| 0·36 | 1·29 | $6·7_6$ |
| 0·46 | 1·64 | $6·8_5$ |
| 0·88† | 3·15 | $6·8_4$ |
| 0·92 | 3·02 | $7·4_6$ |
| 0·92 | 3·06 | $7·3_4$ |
| 0·92 | 3·13 | $7·1_4$ |
| 1·49 | 5·04 | $7·1_6$ |
| 1·79 | 5·82 | $7·4_7$ |
| 1·79 | 6·03 | $7·2_5$ |

* In 0·2 *M* potassium iodide in N,N-dimethylformamide.

† In 0·1 *M* sodium nitrate in N,N-dimethylformamide.

The data from these experiments (Table 1 an Fig. 1) extrapolate to a molecular weight of 6,200 ± 300 at $C = 0$. Assuming that the deviation fro ideality at higher concentrations is entirely due to monomer–dimer equilibrium, $2I \rightleftharpoons I_2$, we calculat an association constant of $2 \times 10^3$ litre-mol.$^{-1}$, corresponding to $\Delta F^\circ = -4·4$ kcal./mol.

The question arises as to whether the fundamenta structure of insulin is disrupted in N,N-dimethylformamide. Facilities for an assay of the activity o insulin recovered from it were not available. However, the following test was applied. It is well know that insulin aggregates to a considerable extent i aqueous solution, and the extent of this aggregation measured by the sedimentation-rate, is presumabl a characteristic of the unaltered molecule. Sedimentation experiments were therefore performed o insulin, which, after solution in N,N-dimethyl formamide, was dialysed against phosphate buffer *p*H 7·5, Γ/2 0·1, in which it was completely soluble Experiments were also performed with insulin dissolved directly in this buffer, for comparison. Withi experimental error, there was no difference betwee the sedimentation constants, $S^W_{20}$ (Table 2), for th original and the recovered insulin.

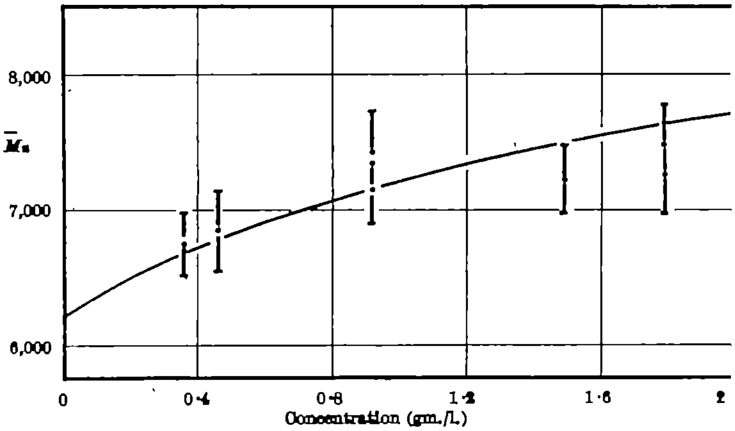

Fig. 1. Apparent number-average molecular weight of insulin in N,N-dimethylformamide as a function of concentration. The theoretical curve for a monomer–dimer equilibrium, with an association constant of $2 \times 10^3$ l./mol.$^{-1}$, is drawn through the data

Table 2

| Sample of insulin | $C$ (gm./l.) | $S_{20}^{w}$ (svedbergs) |
|---|---|---|
| Dissolved directly | 5·1 | 3·3 |
| | 2·9 | 2·9 |
| Recovered from N,N-dimethylformamide | 5·1 | 3·1 |
| | 2·5 | 2·8 |

Although minimal molecular weights of 6,000 and .000 have been reported, there is no inconsistency cessarily involved. The value of 12,000 has been ·md in aqueous solutions, in which it is not unlikely at the dimer persists. Two reports of the value 000 have now been obtained independently by arfenist and Craig[4] and in this communication, in n-aqueous solvents, in which the aggregation actions are apparently less favoured, and the true inimal molecular weight is observed.

This work is part of a study of the solubilities and operties of proteins in non-aqueous solvents, which ll be reported in detail elsewhere.

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# Inhibition of Complement Activity by Di-*iso*propyl Fluorophosphate

IT is generally agreed that di-*iso*propyl fluoro- 1osphate acts specifically to inhibit enzymes with terase activity[1]. In the light of this conclusion, e finding that it inactivates guinea pig complement ′) is felt worthy of this brief communication. (In personal communication, Dr. Laurence Levine ported that he has independently observed this me finding.)

When di-*iso*propyl fluorophosphate in concentrations ' $8{\cdot}0 \times 10^{-8}$ to $1{\cdot}0 \times 10^{-4}$ *M* was incubated with luted or undiluted guinea pig serum up to 4 hr. 37° C., or overnight at 26° or 4°, and then the rum diluted and tested for complement activity, effect of the fluorophosphate could be detected. 'hen, however, $8{\cdot}0 \times 10^{-8}$ *M* di-*iso*propyl fluoro- 1osphate was incubated for ½ hr. at 37° with varying ncentrations of 1–100 diluted guinea pig serum in e presence of sheep cells sensitized with rabbit emolysin, 75–80 per cent inhibition of the hæmolytic tivity of complement was noted. In the same rcumstances, $3{\cdot}5 \times 10^{-8}$ *M* di-*iso*propyl fluoro- hosphate gave 10 per cent inhibition. On testing e dialysed supernatants from the latter reaction r the presence of the four components ($C'1$, $C'2$, '3, $C'4$) of complement by the usual methods[2], only e first component ($C'1$) was found to have been opreciably inactivated.

That the effect of di-*iso*propyl fluorophosphate is 1 $C'1$ was confirmed by using sensitized sheep cells ntaining the first, second and fourth components 'a $C'1$, 4, 2). These were prepared as described by Levine *et al.*[3] and incubated overnight at 30° with di-*iso*propyl fluorophosphate, then washed, resuspended in buffer and tested for activity with reagents specific for the respective components. As can be seen in Table 1, the concentrations required for inhibition of the $C'1$ activity of these cells varied from $2{\cdot}7 \times 10^{-8}$ to $8{\cdot}3 \times 10^{-8}$ *M*. This is considerably less than the molar concentrations ($8{\cdot}0 - 3{\cdot}5 \times 10^{-8}$) required for inhibition of $C'$ for whole serum. The $C'4$ activity was not affected by this treatment. The effect of di-*iso*propyl fluorophosphate on $C'2$ could not be tested, since $C'2$ was spontaneously inactivated on standing in buffer alone. Partial reversal of the inhibition of $C'1$ activity could be obtained by allowing the cells treated with fluorophosphate to stand overnight in the presence of 0·1 *M* nicotinohydroxamic acid[4].

Table 1. INHIBITION OF $C'1$ ON $EAC'$ 1, 4, 2, INCUBATED WITH DI-*iso*PROPYL FLUOROPHOSPHATE

$1{\cdot}0 \times 10^{8}$ cells/ml. were incubated at 30° C. overnight with saline–veronal–bicarbonate buffer to which was added the di-*iso*propyl fluorophosphate, 0·001 *M* calcium ions, 0·003 *M* magnesium ions, and 0·04 *M* imidazole buffer *p*H 7·6. The cells were then centrifuged, washed, resuspended in buffer and reacted with $R_1$, the reagent for testing the $C'1$ reaction (ref. 2).

| | | | | | |
|---|---|---|---|---|---|
| Molar concentration of DFP ($\times 10^{8}$) | 270 | 41 | 21 | 8·3 | 0 |
| Time (min.) required to attain 50 per cent hæmolysis | > 30 | 20 | 9 | 4 | 1 |

From this it is concluded that the first component of complement $C'1$ is an enzyme with esterase activity which exists in serum in a precursor form resistant to the action of di-*iso*propyl fluorophosphate. In the course of the immune hæmolysis reaction, the $C'1$ precursor is changed to an active form of $C'1$ which is now capable of being inhibited by the fluorophosphate. The $C'1$ on the 1, 2, 4 cells apparently exists in such an active form, or was possibly changed into such an active form, during incubation with the fluorophosphate.

I am grateful to Dr. C. T. Harwood and to Dr. Bernard Jandorff for supplies of di-*iso*propyl fluorophosphate, and to Dr. I. B. Wilson for a sample of nicotinohydroxamic acid.

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# Occurrence of an L(+)-Alanine-Dehydrogenase in *Bacillus subtilis*

THE metabolic analysis of mutant strains of *B. subtilis* has shown that the ability to use the ammonium ion as the sole source of nitrogen for growth corresponds to the presence of a glutamic-dehydrogenase[1]. However, a mutant unable to use the ammonium ion (strain $S^{-}$), lacking glutamic-dehydrogenase, oxidizes glutamic acid very actively. This strain may grow, with aeration, in a culture medium containing: *l*(+)-glutamate 0·01 *M*, ammonium sulphate 0·01 *M*, phosphate buffer ($KH_2PO_4$–$Na_2HPO_4$) 0·02 *M*, *p*H 7·5, sodium chloride 0·01 *M*, potassium sulphate 0·01 *M*, magnesium sulphate 0·001 *M* and ferric citrate 0·0004 *M*.

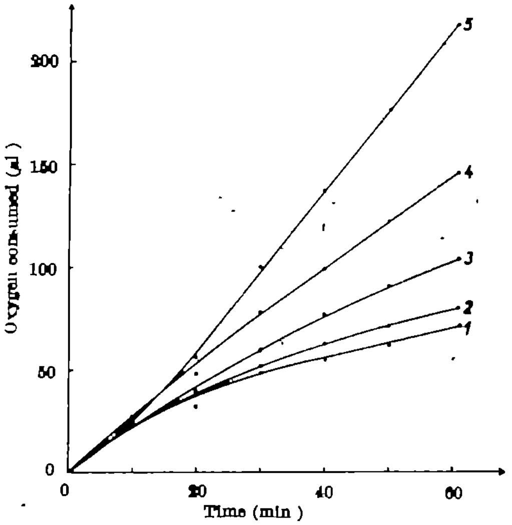

Fig. 1. Oxidations followed with a Warburg apparatus at 35° C. Each vessel contains: 2·0 ml. cell suspension (optical density 2·16) in 0 05 *M* phosphate buffer, *p*H 6 7; 0·2 ml. 5 *N* sodium hydroxide in the central cup. Curve 1, without substrate. Additions: curve 2, 100 μmole glycine; curve 3, 100 μmole *l*(+)-aspartate; curve 4, 100 μmole *l*(+)-alanine; curve 5, 100 μmole *l*(+)-glutamate

The absence of the glutamic-dehydrogenase in the $S^-$ strain implies an oxidative pathway of glutamic acid different from the ordinary one.

α- and γ-Aminobutyric acids are slowly oxidized by this bacterium, and the test for glutamic-decarboxylase in extracts is negative. This finding suggests that an oxidation preceded by a decarboxylation is not operative in this case. Another possibility might be the oxidation of a compound formed by transamination of glutamic acid, according to reactions (1) and (2):

$$\text{Glutamic acid} + R\text{—CO—COOH} \rightleftharpoons R\text{—CH(NH}_2\text{)—COOH} + \alpha\text{-ketoglutaric acid} \quad (1)$$

$$R\text{—CH(NH}_2\text{)—COOH} + O_2 \rightarrow R\text{—CO—COOH} + H_2O + NH_3 \quad (2)$$

$$\text{Glutamic acid} + O_2 \rightarrow \alpha\text{-ketoglutaric acid} + H_2O + NH_3 \quad (3)$$

In this system, α-ketoglutaric acid is used as the source of carbon for growth. The α-keto-acid, which is the acceptor of $-NH_2$, is regenerated by oxidation. This mechanism implies that the α-keto-acid originates from cell reserves, and is not lost by any secondary reaction. These restrictive conditions are not necessary if the α-ketoglutaric acid can regenerate the α-keto-acid. If we suppose that the α-ketoglutaric acid is oxidized through the Krebs cycle, the *R*—CO—COOH compound could be oxalacetic acid or its decarboxylation product, pyruvic acid, or glyoxylic acid arising from the decomposition of citric acid[8]. In this case, *R*—CH(NH$_2$)—COOH would be aspartic acid or alanine or glycine. Of these three substances, alanine is readily oxidized, aspartic acid is less oxidized and glycine almost not at all (Fig. 1).

*B. subtilis* $S^-$ cells, grown on the medium describ before, harvested when in the exponential phase, a treated with lysozyme[3], give an extract which is n able to absorb oxygen. The utilization of oxygen reinforced by addition of alanine and, to a less degree, by aspartic or glutamic acid. This oxyg consumption could result from the presence of flavoproteic *l*-amino-acid-oxidase, such as in *Neu spora crassa*[4], which oxidizes *l*(+)-alanine, *l*(- phenylalanine and, less actively, glutamic acid a aspartic acid. However, an extract prepared fro 12·5 mgm. lyophilized bacteria per ml., treated wi lysozyme and centrifuged at 80,000 *g* for 45 mi gives a clear supernatant which does not oxidi *l*(+)-alanine with oxygen, but in which the alani intensively reduces diphosphopyridine nucleoti (DPN+). The same extract, precipitated ammonium sulphate at saturation, redissolved a dialysed against phosphate buffer (0·05 *M*, *p*H 7· gives the activity reported in Fig. 2.

*l*(+)-Glutamic acid, *l*(+)-aspartic acid, *l*(– phenylalanine and *l*(–)-leucine have no actio Triphosphopyridine nucleotide is not reduced in t same conditions.

As shown in Fig. 2, the maximum reduction diphosphopyridine is a function of the concentrati of alanine. An equilibrium is obtained, as is al evident from the re-oxidation brought about addition of ammonium ions and to a lesser degr by hydrogen ions. The oxidation product of *l*(+ alanine is pyruvate. By incubation, during 30 mi at room temperature and *p*H 8·75, of a mixture 0·4 ml. of extract, 20 μ*M* of *l*(+)-alanine and 0·36 μ of diphosphopyridine and 0·4 ml. of pyrophospha buffer 0·1 *M* in a total volume of 1 ml., 0·31 μ*M* pyruvate is formed. The pyruvate gives a reoxid tion of the diphosphopyridine of the same magnitu as the ammonium ion.

One can conclude that the extract contains e enzyme which catalyses the reversible reaction (4

$$CH_3\text{—CH(NH}_3\text{)}^+\text{—COO}^- + DPN^+ + H_2O \rightleftharpoons CH_3\text{—CO—COO}^- + DPNH + H^+ + NH_4^+ \quad ($$

This enzyme may be called '*l*(+)-alanine-dehydr genase', in conformity with *l*(+)-glutamic-dehydr

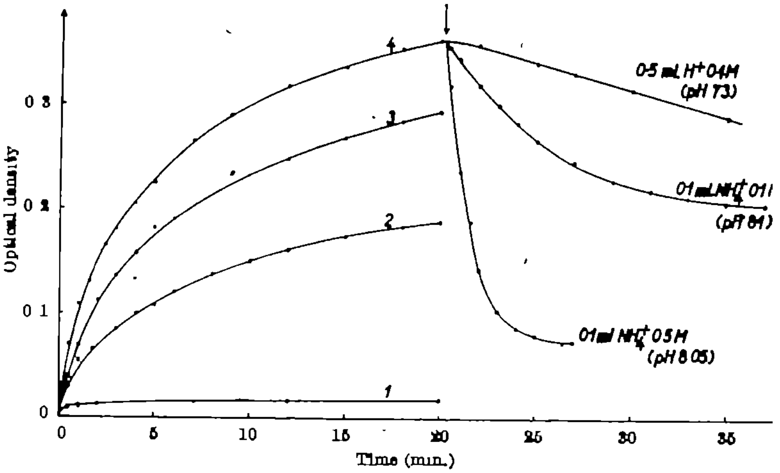

Fig. 2. *l*(+)-Alanine dehydrogenation followed by change in optical density of diphosphopyridine nucleotide at 340 mμ, with a Beckman Model *D.U.* spectrophotometer, at room temperature. The reaction mixture contained: 0 5 ml. cell-free extract, 0·5 ml. 0·1 *M* sodium pyrophosphate, 1 0 ml. 0·1 *M* phosphate buffer, *p*H 7·3; final *p*H, 8·1. Curves 1, 2, 3 and 4 correspond respectively to 0, 2, 5 and 10 μmole of *l*(+)-alanine in a volume of 0·5 ml. At zero time, 0·3 ml. of 0 001 *M* diphosphopyridine nucleotide is added. At the arrow, addition of ammonium ion and hydrogen ion as indicated on the curves. Values are corrected for dilution by the different additions

ıase, the only comparable enzyme known. Like former, this enzyme is very specific, since it does t act on $d(-)$-alanine and the other compounds ited.

Ihe reversibility of reaction (4) shows that this zyme is important, not only in the oxidation of +)-alanine, but also in the assimilation of ammonium. Although the assimilation of ammonium s only been shown to occur through glutamic-hydrogenase[1], other observations suggest that ferent mechanisms may exist[5].

The $S^-$ strain used in this work does not grow on nine as sole nitrogen source, and in this case the ination of pyruvic acid by ammonia is not erative.

One of us (A. P.) thanks the Institut pour l'Encourement de la Recherche Scientifique dans l'Industrie l'Agriculture for a grant.

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## Action of Ribonuclease on Living Cells *in vitro* and Synthesis of Deoxyribonucleic Acid

THE action of ribonuclease on living cells from arious materials has recently been studied[1,2]. Chick broblasts and myoblasts *in vitro* are readily affected; rowth of the cultures and the number of mitoses re considerably reduced[2]; cytoplasmic and nucleolar asophilia is diminished or suppressed and a typical odification of the chromatin, seen both with phase-ontrast optics in living cells and on fixed preparaions, is observed. Many nuclei (up to 95 per cent hen the action of ribonuclease has been particularly ntense) contain granular, or granular and filamentous, aterial or even are prophasic in appearance[3]. Even hen many nuclei are showing this prophasic aspect, ew—if any—other mitotic stages are encountered.

Histospectrophotometric measurements were unlertaken to assess how the hydrolysis of ribonucleic oid affected deoxyribonucleic acid metabolism. The quipment and techniques used for quantitative Feulgen determination after osmium fixation will be lescribed in detail elsewhere. They are essentially imilar to those of the Pollister and Leuchtenberger chool. Measurements of randomly chosen internitotic nuclei (all non-overlapping nuclei in a straight ine tangential to original explants, several explants being used for each group) were measured at 546·1 mμ. The most striking results were obtained with cultures which had had a long contact (3 days) with ribonuclease (crystallized ribonuclease G.B.I.). In Fig. 1, the histogram for such cultures is compared to normal controls of the same age. There is a considerable decrease in the percentage of the cells with a normal diploid value (1·82 ± 0·17 in arbitrary units) and a considerable increase in the number of cells with a tetraploid (3·65) or intermediate value. Other cultures in contact with ribonuclease for a shorter time (15 hr.–2 days) show a similar but less marked shift in deoxyribonucleic acid values.

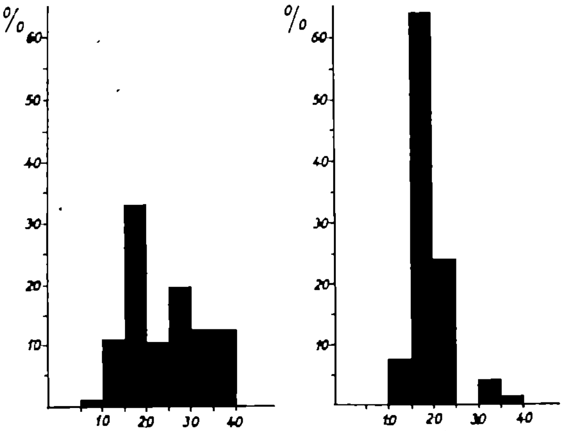

Fig. 1. Histograms of deoxyribonucleic acid values (arbitrary units) in intermitotic nuclei of 3-day old chick fibroblasts and myoblasts cultures. On the left, cultures treated with ribonuclease (1/300) in the medium (number of measurements, 108). On the right, controls of the same age (number of measurements, 81)

It should be emphasized that the granular distribution of deoxyribonucleic acid in many of the affected cells increases the heterogeneity of the dye distribution in the nucleus, and thus the measured extinction is lower than it would be if the same material was as homogeneously distributed as it is in the controls. A number of deoxyribonucleic acid values can be considered as too low, and the difference from the controls is certainly more marked than the histogram shows. In order to eliminate this lowering of values due to heterogeneity and to be able to measure prophasic or pseudoprophasic nuclei, we have used the two wave-lengths method of Patau[4] on some of these. This technique is more accurate but slower, and cannot be applied to all nuclei in our conditions. Measurements were made at 485 ± 20 mμ and 515 ± 20 mμ. Results are transformed into the units used above by a correction factor. All the prophasic nuclei measured by this technique in treated cultures proved to be tetraploids, and some very granular nuclei showed similarly high values.

As the treated cultures contain fewer mitotic figures (other than arrested prophases) than the controls, the difference between them is not due to a higher rate of cell multiplication in the treated cultures. Indeed, in an actively growing culture, the histogram has still another shape: a tetraploid peak of up to 15 per cent of cells is found with but few intermediate values. The effect observed is still different from that found in colchicine-treated cultures, where tetra- and octoploid nuclei appear as the result of mitoses interrupted at metaphase by spindle inhibition[5].

It appears that removal of cellular ribonucleic acid by ribonuclease does not prevent the synthesis of deoxyribonucleic acid by the cells before prophase, but inhibits further development of mitosis. We have thus a true prophasic inhibition of mitosis. It can be concluded that ribonucleic acid is not involved in the synthesis of deoxyribonucleic acid but is in some way necessary to the normal mitosis in this material.

This work, including comparison with other materials, will be reported more fully elsewhere.

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# A Critical Method of measuring the Diameter of Living Bacteria with the Interference Microscope

With an ordinary microscope, the accuracy of measurement is limited by the numerical aperture of the optical system and the wave-length of the light used, and it is scarcely possible to determine the dimensions of an object more accurately than to the nearest 0·4μ. Consequently, the size of very small objects such as living bacteria can only be estimated roughly by direct measurement.

With the interference microscope, however, it is possible to measure very critically the amount by which the light is changed in phase as it passes through an object, and, since this phase-change is proportional to the product of the object's refractive index and thickness, it should be possible to measure its thickness with considerable accuracy if its refractive index were known. One would no longer be limited in accuracy by the wave-length of the light used.

It is, in fact, possible to measure the refractive indices of many living bacteria quite accurately by the method of immersion refractometry developed in 1952 by R. Barer and his collaborators[1]: and so an attempt was made to combine this method with interferometry to obtain an accurate estimate of the mean thickness of a living bacillus.

The organism selected was *Bacillus bulgaris*, cultures of which were obtained from the Yalacta Laboratories in Paris. When measured with an eyepiece micrometer, it always appeared to be between 1μ and 1·5μ in diameter, both in the original cultures and in the subcultures grown from them. The refractive indices of all the bacilli were found to lie between 1·4000 and 1·4090 in each of the cultures investigated; and, when suspended in a bovine plasma–albumin solution that had a refractive index of 1·4045, approximately equal numbers of dark and bright bacilli were visible under the phase-contrast microscope. This figure was therefore taken as their mean refractive index.

Bacilli were suspended in a 0·25 per cent sodium chloride solution for examination with the interference microscope. This suspension-fluid was assumed, as a result of a previous investigation[2], to have a tonicity approximately equivalent to the above-mentioned bovine plasma solution, and it h a refractive index of 1·3350. The double-refracti interference microscope of Messrs. Charles Baker Holborn was used, and measurements were ma with a 2-mm. double-focus objective in conjuncti with the recently developed half-shade matching ey piece described by Smith[3]. Light from a 'Pointolit lamp was used, filtered through an Ilford 807 filt which gave a narrow green spectrum with a maximu intensity at about 542 mμ. With this arrangemen it was possible to measure the phase-changes caus by bacilli lying with their long axes at right angl to the optical axis of the microscope to the neare 1/60 wave-length, or more accurately than this.

It was, however, necessary to apply a sma correction to these recorded measurements, becau the bacilli were too small for any intensity differenc to be appreciated between their edge and midd line; which their cylindrical cross-section would lea one to expect. Thus, each phase-change recorde represented the integrated phase-change over th whole object, such as would be caused by its *mea* thickness as opposed to its *maximum* thickness. Th mean thickness of an object of circular cross-sectic is equal to the length of the side of a square equ in area to the circle: and a correction of $\times \frac{2}{\sqrt{\ }}$ or approximately × 1·13 must therefore be applie

Ten measurements of the phase-change were mad on different bacilli in each culture studied, and th mean taken. The mean thickness, *t*, of the bacil in each preparation was then calculated from th formula:

$$t = 1{\cdot}13 \times \frac{\varphi}{360} \times \frac{\lambda}{n-m}$$

where $\varphi$ was the measured mean phase-chang expressed as an angle, $\lambda$ the mean wave-length o the light used (542 mμ), $n$ the mean refractive inde of the bacilli (1·4045), and $m$ the refractive inde of the saline mounting medium (1·3350).

Table 1

| *Bacillus bulgaris* culture (date) | Mean $\varphi$ (degrees) | $t$ ($\mu$) |
|---|---|---|
| Paris, 11/7 | 55·8 | 1·37 |
| Paris, 11/7; subcultured, 16/7 | 55·4 | 1·36 |
| Paris, 11/7; subcultured, 24/7 | 52·6 | 1·29 |
| Paris, 25/7 | 52·8 | 1·29 |
| Paris, 25/7 | 53·2 | 1·30 |
| Paris, 25/7; subcultured, 27/7 | 52·2 | 1·28 |
| Paris, 25/7; subcultured, 27/7 | 53 6 | 1·31 |
| Paris, 25/7; subcultured, 27/7 | 52 0 | 1·28 |
| Paris, 25/7; subcultured, 27/7 | 54·4 | 1·33 |
| Paris, 25/7; subcultured, 27/7 | 53·6 | 1·31 |

Table 1 shows the values for the mean phase change and thickness obtained in ten different preparations, including cultures and subcultures o several different dates. Each figure in the table is the mean of ten observations. It will be seen tha the mean thicknesses thus calculated vary from 1·28μ to 1·37μ: a maximum scatter of only 0·09μ. It is evident that the diameter of the bacilli in the various cultures is remarkably uniform. The limit to the accuracy of this method is presumably set by the accuracy with which $\varphi$ can be determined.

I wish especially to thank Dr. J. R. Baker, of the Cytological Laboratory, Department of Zoology, Oxford, and Mr. F. H. Smith, of Messrs. Charles Baker, Holborn, for much valuable criticism and advice. Most of the apparatus used was provided

t of a grant from the London University Central search Fund.

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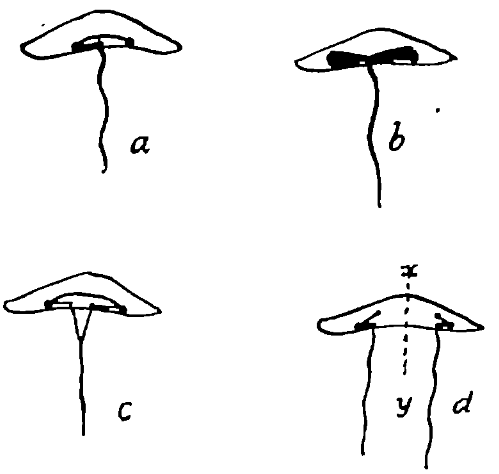
## Taxonomic Position of the Genus *Selenomonas* (von Prowazek)

In a recent analytical review[1], Lessel and Breed ve reiterated the conclusions of Boskamp[2] upon bacterial nature of *Selenomonas palpitans* (Simons, Boskamp). Although they do not add materially the information available, these authors state that *lenomonas* clearly belongs to the family Spirillaceae. I have studied the morphology both of *Selenomonas lpitans* from the guinea pig caecum, and of *S. utigena* from the human mouth, and am of the inion that the nuclear structures, flagellation and de of cell division are entirely unlike those of cteria and reflect a much closer relationship with protozoa.

The nucleus consists of a filament with expanded ds, one of which is connected by a rhizoplast to the pharoplast, from which arises the flagellum, usually the centre of the concave side of the crescentic cell. e nucleus and a portion of the neuromotor appara- s are embedded in deeply staining basophilic asses, in the form of two cones, point to point ig. 1,*b*). When the nucleus divides, a second rhizo- st appears, joining the blepharoplast to the free d of the nuclear filament. The blepharoplast vides, initiating division of the flagellum, and the vision of the nucleus follows (Fig. 1,*c*). The cell en divides by constriction. This is entirely unlike y known scheme of nuclear division in bacteria[3]. The cell wall fails to stain in the characteristically cterial manner with tannic acid and crystal violet, with phosphomolybdic acid and methyl green[3,4], d the cell lacks the cross-walls which are found in many bacteria, including spirilla[3]. The flagellum, when compared with those of bacteria in the same field of the electron microscope, was entirely distinct in its appearance. It is composed of numerous tiny fibrils, like the flagella of protozoa, and unlike either the monofibrillar flagella of bacteria or the compound flagella of certain spirilla[3]. The flagellum of *Selenomonas* is also distinct from that of bacteria in that it can be demonstrated in the light-microscope by staining with Giemsa or simple dyes without previous mordanting. The frayed 'whip-tuft' appearance shown by Boskamp[2] and others is an artefact, due to unsuitable technique. The cell moves in an irregular tumbling course, which once more is more reminiscent of protozoa than of bacteria.



ig. 1. (*a*) Nuclear structure in an adult cell of *S. palpitans*. b) Masking basophilic materials often confused with the nucleus roper. (*c*) Division of nucleus and splitting of flagellum. d) Nuclear division completed, cell now divides by constriction along *x*—*y*

These findings indicate clearly that the affinities of the genus *Selenomonas* are with the Protozoa. The classification of Wenyon[5], which places it in the family Monadidae (Kent), is adequate to the present extent of our information.

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## Paper Chromatographic and Biological Properties of Reserpine and Related Compounds

Little is known of the metabolism (in man and experimental animals) of the alkaloids of *Rauwolfia serpentina*. We are particularly interested in the reported antifertility effects of reserpine in rats[1] and the mechanisms of sedative action[2] of *Rauwolfia serpentina* alkaloids in schizophrenic patients. Reserpine is known[3] to be hydrolysed *in vivo* to methyl reserpate and presumably trimethoxybenzoic acid. The latter compound has been shown[4] to influence certain enzyme systems *in vitro* which are of importance in relation to the mode of action of œstrogens on the uterus. Using a fertility performance test, we have studied the effects of the administration to male and female rats of daily oral doses of 80–100 mgm. of sodium trimethoxybenzoate given over a period of ten weeks. Since no alteration in fertility was observed, we conclude that reserpine itself or some polycyclic metabolite is responsible for the observations of previous workers[1].

We recommend the following paper chromatographic procedures as a means of checking the purity of commercial samples of *Rauwolfia* alkaloids and determining the composition of complex mixtures of the alkaloids used for therapeutic purposes and in pharmacological tests. At the time of writing, we are unaware of any detailed reports on paper chromatography of *Rauwolfia* alkaloids. The methods introduced by us employ Whatman paper No. 542 and the following developing solvent systems:

(1) '*Single phase*' *systems* (no pre-equilibration, capillary ascent technique employed).

(*a*) 10 per cent (v/v) acetic acid in aqueous 5 per cent sodium acetate is shaken with *n*-butyl ether, added in small portions, until saturation of the aqueous phase is just reached. The clear aqueous phase is used.

(*b*), (*c*) and (*d*), similar to (*a*) but using tertiary amyl alcohol, *sec*.-butyl alcohol or methyl*iso*butylketone instead of *n*-butyl ether. (*d*) was particularly useful for slow-moving components in (*a*). Similar solvents have been used previously for urinary phenols and œstriol[5].

(*e*) Xylene 200, methanol 75, methyl*iso*butylketone 25.

(2) *Partition chromatography* (pre-equilibration required).

(*a*) *n*-Amyl alcohol 200, water 180, acetic acid 20.

(*b*) *n*-Hexyl ether 200, methyl*iso*butylketone 50, acetic acid 20, water 180.

Two-dimensional paper chromatography of a commercial concentrate of reserpine and other alkaloids from *Rauwolfia serpentina* revealed twenty-four fluorescent components without using any spray reagents. Suitable combinations of solvents were (2*b*) followed by (1*a*) or (1*b*), or (1*e*) followed by (1*a*).

The following tests may be used for locating the compounds: (i) Fluorescence in ultra-violet light (Wood's glass filter). (ii) Fluorescence after streaking or spotting the paper with 3 per cent sodium nitroprusside in 50 per cent trichloracetic acid (cf. ref. 3). (iii) Fluorescence 30 min. after spotting the paper with microdroplets of 90 per cent sulphuric acid and later spraying with 9 per cent sodium carbonate. Intense blue, green or greenish-blue fluorescent spots are obtained in the alkaloid zones. (iv) Tests (ii) and (iii) followed by spraying with alkaline diazotized I.C.I. 5091 [4]—pink colours. Methyl reserpate and ajmaline are particularly intense. (v) Ehrlich's dimethylaminobenzaldehyde reagent; ajmaline-blue spot which is intensified by the reagent used in (ii). (vi) Bismuth iodide – iodine in ethyl acetate, acetic acid followed by 0·5 per cent sodium dithionite to remove the orange background. Several compounds give salmon-coloured spots; but the sensitivity is not high.

Tests (i) to (iv) are used together as a routine on single chromatograms.

Solvent system (1*a*) gave the best results and tests (ii) and (iii) gave positive reactions with less than 1 μgm. amounts of reserpine and rescinnamine.

The following relative $R_F$ values were obtained using solvent (1*a*): ajmaline 0·76, deserpidine 0·41, methyl reserpate 0·52 principal spot, and 0·76 as well as two other minor components, rauwolscine 0·63, reserpine 0·34, rescinnamine 0·26, serpentine 0·5, yohimbine 0·58, new yohimbine 0·62. With solvent (1*b*) $R_F$ values were: ajmaline 0·75, ajmalicine 0·5, canescine 0·59, corynanthine 0·64, reserpine 0·43, and impurity 0·55, rescinnamine 0·31, and impurity 0·41, serpentine 0·5.

We thank Profs. S. Zuckerman and J. Elkes for their interest and support in these studies. One of us (A. B. K.) is on deputation from the Central Drug Research Institute, Lucknow, India, under the Colombo Plan.

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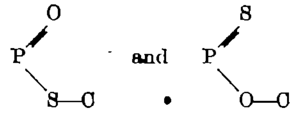
## A General Method for locating the Spot on a Paper Chromatogram of Tertiary Alkyl Phosphates, Thiolophosphates and Thionophosphates

There is no method described in the literat that is generally satisfactory for rendering th compounds visible in paper chromatography. Ha and Isherwood[1] describe a method for phosph amides, for example, 'Schradan'. This method fa with many compounds containing



In the case of 'Systox', about 50 μgm. gives posit results when treated with alkali for a period of to 70 hr.

J. W. Cook[2] reported a new spot test for so organo-phosphorus compounds containing sulph ('Systox' and its isomers). In this method t chromatogram is first treated with N-bromosucci imide and then with fluorescein. The former rea with the sulphur-containing organo-phosphorus co pound. The remaining area of the paper contains fr N-bromosuccinimide which afterwards reacts wi fluorescein, forming a non-fluorescent compoun Exposing the chromatogram to ultra-violet lig renders the organo-phosphorus compound visible a fluorescent spot. Only when the proper amounts N-bromosuccinimide and fluorescein are used is t bromine completely absorbed by the spot, which then located by the fluorescence of fluorescein. T method has therefore the disadvantage that a co trolled amount of bromine and fluorescein has to used. If a quantity of N-bromosuccinimide grea than is needed to brominate the compound is use the excess will brominate the fluorescein as in t background, and thus mask the spot. Similarly, excess of fluorescein will mask the spot throu fluorescence of the background.

If there is more than one spot and the quantities substance in the spots differ, it follows that it impossible to adjust the amounts of reagents to reve them all and give an indication of their concentrati in any one chromatogram.

It was found that all organo-phosphorus compoun containing sulphur so far investigated are, after trea ment with N-bromosuccinimide (dissolved in aceton much easier to hydrolyse. Treatment with ammoniu molybdate solution as used by Hanes and Isherwoo formed blue spots after 10–20 min. exposure ultra-violet light. The method is very sensitiv less than 7 μgm. may be detected as very clea distinct spots. Details of this work will be publish later.

I would like to thank Mr. A. J. Lambie for h help and encouragement and the Directors of Fis Pest Control, Ltd., for permission to publish the results.

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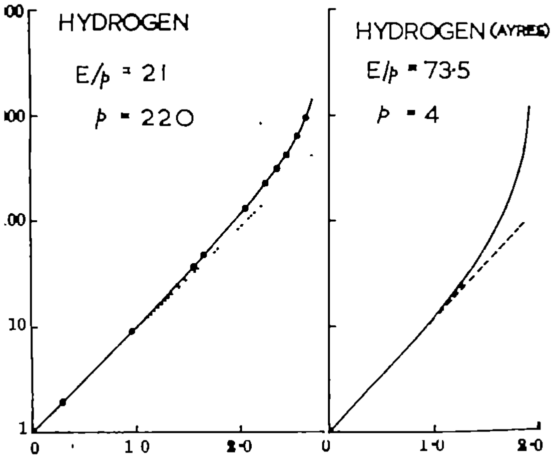
## Growth of Pre-Breakdown Ionization Currents in Hydrogen

HE growth of ionization currents with distance onstant low values of $E/p$ ($E$ is the field, $p$ the pressure) at high values of $p$ has been investigated this laboratory primarily to obtain precise de-nimations of the ionization coefficients $\alpha$ and $\omega/\alpha$ conditions, when special attention was paid to state of the gas and cathode surface. Some of results obtained preliminary to the main part his investigation are, however, of general interest. he ionization chamber used was the same as that imilar work with air[1] and nitrogen[2]; the gas was k hydrogen passed through heated palladium and rwards cooled by liquid air. A typical log $I/I_0$ vs. rve ($I$ is the ionization current, $I_0$ the initial current n the cathode, $d$ the gap distance) for $E/p$ = V./cm. mm. mercury and $p$ = 220 mm. mercury hown in Fig. 1, which also gives for comparison rve obtained for hydrogen by Ayres[3] for $E/p$ = 5 V./cm. mm. mercury at the low pressure, $p = 4 \cdot 1$ ı. mercury. It can be shown that both curves ee within the experimental error with the well-wn Townsend relationship :

$$I = I_0 \exp \alpha d/\{1 - \omega/\alpha\,(\exp \alpha d - 1)\}$$

re $\alpha$ is the primary ionization coefficient and $\omega/\alpha$ generalized secondary ionization coefficient. It ows from this result that the mechanism which the criterion for static breakdown in uniform ds is the same at $pd_s \sim 640$ mm. mercury cm. at ressure of 220 mm. mercury as at $pd_s \sim 10$ mm. rcury cm. at a pressure of 4·1 mm. mercury ($d_s$ ng the sparking distance). In this respect the trical properties of hydrogen are similar to those ir and nitrogen.

ther values of $pd_s$ have been investigated and ilar results obtained; these results will be dis-sed elsewhere, since they are concerned mainly h the precision determination of the coefficients l cathode effects. However, since previous asurements[3–5] of $\alpha/p$ were mostly obtained at low pressures and there are considerable discrepancies ween results obtained by different observers, it is interest to give[6] here the preliminary values (maximum error ~ 15 per cent) obtained for $\alpha/p$. These values, obtained for a range of $E/p$ from 16 to 25 V./cm. mm. mercury at a pressure of 150 mm. mercury, are shown in Fig. 2. There is good agreement between these results and the recent results obtained by Rose[6] using modern techniques for the same range of $E/p$ but at low gas pressures. This agreement in values of $\alpha/p$ obtained at the same $E/p$ but widely different gas pressures is direct experimental evidence that the similarity relation $\alpha/p = f(E/p)$ holds for primary ionization over a wide range of pressures from pressures of a few millimetres to 150 mm. mercury in hydrogen. It follows, therefore, that the mechanism of primary ionization is the same over this range of pressures, and implies that the applied field is not substantially distorted in the electron avalanche with the initial current densities ~ $3 \times 10^{-12}$ amp./cm.[2] used.



(a) (b)

lg. 1. Curves of log $I/I_0$ vs. $d$ for hydrogen. (a) High pressure $/p = 21$ V./cm. mm. mercury; $p = 220$ mm. mercury. (b) Low ressure (ref. 3); $E/p = 73 \cdot 5$ V./cm. mm. mercury; $p = 4$ mm mercury

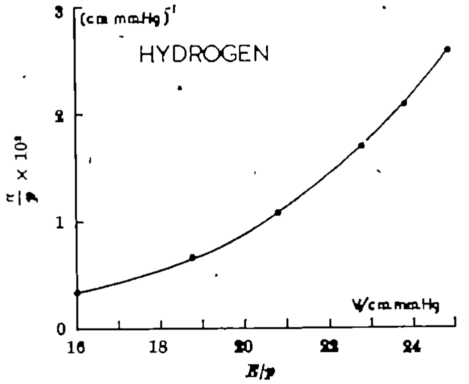


Fig. 2. $\alpha/p$ vs. $E/p$ in hydrogen at a pressure of 150 mm. mercury

We wish to thank the Central Electricity Authority for its support of this investigation; and we are grateful to Prof. F. Llewellyn Jones, in whose laboratory this work was carried out, for his help and interest.

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## Measurements of Retarding Potential on the Hollow Cathode

The hollow cathode[1] consists of a cylindrical closed box of nickel with a small hole at one end. The inner surfaces of the box and the hole are coated with conventional cathode paste.

Various attempts have been made to explain the high current densities (10–100 amp./cm.[2]) which can be obtained from such a cathode; but these cannot be verified until the experimental investigation of the cathode has been completed. In particular, no

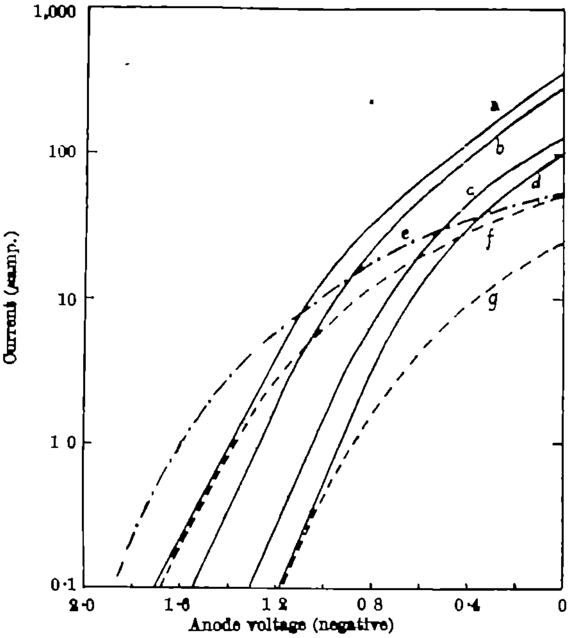

Fig. 1. ———, Hollow cathode: (a) 940° C., (b) 920° C., (c) 865° C., (d) 840° C. – – – –, 'Plug' cathode: (f) 940° C., (g) 840° C. — —, Flat cathode: (e) 940° C.

information was available on the temperature of electrons leaving the cathode, as determined by retarding potential measurements. Such measurements have now been made on hollow cathodes of two types and these have been compared with results obtained with planar diodes.

One type of hollow cathode had an end-wall thickness of 0·75 mm. and a hole diameter of 0·35 mm., and was placed 1·9 mm. away from a plane molybdenum anode. The second type was a 'plug' cathode geometrically similar, but with the hole completely filled with cathode paste instead of being merely coated on its sides. For comparison purposes, some planar diodes were made with a cathode diameter of 4 mm. Typical results are shown in Fig. 1.

It is interesting to compare the curves for the 'plug' and 'hollow' cathodes. The effect of filling the hole in the hollow cathode with cathode paste was to reduce the number of slow electrons emerging from the cathode. The curves tend to merge together as the anode becomes more negative. It was not possible to estimate the electron temperature accurately from the slope of log $I$ plotted against $-V$ because the retarding potential plots did not give the expected straight lines, even with planar cathodes. The electron temperatures calculated from the linear portion of the graph for the hollow cathode were about 1·4 times the values of cathode temperature found from pyrometer and thermocouple measurements. A similar discrepancy was noted in the case of the flat oxide-coated cathode, and this is in agreement with results obtained by Nottingham[2]. He found that the phenomenon was peculiar to oxide-coated cathodes and did not occur with thermionic emission from pure metals.

For low values of anode voltage there was an apparent deficiency in slow electrons for all three types of cathode. It is interesting to note that the effect was more pronounced with the hollow cathode than with the 'plug' cathode. Similar results were obtained with conventional oxide cathodes by Reynolds[3].

The results tend to suggest that the elect temperature of the hollow cathode does not d greatly from that of a normal oxide cathode at same cathode temperature. The explanation of the h current densities observed with positive anode v age does not appear to be due to the property of electron gas inside the box. Tests on the 'plug' cath showed that it was possible to draw anode curre of the same order as those obtained with the hol cathode.

These measurements are indirect support of hypothesis that the greater part of the emiss comes from coating near the edge of the hole.

This communication is published by permiss of the Admiralty.

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Services Electronics Research Laboratory,
Baldock. July 27.

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## Electrophoretic Measurement of the Tru Zeta-Potential of Arsenious Sulphide So in the Region of Slow Coagulation

ACCORDING to Bikerman[1], for "rod-shaped partic with half spherical ends" the true ζ-potential a $\zeta_s$, the potential calculated from the Smoluchow equation, are linked by the following equation

$$\zeta = \zeta_s\left[1 + \frac{2\chi}{(L-r)S}\right]$$

where $\chi$ represents the specific surface conductivity the bulk specific conductivity of the intermicel fluid, $L$ the length and $r$ the radius of the cross-secti of the particle. The equations of Henry[2] and Boo for spherical particles and sufficiently large value the product of the radius of the particle and t reciprocal of the thickness of the electrical dou layer can be expressed in the form

$$\zeta = \zeta_s\left(1 + \frac{\chi}{rS}\right)$$

$$\text{or } \frac{1}{\zeta_s} = \frac{1}{\zeta} + \frac{\chi}{\zeta r S}$$

It follows from equation (3) that under conditio in which $\chi$, $r$ and $\zeta$ remain constant, a plot of 1 against $1/S$ should yield a straight line.

A linear relation between $1/\zeta_s$ and $1/S$ has be observed by Ghosh and co-workers[4-6], when measur by the electro-osmotic method the true ζ-potent of the coagula of colloids in the presence of eq coagulating concentration of electrolytes. The electr phoretic experiments have, therefore, been carri out by us in the presence of equi-coagulating co centration of electrolytes and in the region of ve slow coagulation of the colloid used. The concent tion of the different electrolytes used was so adjust in each case that coagulation of the arsenious sulphi sol occurred between 24 and 25 hr. Burton's $U$-tu apparatus, modified so as to facilitate quick filli with the colloid electrolyte mixture, was used in t experiments. A given volume of the arsenic sulphide sol was mixed with an equal volume of t electrolyte of proper concentration and allowed stand for 30 min. It was next centrifuged for 3 m at a given speed of rotation, the upper portion of t

Table 1

| Electrolyte used | $S \times 10^4$ in mhos | Values of $\zeta_e$ for the movement of boundary | | Average $\zeta_e$ in milli-volts |
|---|---|---|---|---|
| | | Upward | Downward | |
| Cl | 75·60 | 44·32 | 48·48 | 46 4 |
| aCl$_2$ | 8·70 | 23·83 | 26·63 | 25·2 |
| gCl$_2$ | 8·67 | 26·03 | 26·20 | 26 1 |
| lCl$_3$ (containing little HCl) | 6·75 | 31 98 | 32·08 | 32 0 |
| lCl$_3$ (containing less HCl) | 5 59 | 31·07 | 32·22 | 31 6 |
| Cl$_2$ and KCl mixture | 10 53 | 37·16 | 37·20 | 37·2 |
| aCl$_2$ and KCl mixture | 12 27 | 30·42 | 30·60 | 30·5 |
| aCl$_2$ and KCl mixture | 15·10 | 33 05 | 32·25 | 32·7 |

l was separated from the sediment of large particles d the lower part of the $U$-tube was filled with it, e upper part being filled with a solution having e same specific conductivity as that of the inter-icellar fluid of the sol occupying the lower part. e electric current, $i$, flowing through the system ring electrophoresis was carefully measured. om the cross-section of the $U$-tube, the current, $i$, d the specific conductivity of the intermicellar id, the potential gradient was calculated. (In no se did the specific conductivity of the intermicellar uid differ from that of the corresponding colloid–ectrolyte mixture by more than 4 per cent. In the se of potassium chloride the difference was less than per cent.) The results are recorded in Table 1.

From these results it was found that if $1/\zeta_e$ is otted against $1/S$, two straight lines are obtained, e for the mixtures of aluminium chloride with drochloric acid and potassium chloride, and the her for magnesium chloride, barium chloride and ixtures of barium chloride and potassium chloride. hese lines meet the $1/\zeta_e$ axis at two points very ose to each other, giving the average value of $= 49 \pm 1$ mV. The different values of $\chi/\zeta r$ for e two straight lines are therefore to be attributed to e variation of either $\chi$ or $r$, or both, depending on e nature of the electrolytes used. Electro-osmotic ta obtained with negatively charged silver iodide agula[3] indicate that $\chi$ does not depend on the ture of the electrolytes, and we are inclined to tribute the variation of $\chi/\zeta r$ to the change of $r$ only.

The true $\zeta$-potential found for the same arsenious lphide sol under identical concentrations of the ated electrolytes by the electro-endosmotic method 51 mV. The values of the true $\zeta$-potential of arsen-us sulphide particles in the region of slow coagula-on in the presence of equicoagulating concentrations the electrolytes, as measured by the electrophoretic d electro-osmotic methods, are thus in good agree-ent, and their mean is 50 mV. These results, erefore, confirm our previous conclusion that a ven rate of coagulation of a colloid is characterized y a definite value of the $\zeta$-potential independent the valency of the counter ions used.

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Booth, *Trans. Farad. Soc.*, **44**, 455 (1948).
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hosh, Rakshit and Chattoraj, *Trans. Farad. Soc.*, **50**, 729 (1954).
hosh and Rakshit, *Sci. Culture*, **18**, 498 (1953).

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## Preparation of Aluminium Borohydride and its Applications in Organic Reductions

IT was found that the reaction of aluminium chloride with calcium borohydride[1] in a tetrahydrofuranic solution gives a solution of aluminium borohydride:

$$2AlCl_3 + 3Ca(BH_4)_2 = 2Al(BH_4)_3 + 3CaCl_2.$$

Calcium chloride is precipitated and can be separated by centrifuging in sealed centrifuge tubes; the supernatant contains the tetrahydrofuranic adduct of aluminium borohydride. (By cooling to − 50° this solution gives colourless crystals of this adduct.) Partial evaporation of such a solution at atmospheric pressure gives a residue the aluminium borohydride content of which is considerably greater. Since the boiling point of aluminium borohydride is about 20° lower than that of tetrahydrofurane, this shows that the aluminium borohydride adduct has considerable stability.

The tetrahydrofurane solution of aluminium borohydride is not spontaneously inflammable in air (unlike undiluted $Al(BH_4)_3$), and thus it is relatively safely applicable for reductions of organic compounds.

It is interesting to note that aluminium chloride gives a good yield of the borohydride only with calcium borohydride; under similar conditions (tetrahydrofurane solution) lithium borohydride gives a small yield, while sodium borohydride does not react.

With such solutions (or with solutions of distilled aluminium borohydride[2] in dry tetrahydrofurane) carboxylic acid esters can be reduced selectively to the corresponding primary alcohols. For example, ethyl benzoate and ethyl-$p$-nitrobenzoate are at room temperature reduced to the corresponding carbinols; similarly the aldehydes and ketones, respectively.

Nitriles give the corresponding primary amines: benzyl cyanide and 3,4-dimethoxy benzyl cyanide give primary amines with a yield of about 50–60 per cent.

Nitriles are not reduced with the borohydrides of the alkaline metals; even calcium borohydride—which is a much stronger reducing agent—reduces nitriles only very slowly and with low yields.

Thus the reducing power of the complex borohydrides is lowest in the class of the borohydrides of the alkaline metals (which have a structure of ionic salt character) and highest in the case of aluminium borohydride, which represents a typical covalent structure (boiling point 44° (760 mm.)). The alkaline-earth metal borohydrides represent an intermediate grade in structure as well as in their reducing power.

These correlations between structure and reducing power have, in our opinion, a bearing on the mechanism of such reductions and indeed point to the importance of a molecular reducing mechanism.

*Note added in proof.* After submitting this paper, a communication appeared by H. C. Brown and B. C. Subba Rao (*J. Amer. Chem. Soc.*, 77, 3164; 1955) dealing with applications of a solution of sodium borohydride and aluminium chloride in diethylene glycol-dimethyl-ether for reduction of organic compounds.

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[1] Kollonitsch, J., Fuchs, O., and Gábor, V., *Nature*, 175, 346 (1955).

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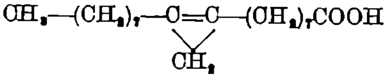
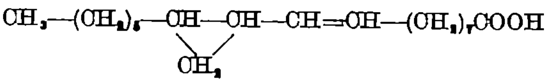
## Structure of Sterculic Acid

In 1952, Nunn[1] put forward a structure for sterculic acid (I), whereas we have assigned to it structure (II)[2]; Dijkstra and Duin[3] have, however, rejected structure (II) on grounds which we believe to be inconsistent with the known facts.



$$\mathrm{CH_3{-}(CH_2)_7{-}\underset{CH_2}{C{=}C}{-}(CH_2)_7COOH}$$

(I)



$$\mathrm{CH_3{-}(CH_2)_5{-}\underset{CH_2}{CH{-}CH}{-}CH{=}CH{-}(CH_2)_7COOH}$$

(II)

(1) Derfer *et al.*[4] have found that the derivatives of *cyclo*propane exhibit an infra-red absorption band in the region 1,000–1,020 cm.$^{-1}$; consequently, they have suggested that a band near 1,010 cm.$^{-1}$ may be used for detecting the presence of a *cyclo*propyl group in a compound.

A *cyclo*propane ring conjugated with a C=C bond (vinyl-*cyclo*propane) has been found by Van Volkenburgh *et al.*[5] to possess a band at 1,010 cm.$^{-1}$. As our value for sterculic acid is 1,004 cm.$^{-1}$ (our revised value[6] being 1,008 cm.$^{-1}$), which is very close to the value of the conjugated compound cited above, a similar type of structure is not unlikely in sterculic acid. Recent work carried out in this laboratory[6] has shown that the bands of the similar *cyclo*propane and *cyclo*propene derivatives prepared synthetically lie almost in the same region, and no analytical value could be set for characterizing a *cyclo*propene group.

(2) Besides cotton seed oil, the Halphen reaction is given by many other seed oils, which according to their reported analyses do not contain even a trace of any fatty acid having a *cyclo*propene group. Further, the exact mechanism of the reaction and nature of the chromogenic substance are not yet settled; possibly some component of the non-saponifiable matter present in the oil is concerned with this colour reaction. In view of this, it is difficult to accept that the reaction is due to the *cyclo*propene grouping alone.

(3) The view that a *cyclo*propane group is less reactive than an ethylene bond is not corroborated in many cases[7]. *Cyclo*propane and its derivatives have been reported[8] to possess appreciable instability and resemble closely the corresponding olefinic compounds in their reaction to heat and some reagents. Thus there does not seem to be any marked fundamental difference between the corresponding derivatives of *cyclo*propane and ethylene, and a *cyclo*propane ring conjugated with a C=C or any other classically unsaturated group behaves very similarly to a typical diene conjugated system[7,9]. It has also been reported[8] that *cyclo*propane and *cyclo*butane are unstable relative to the isomeric alkenes.

On the other hand, the *cyclo*propene derivatives are not so unstable as Dijkstra and Duin[3] have indicated. Their comparative stability and semi-aromatic character were demonstrated by Goss, Ingold and Thorpe[10] so early as 1923. Further, the work carried out in this laboratory[6] on the syntheses of *cyclo*propene compounds has shown that they are fairly stable, so much so that they could be vacuu distilled without decomposition. It may be add that the comparative study of the polymerizati of sterculic acid and 9 : 11-octa-decadienoic acid h not so far been reported, but it is well known th dehydrated castor oil, in which the glyceride of t latter is present to the extent of only 25 per ce gels at ordinary temperature after some time.

Finally, a strong argument against the structu (I) proposed by Nunn[1] is that the compound of th constitution has been synthesized and proved to different from sterculic acid as already reported[2,6].

Dijkstra and Duin[3] have isolated an unkno $C_{18}$-fatty acid from kapok seed oil and assume it contain a *cyclo*propene group, thus leaving a straig chain of 17-carbon atoms (odd number); this unique and merits careful investigation.

The chemical and analytical data giving furth evidence for structure II will shortly be publish elsewhere.

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Sept. 14.

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## Humidity and Corrosion

I should like to support and emphasize Dr. J. Hudson's comments on Major P. A. Cartwright communication in *Nature* of October 15, p. 74 As the figures (obtained at the Ministry of Suppl Tropical Testing Establishment, Nigeria; see Ambl and Bain, *J. App. Chem.*, 5, 437 (1955) ) in the tab below show, corrosion at two sites of roughly equ humidity may range from 'highest anywhere' to le than in rural Britain, the operative variant bei salinity.

| | R.H. (per cent) | | Corrosion of mild steel (gm./dm.$^2$/month) | Salinity (sodium chloride deposited on damp surface: mgm./m.$^2$/day) |
|---|---|---|---|---|
| | Av. max. | Av. min. | | |
| Lighthouse Beach, Lagos, 50 yd. from H.W.M. | 94 | 78 | 5 6 | 800 |
| Jungle clearing at Nkpoku, 30 miles from sea | 95 | 80 | 0·10 | 7 5 |

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# FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

## Monday, December 5

trition Society (at the Royal Society of Medicine, 1 Wimpole t, London W.1), at 5 p.m.—Dr. Harry J. Deuel, Jr. (U.S.A.): as an Essential Component of Diet".

## Tuesday, December 6

itution of Chemical Engineers (at the Geological Society, ington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. E. S. s and Mr. D. R. Augood: "Distillation of Liquid Hydrogen"; J. F. Davidson: "Transient Behaviour of Plate Distillation mns".

iversity of London (at the Royal College of Science, South ington, London, S.W.7), at 5.30 p.m.—Prof. A. Tustin: "The e to Human Welfare" (Inaugural Lecture).

ciety of Chemical Industry, Plastics and Polymer Group ne Rooms of the Chemical Society, Burlington House, Piccadilly, lon, W.1), at 6.30 p.m.—Dr. M. Gordon: "Second Order sitions in High Polymers".

yal Aeronautical Society (at 4 Hamilton Place, London, , at 7 p.m.—Mr. W. A. P. Fisher: "Fatigue Aspects of Structural gn".

ciety of Instrument Technology, Control Section (at on House, Portland Place, London, W.1), at 7 p.m.—Mr. Eric B. son: "Planning a Servo-mechanisms Laboratory for Instructional oses".

ciety for Visiting Scientists (at 5 Old Burlington Street, lon, W.1), at 7.30 p.m.—Discussion Meeting—"Government onsibility in Industrial Research". Chairman: Sir Henry T. rd, F.R.S. Speakers: Dr. E. W. R. Steacie, F.R.S., and Dr. K. Blount.

## Wednesday, December 7

yal Society of Arts (at John Adam Street, Adelphi, London, 2), at 2.30 p.m.—Mr. H. Bagenal: "Planning Against Noise" red Bossom Lecture).

genics Society (at the Royal Society, Burlington House, adilly, London, W.1), at 5.30 p.m.—Prof. H. J. Eysenck: "The re and Inheritance of Extraversion".*

stitute of Fuel (at the Institution of Civil Engineers, Great ge Street, London, S.W.1), at 5.30 p.m.—Dr. Alfred Parker, E.: "Power, Population and Productivity" (Melchett Lecture).*

stitution of Electrical Engineers Radio and Telecomication Section (at Savoy Place, London, W.C.2), at 5.30 p.m.— R. S. Webley, Dr. H. G. Lubszynski and Mr. J. A. Lodge: "Some f-Tone Storage Tubes".

stitute of Metals (at 4 Grosvenor Gardens, London, S.W.1), .30 p.m.—"Metals at Low Temperatures", a Report on the recent -Temperature Conference held in Paris. Speakers: Dr. P. L. h and Dr. H. M. Rosenberg, introduced by Sir Francis Simon, S.*

stitute of Physics, London and Home Counties Branch 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Sir Geoffrey lor, F.R.S.: "Recent Studies of Water Waves".

## Wednesday, December 7—Thursday, December 8

stitute of Welding (joint meeting with the British Welding earch Association, Institution of Naval Architects, British building Research Association and the Aluminium Develop- t Association, in the Weir Lecture Hall, Institution of Naval hitects, 10 Upper Belgrave Street, London, S.W.1), at 10 a.m. —Symposium on "The Use and Welding of Aluminium in Shipping".

## Thursday, December 8

oyal Society (at Burlington House, Piccadilly, London, W.1), .0.30 a.m.—Discussion on "Dynamics of Natural Populations" ed by Dr. E. B. Ford, F.R.S.

itish Psychological Society, Industrial Section (in Room Birkbeck College, Malet Street, London, W.C.1) at 1 p.m.— E. P. Kelsall: "Strikes from the Viewpoint of a Psychologist".

oyal Society of Arts, Commonwealth Section (at John Adam et, Adelphi, London, W.C.2), at 5.15 p.m.—Dr. R. S. F. nessey: "Some Social Effects of Tropical Medicine within the monwealth".

oyal Meteorological Society (in the Conference Hall, County l, London, S.E.1), at 5.30 p.m.—Mr. P. J. Meade: "Fog and ospheric Pollution" (Lecture open to sixth-form scholars).

niversity of London, British Postgraduate Medical Fedtion (at the London School of Hygiene and Tropical Medicine, pel Street, London, W.C.1), at 5.30 p.m.—Dr. Audrey Smith: perimental Hypothermia in Animals". (Thirteenth of fifteen tures on "The Scientific Basis of Medicine".)*

niversity of London Institute of Education (in the Assembly l, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m. r. T. W. Taylor: "Education in Eastern Germany".*

ociety of Chemical Industry, Microbiology Group (at the ical Society of London, 11 Chandos Street, Cavendish Square, don, W.1), at 6.15 p.m.—Scientific Papers.

Royal Institute of Chemistry, London Section (joint meeting with the Battersea Polytechnic Chemical Society, at the Battersea Polytechnic, Battersea Park Road, London, S.W.11), at 7 p.m.—Prof. Sir Eric Rideal, F.R.S.: "Surface Chemistry".

British Glaciological Society (at Bedford College, Regent's Park, London, N.W.1), at 7.30 p.m.—Annual General Meeting, followed by a discussion on "The Future Lines of Progress in Glaciology".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. P. H. Abbott: "Mycetoma in the Sudan".

Society of Cosmetic Chemists of Great Britain (at the Royal Society of Arts, John Adam Street, London, W.C.2), at 7.30 p.m.—Mr. A. J. Krajkeman: "Some Aspects of Perfumery Chemicals".

## Thursday, December 8—Friday, December 9

British Institute of Radiology, incorporated with the Röntgen Society (at Caxton Hall, Victoria Street, London, S.W.1)—Seventeenth Annual Congress and Exhibition.

## Friday, December 9

Association of Applied Biologists (in the Meeting Room of the Royal Entomological Society, 41 Queen's Gate, London, S.W.7), at 10.30 a.m.—Scientific Papers.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Meeting.

Physical Society, Acoustics Group (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Mr. E. J. Evans: "The Absorption of Sound in Humid Air".

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Discussion on "Information Bulletins, their Contents and Function".

Institution of Electrical Engineers; Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Aids to Teaching the Subject of Windings in Rotating Machinery".

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. F. R. Smith: "Recent Work on the Tropane Alkaloids".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "The Discovery of Useful Electricity".

## Saturday, December 10

British Mycological Society (in the rooms of the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon—Annual General Meeting.

British Psychological Society (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. Robert Leeper: "Relationships of Learning Theory and Personality".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. W. F. Grimes: "The Science of Archaeology".*

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head (with high academic qualifications and teaching experience together with industrial or research experience in applied mathematics) of the *Department of Mathematics—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (December 7).

River Inspector (preferably Corporate Member of the Royal Institute of Chemistry and the Institute of Sewage Purification), with the Banff, Moray and Nairn River Purification Board—The Clerk to the Board, County Buildings, Elgin (December 8).

Lecturer (Grade II) in Plant Pathology in the Faculty of Agriculture, University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (December 10).

Lecturers (with M.R.C.V.S.) in (*a*) Bacteriology and (*b*) Biochemistry, in the Faculty of Agriculture, University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (December 10).

Lecturer in Geography and Economics—The Principal, Wigan and District Mining and Technical College, Wigan (December 12).

Lecturer in Mathematics at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 12).

Junior Research Fellow, and a Senior Research Fellow (physicists or physical chemists) in the Department of Glass Technology—The Registrar, The University, Sheffield (December 15).

Nuffield Research Fellow at the Wheatstone Physics Laboratory, to work on the physical chemistry of fibrous proteins—Prof. J. T. Randall, F.R.S., Department of Physics, King's College, Strand, London, W.C.2 (December 15).

Assistant Lecturer in the Department of Applied Mathematics—The Registrar, University College of Wales, Aberystwyth (December 16).

HEAD (with high academic qualifications, preferably an honours degree in mining, practical mining experience and teaching experience) OF THE MINING AND GEOLOGY DEPARTMENT—The Principal, Wigan and District Mining and Technical College, Wigan (December 19).

LECTURER (graduate in science or technology and preferably with experience of reinforced concrete design) IN STRUCTURAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (December 19).

LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Manchester 13 (December 19).

CHEMIST, Senior Research Officer or Principal Research Officer grade (with a good honours degree in chemistry, with postgraduate research experience in the fields of inorganic or physical chemistry), with the Australian Atomic Energy Commission, to undertake research in the chemistry of reactor materials including their behaviour under conditions of high temperature irradiation—The Secretary, Australian Atomic Energy Commission, G.P.O. Box 5343, Sydney, Australia (December 31).

DEMONSTRATOR (with a good honours degree in physiology, biochemistry or chemistry, with subsidiary physiology, or medically qualified) IN CHEMICAL PHYSIOLOGY—The Registrar, The University, Manchester 13 (December 31).

HEAD (with high academic qualifications and teaching experience together with industrial or research experience in applied physics) OF THE DEPARTMENT OF PHYSICS—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (December 31).

PHYSICIST, Principal Research Officer grade (with a good honours degree in physics, plus at least ten years research experience), with the Australian Atomic Energy Commission, to work in the field of reactor physics embracing such aspects as exponential and zero energy experiments and criticality and kinetic studies—The Secretary, Australian Atomic Energy Commission, G.P.O. Box 5343, Sydney, Australia (December 31).

PLANT PHYSIOLOGIST, STATISTICIAN (Biometrician), and an ASSISTANT ENTOMOLOGIST in the Wattle Research Institute of the University of Natal, Pietermaritzburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, December 31).

SENIOR LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (January 6).

READER IN MECHANICAL ENGINEERING at King's College, London, W.C.2—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 10).

READER IN METALLURGY at King's College, London, W.C 2—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 12).

LECTURER OR ASSISTANT LECTURER IN METALLURGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, January 15).

CHAIR OF CIVIL ENGINEERING at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 18).

CHAIR OF BIOCHEMISTRY at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 19).

READER IN PHYSIOLOGY at London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 26).

READER OR SENIOR LECTURER IN THE THEORY OF COMPUTING in the Department of Mathematics—The Registrar, The University, Manchester 13 (January 31).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS (2) IN PHYSICS, CHEMISTRY, METALLURGY, ENGINEERING OR GEOLOGY, or in a subject allied to these—The Registrar, University of Wales, University Registry, Cathays Park, Cardiff (March 31).

ANALYTICAL CHEMIST, Experimental Officer grade (preferably with a pass degree in chemistry, or at least H.N.C. (science) or equivalent, several years experience in a research or inspection laboratory, and a sound knowledge of basic analytical methods), for research and development work in an analytical laboratory—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting A.629/34.

ENGINEER (with a first- or second-class honours degree or equivalent in engineering, and good mathematical ability) IN THE STRUCTURES DIVISION of the Royal Aircraft Establishment, Farnborough, Hants, for duties which involve planning and execution of instrumented flight trials and analysis of results of such tests—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.527/5A.

EXPERIMENTAL OFFICER OR ASSISTANT EXPERIMENTAL OFFICER (with considerable experience of the breeding and management of rabbits, rats, mice, etc., for experimental work) to take charge of the Small Animal Department—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

EXPERIMENTAL OFFICER (with at least H S.C. in science subjects, or equivalent qualifications) IN THE CHEMICAL ENGINEERING DIVISION, for work in a cryogenic laboratory engaged on the operation of liquid hydrogen plant and the construction and operation of experimental low temperature equipment—The Establishment Officer, U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 453.

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

LECTURER OR ASSISTANT PROFESSOR IN PURE MATHEMATICS, and a LECTURER OR ASSISTANT PROFESSOR IN APPLIED MATHEMATICS—Prof. I. R. Pounder, The University, Toronto.

LECTURERS (with a good honours degree and industrial experience) IN (*a*) HEAT ENGINES, and (*b*) FLUID MECHANICS, in the Department of Civil and Mechanical Engineering—The Secretary, Royal Technical College, Glasgow.

PHYSICISTS, to assist in physical and clinical work associated with X-ray and isotope treatment and investigation—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W 3.

RESEARCH FELLOW IN ANIMAL ECOLOGY for research in the ec
of the insects and mites associated with pastures in the wheat
of South Australia—The Registrar, University of Adelaide, Ade
South Australia.

SENIOR LECTURER (with a good honours degree, together
teaching experience, and preferably with industrial and/or res
experience) IN INORGANIC CHEMISTRY, in the Department of Chem
and Biology, College of Technology, Liverpool—The Direct
Education, 14 Sir Thomas Street, Liverpool 1.

# REPORTS and other PUBLICATIO

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

University of Liverpool: Department of Social Science. Occas
Paper No. 2: Industrial Democracy—a Revaluation. By W
Scott. Pp. 40. (Liverpool: Liverpool University Press, 1
2s. 6d.

Bulletin of the British Museum (Natural History) Zoology. V
No. 13: The Morphology of the Head of the Hawfinch (Coccothra
Coccothraustes), with special reference to the Myology of the
By Reginald William Sims. Pp. 369–393. 8s. Vol. 3, No. 2:
Polychaete Fauna of the Gold Coast. By Norman Tebble. Pp. 59–1
1 chart. 20s. Vol. 3, No. 4: A Revision of the Family Epicr
(Acarina-Mesostigmata). By G. Owen Evans. Pp. 169–200+p
1 and 2. 10s. (London: British Museum, Natural History, 1955.)

The Nimonic Alloys: Design Data. Third edition, extend
revised. Pp. 48. (Birmingham: Henry Wiggin and Co.,
1955.)

Edinburgh School of Agriculture: Edinburgh and East of Scot
College of Agriculture. Calendar for 1955–56. Pp. 84. (Edinbu
School of Agriculture: Edinburgh and East of Scotland Scho
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List of Books and Pamphlets (Supplement, concluded Decem
1954) in the Special Library of the Industrial Diamond Informa
Bureau. Pp. 63. (London: Industrial Distributors (Sales),
1955.)

*Planning*. Vol. 21, No. 385 (12 September, 1955): Better Indus
Design. Pp. 157–172. (London: Political and Economic Plan
1955.) 2s. 6d.

The Art of Science: an Inaugural Address delivered at Make
University College of East Africa, Kampala, Uganda, on Octobe
1954. By Prof. L. C. Beadle. Pp. iii+22. (London: Ox
University Press, 1955.) 3s. 6d. net.

Forestry Commission, Bulletin No. 25: Studies of North-
American Forests in Relation to Silviculture in Great Britain. By
Wood. Pp. iv+43+35 photographs. (London: H. M. Statio
Office, 1955.) 6s. net.

## Other Countries

Ministry of Public Works, Egypt. Nile Control Department. P
No. 2. The Nile Basin (Fourth Supplement to Volume 4). Ten
Mean and Monthly Mean Discharges of the Nile and its Tributarie
the years 1943–1947 and normals for the period 1912–1947. By
H. E. Hurst, Y. M. Simaika and R. P. Black. Pp. viii+350. P
No. 3: The Nile Basin (Fourth Supplement to Volume 5). Ten
Mean and Monthly Mean Gauge Readings of the Nile and its Tr
taries for the years 1943–1947 and Normals. By Dr. H. E. H
Y. M. Simaika and R. P. Black. Pp. xii+359. P.T. 100; 20s. P
No. 4: The Nile Basin (Second Supplement to Volume 6). Mon
and Annual Rainfall Totals and Number of Rainy Days at Station
and near the Nile Basin and Normals for the Period 1943–1947.
Dr. H. E. Hurst, Y. M. Simaika and R. P. Black. Pp. vii+20
plates. P.T. 200. (Cairo: Government Press, 1953–1955.)

Sixth Annual Report of the Commonwealth Scientific and Indust
Research Organization for the year ending 30th June, 1954. Pp.
(Canberra: Government Printing Office, 1954.) 10s. 6d.

New South Wales: Department of Agriculture. Contributions f
the New South Wales National Herbarium. Vol. 2, No. 2: An Enum
ation of Plants in the Albury, Holbrook and Tumbarumba Distric
New South Wales. By H. J. M. Barron. Pp. ii+89–284. (Sydn
Government Printers, 1955.)

New Zealand. Department of Scientific and Industrial Resea
Geophysics Division. Seismological Report for October, Novem
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ment Printer, 1955.)

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Annales de l'Institut de Physique de Globe de l'Université de P
et du Bureau Central de Magnétisme Terrestre. Tome 27. Pp. iv+
(Paris: Institut de Physique du Globe de l'Université de P
1954.)

West African Institute for Oil Palm Research. Quarterly Prog
Reports. No. 13 (April 1st, 1955, to June 30th, 1955). Pp. 26. (B
City: West African Institute for Oil Palm Research, 1955.)

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Melbourne. Bulletin No. 274: Sown Pastures for South-East
Queensland. By T. B. Paltridge. Pp. 108+6 plates. Bulletin No. 2
Common Names of Insects. Compiled under the direction of F. J. G
Pp. 32. (Melbourne: Commonwealth Scientific and Industrial Rese
Organization, 1955.)

Colony of Singapore. Annual Report of the Botanic Gard
Department for 1954. By J. W. Purseglove. Pp. i+11+4 pla
(Singapore: Government Publications Bureau, 1955.)

Metropolitan Life Insurance Company Statistical Bulletin, Vol.
No 7 (July, 1955): Mortality at New Minimum. Pp. 12. (New Yo
Metropolitan Life Insurance Company, 1955.)

Publications de l'Institut National pour l'Étude Agronomique
Congo Belge. Atlas Anatomique des Bois du Congo Belge. Vol.
Spermatophytes (Podocarpaceae, Cupressaceae, Ulmaceae, Morac
Proteaceae, Olacaceae). Par Prof. Lucien Lebacq. Pp., 58+32 pla
(Bruxelles: l'Institut National pour l'Étude Agronomique du Co
Belge, 1955.) 250 francs.

# HIGHER TECHNOLOGICAL EDUCATION IN BRITAIN

LTHOUGH in his inaugural address as rector of the Imperial College of Science and Technology October 11, Dr. R. P. Linstead made no fresh tement as to the building plans for the College, he l enough about the future of the Imperial College indicate the shape that this new development in her technological education is likely to take. Some the implications can now be seen fairly clearly, l it is important that they should be fully dis- sed, and appropriate measures taken elsewhere counteract any possible weaknesses which this iely new but desirable experiment in techno- ical education may involve in the system of higher hnological education in Britain. Dr. Linstead's lress establishes beyond question that the expan- n of the Imperial College is being planned to make major contribution to the supply of technologists the postgraduate level, and that it is doing so in ys for which there is no precedent in the univer- es of Britain or in institutions such as the Massa- setts Institute of Technology in the United States elsewhere.

In his presidential address to the North-Western anch of the Science Masters' Association a year o, Dr. B. V. Bowden described the American titutes of technology as essentially universities, ling in the main with practical subjects, with nanities as subsidiaries ; and he added that one of ir aims was to produce large numbers of cultured lified men who at the same time are essentially ctical rather than theoretical in outlook. That is air description of the type of men and women ich the Imperial College hopes to produce in reasing numbers ; but, as Dr. Linstead indicated, s hoped to do so without including the humanities cifically in the curriculum.

Since some of the American institutes of tech- ogy require their students to spend 16–20 per t of their time on the humanities, the expansion the Imperial College to what may fairly be cribed as a technological university with some 00 students—with about 1,400 of them post- duates—and an administrative and teaching staff 1,500, comparable in size roughly with the Univer- es of Birmingham, Leeds or Liverpool, may be cribed as a new venture in respect both of structure l of curriculum. The scientist and technologist l have unfettered and unchallenged opportunity demonstrate the capacity of their disciplines to elop men capable not only of clear thinking but o of a balanced outlook, and imaginatively alive the human issues with which the technologist, less than the manager and administrator, is fronted.

Dr. Linstead was re-assuring on two or three nts. He does not think that the proposed expan- n will be achieved at the expense of other versities or of the technical colleges. Although ost the whole of the undergraduate students of the College come from within the United Kingdom, it is probable that the additional intake of about one hundred freshmen a year will come from the impending bulge in the senior school population, quite apart from attention to such measures as have been suggested in the report on "Early Leaving" and elsewhere. Moreover, the extent to which postgraduate students are drawn from overseas suggests that the prospects of obtaining the greater numbers of students of high quality is reasonable enough, in spite of the misgivings which Sir Henry Tizard expressed in his Haldane Memorial Lecture. Further, as Dr. Linstead pointed out, a considerable proportion of the postgraduate students will come from posts in industry or government service, and from other universities and colleges.

Concentration of such advanced specialized technological training is clearly desirable from the national point of view, and Dr. Linstead indicated that the Imperial College recognizes its responsibility for choosing its regions of specialization wisely in relation to national needs and the provisions made elsewhere. He also forestalled criticism in his remarks as to the reduction of wastage. This occurs in all universities, though not always at the same stage. At the Imperial College it occurs mainly at the end of the first year, where it is obviously better to effect any necessary elimination rather than later. None the less, attention is being given to the further reduction of this wastage. some of which is certainly unavoidable if high standards are to be maintained.

On these and other points it must be some years after the end of the next quinquennium before any sound judgment can be formed as to the value of this experiment, or as to its full implications for the expansion or development of technological and technical education in Britain. Meanwhile, it should be recognized for what it is—a massive experiment in education that is in line with much that has been in progress elsewhere in the universities since the Second World War and of which the University College of North Staffordshire provides a striking example. It is also thoroughly in keeping with the British genius for improvization and experiment, to which we already owe important advances, and which incidentally provides one of the fundamental reasons why a system of education is not exportable.

Perhaps the feature of this expansion which will be watched with the closest interest is the success of the attempt to provide a broader education, and by novel methods to produce technologists and scientists of the highest professional competence who are also well-educated men and women competent, in Milton's phrase, "to perform justly, skilfully, and magnanimously all the offices both private and public of peace and war" that may fall to their lot. The interest will indeed be the keener in that here the Imperial College has not yet fully determined in detail the methods it means to use. Indeed, as Dr.

Linstead pointed out, some of the most important broadening influences cannot come into play on any adequate scale until the building plans have advanced.

Prominent among these are the plans to increase the residential accommodation from its present eight per cent to sixteen (about five hundred residents) and to provide a new Students' Union double the size of the old. This expansion is viewed as part of a deliberate attempt to encourage the broadening influence of informal discussion between students outside their formal studies, and to provide conditions in which the programmes of general studies and week-end discussions can most favourably take place. Dr. Linstead stressed the importance of all such efforts the more in that he recognized that there are strict limits to what can be attempted within the normal curricula. He also referred to the broadening influence of the great flood of London life as something unrivalled in more provincial environments.

While the possibility of such an extra-curricular education will be granted, Dr. Linstead may well be optimistic as to its probability, even under due guidance and encouragement. Some inquiry on this point might well be worth while. What he said as to keeping the range of studies natural and appropriate to the College as wide as possible, should also be noted. The full range of subjects appropriate to a university will not be achieved at South Kensington; but on the teaching and practice of the departments of pure science will largely depend the success of this attempt to provide, not narrow technologists, but educated men capable of vision and sound judgment. Unless those departments rise to the challenge and show that their disciplines can be taught with imagination and balance, the experiment will be in grave danger.

Clearly, much will depend on the extent to which the departments of pure science are kept strong and of the highest standard, and on the quality of the staff; though it is probably also true that in respect of some of the other broadening influences mentioned by Dr. Linstead the quality of the students will have some influence in determining their effectiveness. This is notably true in respect of life in London, which presupposes a certain stability of character if it is to be beneficial, and also no undue pressure of home influence or poverty. At best, in fact, while a modicum of hostels and a good Students' Union make the social life of the College warm, their broadening influence is random.

Nor is the mastery of and delight in the Queen's English, which Dr. Linstead also commends, to be achieved without systematic and deliberate effort. Particularly if it is to assist the graduate to carry away from such an institution an awareness of the richness and diversity of life and an appreciation of those things which adorn it, more is likely to depend on the teaching in the schools than on that given at the Imperial College in a curriculum from which non-scientific subjects are excluded. The Imperial College under such conditions can do little to further this end, except perhaps by developing as early as possible, and perhaps expanding, the experiment of an optional preliminary year to which Dr. Linstead referred. The non-scientists entering under suc scholarship scheme could well provide a very effec leaven under the conditions which increased r dential facilities and the new Students' Union provide.

An even more promising and less-random influe could be the teaching of the history of science technology, a general knowledge of which would Dr. Linstead said, give a sense of perspective balance, and show something of the way in wh great minds have urged men forward. It is a li disappointing that Dr. Linstead did not give evidence that the Imperial College proposes experiment in this field, as has been done elsewh in recent years. Cambridge scientists, for exam are almost unanimously in favour of teaching history and philosophy of science, and under History of Science Committee set up in 1947 th courses have been tried to spread such teaching. proportion of scientists reading the history philosophy of science is now about one in ten, an diploma in the subject is at present under conside tion and, alternatively, a proposal to make it subject for Part II of the Natural Sciences Tripos even a separate Tripos.

Another such experiment, in the more limited fi of engineering history, at King's College, Univers of Durham, was described by Prof. A. F. Burstall the summer meeting of the Newcomen Society June. Here, however, the primary objectives w to teach the students to read critically and to courage them to acquire sufficient broad fact knowledge of the history of technology to deve the breadth of vision claimed as characteristic students of history. It was also desired to encour them to work together, and in a measure to le from one another in just the way in which Linstead visualizes the students at the Impe College may acquire a broader outlook.

Whether or not the decision to extend the fi degree course from three years to four years is tak a strong case can thus be argued for including history of science and technology in the be curriculum. Its exclusion could only be justified the face of clear evidence that sustained and w planned, rather than random, efforts are being m to encourage the development of a broad outlo and wide appreciation of cultural values and hum achievement. Dr. Linstead and his colleagues sho be alert to see that neither any promising experim of this kind nor the scholarship experiment for n scientists to which he referred is allowed to hamstrung or limited by unreasonable examinat requirements.

The study of English, however, has a further, equally important, aspect for the student of scie or technology on which Dr. Linstead did not tou though it was the subject of a lively discussion l month before the Parliamentary and Scientific Co mittee, in which the Duke of Edinburgh took pa

Mastery of the English language is desirable fr the point of view of the communication of ide quite as much as from that of encouraging a scie of perspective and balance. Whatever point of vi take with regard to the interpretation of science, ether we lay the onus on the scientist for expressing aself in terms and in ways that the layman can lerstand, or whether, like the Duke of Edinburgh l Sir Henry Tizard, we look rather to the improve- nt of the scientific education of the layman, with- a reasonable mastery of English the scientist is likely to be able to communicate fully even with se in other scientific fields. It is not simply a tter of avoiding unreasonable demands on the entist to express himself in non-technical language; less his choice of technical terms is restrained the sense of perspective and balance which an equate knowledge of his mother-tongue confers, no provement in the technical and scientific know- ge of the ordinary citizen will avoid confusion and sunderstanding. Mr. Ritchie Calder has quite htly insisted that the communication of knowledge d ideas depends fundamentally on the careful and lful handling of words, and this is as true of scientific or technical paper as of popular position.

The success of this experiment at the Imperial llege of Science and Technology will really depend two things: first, whether the College can secure d maintain a teaching staff of the requisite standard d breadth of vision, capable, within the limits set the scientific and technological disciplines to be ght, of inspiring their students with that same eadth of vision and understanding, no less than th the capacity for clear and critical thinking. condly, it will depend no less on a continuing entry students of sufficient capacity. Any relaxation of ndards in either respect—in the recruitment of ff, or the selection and elimination of students— uld be fatal. For that reason alone, the progress the experiment should be closely watched, and rticularly carefully by the University Grants Com- ttee and the Parliamentary and Scientific Com- ttee. For although the recent broadsheet on raduates' Jobs" issued by Political and Economic nning is only a preliminary survey, it gives at st a hint, which is supported elsewhere, that there a strict limit to the number of students qualified to fit by courses such as an institution of the standard the Imperial College provides. Part of the solution Britain's problem of scientific and technical man- wer lies in the wiser and more efficient use of the ited supply of really first-class minds.

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# PURPOSE IN EDUCATION

ucation and the Modern Mind

Prof. W. R. Niblett. Pp. 155. (London: Faber d Faber, Ltd., 1954.) 8s. 6d. net.

MANY books are published dealing with educational topics; surprisingly few are written out education itself. Prof. W. R. Niblett has empted to do this, and by all except the con- ned materialist, his book will be welcomed both its inspirational qualities and for its practical ggestions on means of achieving ends which are mittedly difficult to attain.

Throughout the book Prof. Niblett emphasizes that it is no good considering the purpose of education without discussing the purpose of living itself; it is impossible to evolve a satisfactory philosophy of education without having evolved a satisfactory philosophy for life. Unfortunately, so many people in the Western world assume that the reason for existence is to 'get on' and be 'happy'. This superficial attitude to life has bitten deep in many people and seems to be an accompaniment to the mentality associated with the Welfare State.

Prof. Niblett questions whether the acquisitive attitude can provide a satisfactory philosophy of life, since it leaves out a whole dimension of human experience; it is very doubtful whether it leads to 'happiness'. Much of the so-called 'happiness' to-day is there only when there is something 'going on'; too often this is succeeded by a vacuum of despair when people come face to face with themselves.

There are signs, however, that the determination to 'get on' is failing to satisfy and that the possession of material resources may be temporarily satisfying but fail to satisfy those fundamental requirements of man which are of an intangible nature. As a result, a new challenge is being presented to all who help to educate the young. Some educationists respond to this challenge by seeking to increase the number of schools and laboratories and community centres. Others, and Prof. Niblett is one, believe that these things are desirable only if they are used to extend and strengthen fundamental values and that much more could be done with existing facilities.

Fundamental values, he says, have been weakened by two main causes—one minor and one major: the minor cause is two World Wars; the major, the spread of the scientific temper of mind. As an instrument of analysis, the latter is indispensable, and there is need for its wider extension throughout the world if, as is desirable, more and more people are to benefit from material progress. Yet extension carries certain dangers. The application of scientific disciplines like psychology and sociology to problems of man himself leads many to believe that all man's experience is amenable to detached analysis. At this point Prof. Niblett stands firm and, in words of rare poignancy, argues with conviction that there is much in human experience which no known methods of analysis can explore. There are different kinds of facts, different kinds of knowledge, and different kinds of human experience. Some of these can be acquired by direct 'education'; some by providing the right kind of environment, inside or outside the schools. Others can only be arrived at by living itself and by the transmission of standards and values from one person and one group to others.

In the latter part of his book Prof. Niblett suggests ways in which educational institutions can effectively pass on the basic requirements for living like the three 'r's' as well as the basic requirements for life like analytic detachment, humour, humility, responsibility, sympathy, unselfishness and courage. Here some educationists will quarrel with his choice of subjects and the suggested methods of treatment. Few will withhold their respect for views which bear the hall-mark of original thought and which do not regard long-established curricula as sacrosanct or immutable. With many children, for example, Prof. Niblett thinks that much time is wasted in trying to teach them arithmetic despite years of failure; why, for such children, should it not be dropped at, say, fourteen years of age? Much valuable time could also be saved if a bolder policy of omission were carried out in all kinds of schools with foreign languages and subjects like drawing and woodwork.

Many sixth-form science teachers will feel that Prof. Niblett's strictures on the teaching of science in grammar schools are a little harsh. Yet most will agree that there is the ever-present danger that, to many sixth-form boys, "his science, instead of being a discipline, becomes an end, itself degenerated to a technique, a know-how of getting through examinations and later a know-how of technical progresses, and not the beginnings of a philosophy". Science can, and should, be taught to nourish the imagination and to add to the power to generalize. With teachers who possess both a philosophy of science and a wide scientific knowledge, it is not too difficult for students to catch the meaning and method of scientific inquiry and the humility which goes with it.

The final chapter is concerned with the release of leadership. The value of tradition in the life of the school is well brought out—as is the difficulty of building one in many secondary modern schools which are too tightly controlled by local education authorities. If ground is to be prepared, however, in which leaders may grow, there must be a constant succession of teachers of high quality—men and women whose own lives reflect the most worthy characteristics of a good society. Does our society want such a flow of teachers? What status have they in the community? What salaries are they paid? How many teachers are asked to serve on representative national committees—even committees upon education itself? How many teachers ever appear in New Year or Birthday Honours lists?

These are questions which a good society would be able to answer in a way that would recognize the importance of the teaching profession at all levels to the community as a whole. They have been sharply pointed by an author who has thought deep and writes with such skill and lucidity that his book deserves to become as well known as Sir Richard Livingstone's "The Future in Education".

T. H. HAWKINS

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# TEXT-BOOKS OF NUCLEAR PHYSICS

### Nuclear Physics

By Dr. Irving Kaplan. (Addison-Wesley Series in Nuclear Science and Engineering.) Pp. xi+609. (Cambridge, Mass.: Addison-Wesley Publishing Company, Inc., 1955.) 10 dollars.

### Nuclear Physics

By Prof. Alex E. S. Green. (International Series in Pure and Applied Physics.) Pp. xv+535. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 64s. 6d.

IN the first of these two books under review, Dr. Irving Kaplan requires no more of his reader than "a two year course in college physics and a familiarity with integral and differential calculus". From such small beginnings he has produced a thoroughly readable and clear account of most features of 'pure' nuclear physics, and found room for such items of 'nuclear technology' as the design of accelerators, nuclear reactors and isotope separation.

In the first quarter of the book the nucleus is approached no more closely than Rutherford's early researches on α-particle scattering allowed. T starting-point is the earliest chemical evidence for atomic theory and a periodic table of elements. T classical experiments on cathode and 'canal-rays' described next, and the discovery of radioactiv and elementary methods of radiation detect follow. Particularly well treated is the derivation the Rutherford scattering law and its verification. which the original experimental results confirm the predicted dependence on the element, α-particle energy, the angle of scattering and thickness are tabulated. An account of Mosele work on X-rays is followed by chapters on quantum theory of radiation, the special theory relativity and the Compton effect, and the hydro spectrum and its interpretation with the Bohr mo The hybrid nature of this model receives pro emphasis; the introduction of wave mechan completes the first part. A plausible derivation Schrödinger's equation is included, without a examples of its solution; the interpretation of periodic table in terms of the electron configurat and the operation of the Pauli exclusion princi are particularly clear.

The second part of the book, approximately o half of the total, is concerned with the nucleus prop The difficulties of the 'electron proton' model for nucleus and its replacement by the 'neutron prot model, the magnetic and electric moments, statist and parity are dealt with first. The accurate deter ination of nuclear masses is described; but interpretation is left to later chapters. Chapters foll on the laws of radioactive decay, with tables of natural radioactive series, on the types of nucl disintegration which may be produced by accelerat particles, on artificial radioactivity and on the det of the interactions with matter and the spectra α-, β- and γ-radiations. At this point, there is return to nuclear reactions, the discussion conc trating on the nuclear physics, rather than nucl chemistry as earlier. The approach is descript throughout, and the experimental methods, resu and interpretations are kept closely together. T classification of reactions follows that of Blatt a Weisskopf; reactions in the lighter nuclei are de with in a separate section and the emphasis in t field on the details of nuclear energy-levels, rat than the reaction mechanisms, is well brought o The second part of the book closes with a chapter nuclear forces and nuclear structure. The summa of results on the interaction of two nucleons perhaps condensed too much, but the evidence for magic numbers is well set out. The descriptions the shell model, and Bohr's collective model, are v short indeed, and there is no account of the 'clou crystal ball'.

The third part of the book, approximately o quarter, deals with special topics and applicatio 'Neutron physics' is concerned mainly with t detection of neutrons, diffusion and slowing dov and the measurement of the various cross-sections different energy regions, with little interpretation results. The remaining chapters are devoted fission, nuclear reactors, accelerators and isoto separation.

The main general impression is that the book extremely readable. The line of development neither strictly historical, nor by subject-mat (certain topics are discussed several times in wid separated sections), but is always clear. All releva major review articles together with many referen the literature are listed at the end of each chapter. list of problems is also given; these are elementary d do not require access to material outside the ok. Illustrations are excellent and copious, and a ge chart of nuclides is included.

The book will be ideal for those whose work in ighbouring fields (reactor engineering and radio-emistry, for example) brings them in close contact th nuclear physics, and for many physics students. r undergraduates intending to specialize in this ld and research students the book will be valuable, t a greater theoretical background will have to be ught elsewhere. No serious inaccuracies were noted. ie text and diagram illustrating the energy-levels the hydrogen atom are in disagreement; the mark that a smaller magnet is required in a linear celerator than in a circular machine producing rticles of the same energy is either self-evident or o subtle for the general reader.

The second book, by Prof. A. E. S. Green, also mmences with a review of atomic physics. This is tremely compressed and requires that the reader ow the field, well beforehand. The next chapter umerates the static properties of nuclei—the radii, asses and moments—and includes a long section on e classical interactions of the various moments with field. The next three chapters are devoted entirely technology and deal with accelerators, 'precision struments' and detectors. It appears that much of e material contained herein would have been better aced in an appendix; an extremely complicated awing of a β-ray spectrometer, circuit diagrams of nplifiers and multichannel pulse-height analysers, d a diagram illustrating how to read the inter-lating lights of a scale-of-eight counter do not seem propriate at this stage. More general ideas on how e various instruments are used for elucidating decay hemes or reaction constants are not put forward lequately. Chapters follow on radioactivity and iclear reactions. The latter includes a detailed dis-ssion on the absorption of γ-radiation and a com-ete treatment of the classical mechanics of reactions d the transformation between laboratory and ntre of mass co-ordinates. The next chapter, on stematics and tendencies of nuclei, is a very orough investigation of the nuclear energy surface a function of atomic and mass numbers (and en–odd properties) and includes a discussion of the egularities at the magic numbers. In the following apter the liquid drop model is presented, and the terpretation and best values of the parameters in semi-empirical mass formula are discussed at igth; the chapter ends with a discussion of fission d the achievement of a chain reaction. The chapter quantum mechanics and the nucleus is an excel-it presentation of the Schrodinger equation; a riety of applications follows—to single bodies in rious wells and to two- and many-body problems. ie discussion includes the time-dependent wave uation, perturbation theory and the coupling of gular momenta. The next chapter discusses various iclear models in fair detail, mainly in relation to ound-state properties. That on nuclear decay vers γ-, β- and α-ray decay theory concisely and arly. The formal theory of reaction processes is veloped next, and this is perhaps the most valuable apter in the book, which closes with an analysis of iat is known of nuclear forces from the low-energy cleon–nucleon interactions and the properties of the iteron, the difficulties raised by high-energy results, d a brief excursion into meson field theory.

Reference lists are given with each chapter, together with problems graded in difficulty, some requiring extensive reference to the current literature.

The book is in many ways complementary to that by Dr. Kaplan. A previous study of the latter will help overcome the difficulties arising from the rather complete separation of techniques, results and interpretation made by Prof. Green. His book, on the other hand, though requiring more from the student and covering less ground, is able to provide the necessary discussion of the more difficult topics treated in a purely descriptive fashion by Dr. Kaplan. A few errors have been noted. The very brief description of deuteron stripping suffers from confusion between the appearance of groups of product particles of discrete energies and resonance in the reaction yield. In the discussion of neutron-detection techniques, the use of a chamber filled with boron trifluoride is described, and the statement is made that "these chambers may be used as proportional counters in the low-energy region, since the reaction yield for a fixed neutron flux depends sensitively on the neutron energy". This is a novel and unhelpful usage of the term "proportional counter". The derivation of the reciprocity theorem needs more explanation, and spin factors might well have been included.

R. C. Hanna

# ELECTRICITY FOR THE UNINITIATED

### A Guidebook to Electricity

By J. H. M. Sykes. Pp. 275+16 plates. (London: Hutchinson's Scientific and Technical Publications, 1955.) 21*s*. net.

Writers of popular science books might well study the handicapping system used in golf. The real expert does not moderate his accuracy to suit the competence of his companion; instead, an approximate adjustment to equal terms is made on a quantitative rather than a qualitative basis, and the full rigour of the game is enforced. If similar measures had been taken by the author of this well-illustrated and informative book, by simply omitting paragraphs here and there, one could recommend it without reservation or criticism.

The descriptions of electrical machines, wiring systems, domestic appliances and communications devices are good, and the technical side is well presented in an interesting manner. Alternating current in general, and three-phase systems in particular, are discussed very clearly in non-mathematical terms; and there are a glossary and some useful tables at the end. The general reader for whom it is primarily intended will gain from it a good idea of the way in which most of the applications of electricity in everyday life work. This, according to the preface, is the limit of the author's aim, and in this he has succeeded.

Bearing this deliberate limitation in mind, any criticism of the references to fundamental principles may seem unfair. But it is one thing to avoid delicate discussion of the facts of life, and quite a different matter to describe stork-legends seriously and in circumstantial detail. That the liberation of an electron from a copper atom "could only be undertaken if enormous force is available, such as the power necessary when nuclear fission is carried out", and that "the speed with which electrons fly round their orbits in each atom is related to the temperature—if the temperature is greatly increased they begin to fly round so rapidly that eventually one of them flies off altogether by a kind of centrifugal force" are statements in a class by themselves. The introduction to radio as the propagation of "electromagnetic and electrostatic" waves by a process of electrostatic induction is unfortunately plausible. The old international ohm is defined as a piece of platinum preserved somewhere, and even the statement of Ohm's law would not be accepted in an Ordinary-level physics examination. The unwritten law (which should be restricted to the same category of book) requiring a certain tempering of the scientific usage of the terms force, work, and power for the layman, so that they are used correctly in some places and interchangeably in others, has been operative here.

The pity is that blemishes of this kind in an attractive and otherwise excellent book should, because they are barely relevant to its main message to the general reader, appear to be trivial. They greatly reduce its value for the student to whom it is also directed, for he cannot afford to take that point of view. In guide-book terms, this does the tourist handsomely and treats the fell-walker pretty well; but it is not for those who also want a little serious climbing.

G. R. NOAKES

# PROBLEMS OF TECHNICAL LIBRARY SERVICES IN GREAT BRITAIN

## Commercial and Technical Libraries

By J. P. Lamb. (The Library Association Series of Library Manuals—10.) Pp. 316+7 plates. (London: George Allen and Unwin, Ltd., and the Library Association, 1955.) 21*s*. net.

THE Sheffield City Librarian, Mr. J. P. Lamb, has long been known outside the circle of public librarians for his part in the highly successful interchange scheme for technical publications which he first described to an Aslib Conference more than twenty years ago. This latest book of his is addressed primarily to those concerned with the running of a public commercial and technical library. While, however, his chapters on the equipment and staffing of such a library, the principles which should determine its relation to the public library system generally or the selection of its stock, whether of books and periodicals or of patent specifications, are chiefly of interest to those engaged in such work, the imagination and shrewd common sense which have contributed so much to the success of the Sheffield scheme continually break through and give his chapters a wider interest or relevance. Always he is impatient of operational ineptitude or of grandiose schemes which have little relation to reality, whether it be for book coverage or anything else. He is keenly alive to the fact that libraries are for use, and this pervading sense of users' needs makes such a chapter as that on organization and administration as interesting to the general reader as to the librarian.

To the technical librarian in industry these chapters are almost as useful and suggestive as they are to the librarian engaged in public library service, and parts of them will interest the technologist and scientist. To such, and perhaps to the industrialist generally, the chapter on external activities will of no less interest, and many will be surprised at t scope and extent of the activities of the technic information departments which are already mai tained by some public libraries. Mr. Lamb's accou is the more welcome in that, as he duly points o an inquiry in this field made by the Federation British Industries, in collaboration with the Panel Technical Information Services of the Committee Industrial Productivity, largely overlooked what w being done by the public libraries and gave indication of the extent to which such activiti enable commercial and industrial concerns economize in the information services they the selves maintain.

In Great Britain the smaller firms especially are yet barely conscious of the needs which the publ commercial or technical library could thus meet, a Mr. Lamb is rightly critical of this omission in important report, the paragraphs of which relati specifically to public libraries he quotes in full in h final chapter. It is this chapter and that in whi he reviews briefly the history of British commerci and technical libraries and notes some of the miss opportunities of the inter-war years that are of mo interest to the general reader as well as to t scientist. To the latter this concluding chapter, wi its admirably balanced survey of the future in whi proposals, for example, for a science centre, includi a national lending library of science and technolog as well as a national reference library for that fiel are placed in their proper perspective in relation the existing library resources of Britain, includi those of the public library system, is absorbing.

This chapter, which displays clearly the bearing an efficient technical library system on technic education, industrial research and industrial efficienc in general, is of particular interest at the moment i that, since this book was written, the Advisor Council on Scientific Policy, in its eighth annu report, reverts again to the place of scientific librari in the national economy, both in securing the mo effective use of the nation's scientific and technic man-power and in furthering the dissemination technical information as well as the development higher technological education. In this respect M Lamb's account needs amplifying, for as it stands suggests that the Advisory Council has dropped i support for the project of a national lending librar For all that, his chapter admirably states the ca for a national lending library and a national referenc library and for the way in which both could be su ported by existing public technical library service It gives a concise but clear picture of the advantage and economy to be derived from a carefully though out policy of utilizing to the full existing service but providing at the centre the essential nation services to which the Advisory Council on Scientifi Policy points.

The limitations of interchange schemes are clear recognized; but none the less, Mr. Lamb puts clear and fairly both the advantages of such schemes i relieving pressure on a national lending library science and technology and the case for a governme grant to those public technical libraries which, b co-operating in this and other ways with the nation lending reference library, would increase its efficienc and resources and secure a better use of the nation' existing resources and services, whether in the wa of books and periodicals or of trained staff.

R. BRIGHTMAN

## itish Journal of Applied Physics

dited by Dr. H. R. Lang. Vol. 5, 1954, and pplement No. 3: The Physics of Particle Size nalysis—a Conference arranged by the Institute of hysics and held in the University of Nottingham om the 6 to 9 April, 1954. Pp. vi+466+supple- ent 218. (London: Institute of Physics, 1954.) 14*s*. 6*d*.

N its annual report to the board of the Institute of Physics, the advisory committee of the *British ournal of Applied Physics* recently commented on e satisfactory increased circulation and high andard of the *Journal*, and this is amply justified y Vol. 5 which covers 1954. The volume contains welve special articles, three conference reports and venty-nine original contributions, in addition to a ngthy supplement of 218 pages.

Most of the special articles consist of lectures elivered by their authors to various branch and roup meetings of the Institute. R. W. G. Wyckoff rites on the growth of X-ray diffraction work in e United States—the subject of his evening discourse the X-ray Analysis Group on November 20, 1953; V. A. Wooster on diffuse X-ray scattering and the hysical properties of crystals; O. R. Frisch on the eginnings of atomic energy, and R. Fürth on statis- cal concepts in theoretical physics, both lectures to he Education Group; V. Daniel on the thermo- ynamic approach to solid structure; and others on uch varied topics as supersonic gas flow, the elec- rical breakdown of gases, the junction transistor, and he near infra-red absorption spectra of fibres. In he three conference reports, the proceedings are ummarized of the conferences on X-ray analysis held n London during November 1953 and in Cambridge uring April 1954, and on electron microscopy in ondon during November 1953.

The secretary of the Institute of Physics and editor f the Institute's journals, Dr. H. R. Lang, contri- utes the editorial note to the supplement, which is record of the proceedings of the conference on the hysics of the analysis of particle size, arranged by he Institute and held at the University of Notting- am during April 6–9, 1954. Forty-two papers were resented, and these, together with the discussions n them, are grouped in eight sections corresponding o the eight sessions into which the conference was ivided. It is sufficient recommendation to quote rom Sir Geoffrey Taylor's opening remarks that new nd valuable contributions to the scientific study of he processes of particle separation are to be found n all the papers presented to the conference.

## eology in Engineering

y Dr. John R. Schultz and Dr. Arthur B. Cleaves. ith a Chapter on Soil Mechanics by E. J. Yoder. p. ix+592. (New York: John Wiley and Sons, nc.; London: Chapman and Hall, Ltd., 1955.) 0*s*. net.

THIS well-planned and well-written book deals with the application of geology to civil engineer- ng. It is more than a text-book of geology for ngineers, since it discusses geology in such a way that ngineers, on one hand, can appreciate when and to hat extent they may expect the geologist to help hem, and the geologist, on the other, may appreciate he problems with which the engineer has to deal.

The book is concerned with principles rather than ase-histories, because it is the authors' opinion that he engineer will employ the geologist more for the inferences he will make than for his factual knowledge. Attention is directed to the necessity for the geologist to know what the engineer is aiming at in order that he may give the right information in the most useful form, while the engineer, on his part, must be able to appreciate the significance of what the geologist tells him.

The book is divided into twenty-two chapters, of which two-thirds deal with those geological processes and phenomena that have special application in engineering projects and difficulties, and the remainder with specific topics such as dams, reservoirs, roads and tunnels, and with recent developments in the field of soil mechanics and the uses of aerial photography in interpreting soil distribution and recognizing geological structures.

The reproduction of the half-tone illustrations which are distributed through the text leaves much to be desired; but there are many excellent text-figures, a useful bibliography at the end of each chapter, and an adequate index. F. J. North

## The Golden Eagle

King of Birds. By Seton Gordon. Pp. ix+246+16 plates. (London: William Collins, Sons and Co., Ltd., 1955.) 16*s*. net.

MR. SETON GORDON has lived all his life in the Scottish Highlands, has had exceptional opportunities of watching eagles, and has made good use of them. Not only has he kept nests under daily observation from the laying of eggs to first flight of the young, but he has also watched the adults hunting in mid-winter when the hills are covered with snow, and later seen them pair and build the nest. The results of all these observations are presented in a very readable form and include a number of new facts. No attempt is made to estimate the number of breeding pairs of golden eagles; but it may be said that during the past twenty-five years the numbers have been more or less stationary—a decrease in one part of the country and an increase in another. It is interesting to learn that birds have returned to their old haunts in the wilds of Galloway and Carrick and northern Ireland. A chapter is devoted to the use of the eagle in falconry, and we learn that in central Asia birds are used for hunting wolves, foxes and gazelle.

With the advent of sheep farming, and grouse shooting becoming a source of income to Highland lairds, the eagle would have been doomed if it were not for the enlightened policy of some landowners. That the eagle does take lambs at times there is ample evidence, and Mr. Seton Gordon himself has seen one carrying off a lamb. Nevertheless, he considers that "In Scotland the number of lamb-killing eagles is small—less than five percent". He goes on to say that lambs are not a regular prey of eagles in Scotland any more than man is of a tiger. Blue hares and rabbits are the principal food, and one wonders what they will turn to now that the latter have become so scarce.

The eagle's prey is varied and includes various mammals, grouse, geese and other birds. Though a number of grouse are taken, the author does not think they are destroyed in sufficient numbers to affect the stock on a moor; on the other hand, eagles kill grey crows, and it would be interesting to know whether the crow or the eagle has the greatest effect on the grouse population. A number of beautiful photographs adds much to the value of this interesting book. N. Kinnear

# MR. H. N. RIDLEY'S HUNDREDTH BIRTHDAY

By J. W. PURSEGLOVE

Director of the Botanic Gardens, Singapore

DECEMBER 10, 1955, marks the hundredth birthday anniversary of Mr. Henry Nicholas Ridley, C.M.G., F.R.S. He was director of the Singapore Botanic Gardens during 1888–1912, and he will always be remembered in South-East Asia for his vital role in the foundation of the rubber industry and for his gargantuan contribution to our knowledge of the natural history of the area.

While still at school at Haileybury, he decided to devote his life to the study of natural history in the tropics. After graduation at Exeter College, Oxford, he was awarded the Burdett-Coutts Geological Scholarship. In 1880 he was appointed to the staff of the Botany Department of the British Museum in charge of monocotyledons, where he worked until 1887. During this period he became acquainted with many tropical plants and published papers on them. In 1887 he explored the island of Fernando de Noronha, Brazil, and later published accounts of its flora, fauna and geology.

Thus when Ridley arrived in Singapore in November 1888 as the first scientific director of gardens and forests, Straits Settlements, he was well qualified for the tasks which lay ahead. The Singapore Botanic Gardens had been founded on their present site in 1859, although there had been an earlier garden started by Raffles in 1822. Ridley's capability as a research worker and his work on economic crops and tropical botany succeeded in a surprisingly short time in pushing the Singapore Gardens to the fore as a centre of this work.

In the Economic Gardens, now the site of the University of Malaya, he found a plantation of *Hevea* rubber trees, produced from seedlings sent out by Sir Joseph Hooker from Kew in 1877, where they had been grown from seeds collected in Brazil by Mr. H. A. (later Sir Henry) Wickham. The seeds had not been smuggled out of Brazil as is often suggested, but had been obtained by the goodwill and co-operation of the Brazilian Government. Ridley at once began his famous tapping experiments, in which he demonstrated that the trees could be tapped regularly. Recently he told me that when he began he had no idea that rubber would be "a permanently milking tree". This work, together with his experiments on the preparation of rubber and his constant advocacy of it as a plantation crop, often in the face of opposition, led to the foundation of the present industry upon which so large a share of the wealth of Malaya and the eastern tropics has rested. Ridley remained in Malaya long enough to see the fruition of his labour and the great rubber boom of 1910. O. D. Gallagher, in an article in *The Observer* of June 25, 1955, writes: "He is one of the hundred or so men, out of the 2,500 million alive to-day, whose personal efforts have helped decisively to shape our modern life. His rewards have been meagre and mainly abstract. . . . Ridley's name is indelibly rubber-stamped in history."

Ridley's work on economic crops was not confined to rubber; he carried out experiments with most of the actual and potential tropical crops known. He provided not only local planters, but also all other tropical parts of the Empire and elsewhere, wit planting material of rubber and many other crop Visitors from all over the world came to see h experimental and demonstration plots. As early 1889 he reported that cocoa would probably be profi able on the better Malayan soils, while in 1907 h directed attention to the possibility of oil palm as plantation crop. Ridley produced the first writte works of their kind on Malayan timbers, rattans an other forest products, as well as drug plants, fruit and spices. It should be realized that until th formation of the Agricultural Department in Malay in 1904, Ridley and his three assistants at Singapor Malacca and Penang were the only trained men t whom the planting community could apply for tech nical advice and help. Ridley studied in some deta the pests and diseases of the economic crops of th area, and specimens were often submitted to hi by the planters for identification with requests fo advice on their control. In 1891 he founded *th Agricultural Bulletin*, so that he could supply th planting community and others with informatio resulting from his many investigations. He con tinued to edit it until his retirement in 1912, an from 1900 it was published monthly.

"Mr. Ridley's work as a field botanist added mor than that of any other single man to our knowledg of the flora of the Malay Peninsula; his *Flor* (1922–25) is the foundation upon which all futur work must rest." He was an indefatigable collecto and a tireless worker. He made excursions to mos parts of Malaya, often remote, as well as visitin Cocos and Christmas Islands, Borneo, Java an Sumatra. In all, he collected many thousands o specimens, of which a large number were the unknown to science. He named for the first time few thousand plants, and a surprising number o Malayan plants are still only known from his origina gatherings. Nor did he confine himself to plants, o which he collected all groups, but he also collecte many animals as well, mainly vertebrates (excludin fish) and insects. Many plants and animals wer named in his honour, including a New Guinea genu of orchids *Ridleyella* and a moth genus *Ridleyana* It was Ridley who discovered that the ant *Oeco-phylla smarangdina* uses its own larvæ to make silk for the construction and repairing of its nest. Ridley added very considerably to the collection of cultivated plants, both Malayan and exotic, in the Botanic Gardens, Singapore, and brought back living plants from many of his excursions for growing here He sent seeds of the more spectacular plants to Kew, where they were flowered for the first time in Europe. Hand-coloured illustrations and descriptions of some of these were published in *Curtis's Botanical Magazine*, of which Vol. 132 (1906) was dedicated to Mr. Ridley.

His first scientific paper was published while he was still at school, and in all he published more than five hundred papers, articles and books, amounting to some ten thousand printed pages, dealing with tropical agriculture, botany, zoology and geology. A full list of his publications up to 1935 is given in the *Gardens' Bulletin* (9), which was dedicated to him n his eightieth birthday. His encyclopædic volume, The Dispersal of Plants throughout the World", mbodying many original observations, was pub- shed in 1930 when he was seventy-five. Com- ienting on his published work, one critic has said: That there were inaccuracies goes without saying, ut it was just that quality of recklessness in Ridley's rork that enabled him to turn out such vast quan- ities of assimilable knowledge when it was most eeded. A lesser man would have feared for his rofessional reputation, but Ridley was above such etty considerations. The work needed doing, and ith the means at his disposal he did it magni- cently".

Mr. Ridley was secretary of the Royal Asiatic ociety, Straits Branch, during 1889–1911, and editor f its journal, in which he published many original apers. In 1905 he gave the first course of botany ctures to the newly formed King Edward VII ollege of Medicine, now the Medical School at the University of Malaya, and continued these lectures until 1910.

Mr. Ridley was elected a Fellow of the Linnean Society in 1881 and of the Royal Society in 1907. His services were recognized by the honour of a C.M.G. in 1911. His work as a naturalist and in establishing the Para rubber industry has been recognized officially by various scientific and industrial bodies. We are planning appropriate celebrations at the Botanic Gardens, Singapore, on his hundredth birthday, which will include an exhibition of "Ridleyana".

It is my fervent hope that the Singapore Botanic Gardens may long continue as a leading centre of research in tropical botany and a worthy memorial to Mr. Ridley and all that he has done for us during his long and productive life. I am sure that readers of *Nature* will join with me in congratulating Mr. Ridley on the present happy occasion of his centenary and in wishing him "Many Happy Returns".

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# THE ROYAL SOCIETY

## ANNIVERSARY ADDRESS* BY LORD ADRIAN, O.M., P.R.S.

## AWARD OF MEDALS, 1955

### Copley Medal : Sir Ronald Fisher, F.R.S.

THE rise of quantitative biology, which has been so noteworthy a feature of this century and specially of the past thirty years or so, has been ue above all to the work of R. A. Fisher. The ariability of living things posed problems and raised ifficulties in the interpretation of experimental and bservational data which made necessary something eyond the methods of the physical sciences. They equired in fact a new approach to inductive inference, nd one which would provide means of drawing con- lusions of assessable reliability from variable aterial often available only in small samples. It is o Fisher's combination of mathematical skill and iological insight that we owe the developments, oth theoretical and practical, which have done so uch towards solving this problem and so making iologists of virtually every kind quantitative in heir experiment, their analysis, and, most important f all, their thought.

Faced with the agronomical problems of Rotham- ted, the staff of which he joined in 1919, Fisher egan the remarkable series of statistical investi- ations which gave us the techniques described in 'Statistical Methods", the tabular matter of "Statist- al Tables" (published with F. Yates) for facilitating heir use, and the philosophy of "Design of Experi- nents" by which they may be understood, appreciated nd extended. The outcome has not merely stood he test of time in those branches of biology with rhich Fisher was immediately concerned, but also has ad an ever-widening influence which now extends ven beyond the borders of biology itself. In building he new biometry, Fisher has given especially to the ounger biologists a confidence and quantitative outlook the full effect of which we have still to see.

While Fisher will always be associated chiefly with these developments in statistics and biometry, it should not be forgotten that he has made outstanding contributions in the field of genetics and evolution. He set us on the way towards the modern study of biometrical genetics, and his mathematical treatment of natural selection has provided the basis for much of our present studies of populations. His theory of the evolution of dominance introduced us to the notion of the modification by selection of gene expression, and we owe primarily to him the theory by which we came to understand the working of the *Rhesus* blood groups. He has indeed long been established internationally as well as nationally as one of our leading geneticists, than whom few have done more to further the understanding of evolutionary processes.

### Royal Medal (A) : Sir Alexander Todd, F.R.S.

Over a wide field, Todd has made distinguished original contributions to the chemistry of natural products, more particularly in the field of compounds of physiological importance. His remarkable contributions to knowledge and his brilliance as an investigator have been recognized internationally by both organic chemists and biologists.

Todd joined Sir Robert Robinson in 1931 and played an important part in investigations on the synthesis of anthocyanins. His earlier work included major contributions in the field of vitamin chemistry, for example, in relation to the development of the structure of vitamin $B_1$, and to its synthesis. Independent of Karrer and Fernholz, Todd established the structure of vitamin E and achieved a synthesis. More recently, he has turned his attention to the vitamin $B_{12}$ group, and his degradative and synthetical studies have recently made fundamental contributions to our knowledge of the nature of these substances.

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* Delivered at the Royal Society on November 30.

Undoubtedly Todd's most outstanding work in organic and biochemistry is in the nucleic acid field. *Inter alia*, he has developed rational methods for the synthesis of natural purine and pyrimidine nucleotides and for their phosphorylation to the nucleosides, including a synthesis of adenosine diphosphate and adenosine triphosphate. These results, among many others, have been achieved by a combination of theoretical knowledge and great experimental skill, aided by modern techniques.

Todd has been a pioneer in the chemistry of cannabinol, a series of complex *bis-iso*quinoline alkaloids, insect pigments (especially the colouring matter of Aphidae), kousso, and natural tropolones of mould origin.

Todd is a most capable investigator ; he has made fundamental contributions to organic and bio-chemistry and is recognized as a leader in these fields.

### Royal Medal (B) : Prof. V. B. Wigglesworth, C.B.E., F.R.S.

Prof. V. B. Wigglesworth has increased our knowledge of almost every branch of insect physiology, and in most cases his work has formed the starting point for other investigators. His contributions to the understanding of those interwoven subjects—growth and cuticle structure—are of paramount importance. It was Wigglesworth who first resolved the epicuticular layer into its four components, showing both the chemical composition and the biological role of these layers, and we owe to him our knowledge of the structure and functioning of the dermal glands. But the formation of the cuticle is inseparable from the study of growth, and following Kopec's first demonstration that hormones were involved in the growth process, the rest of this vast and complex subject belongs to Wigglesworth : the hormonal balance giving rise to nymph or adult, the individual fields of organization in the epidermis, the mechanism of the parallel case of wound healing, and most recently, the way in which various hæmocytes enter into the process.

In the study of respiration, too, Wigglesworth has been a pioneer, and his recent studies on the migration of tracheoles and the effects of low oxygen tensions on tracheal organization have altered our entire concept of this subject.

He has done fundamental work on the digestion of blood meals by parasitic insects, and has demonstrated the formation of a peritrophic membrane in many species by secretion through an annular press. The detailed picture of the histological and chemical cycle of excretion through Malpighian tubules, and the secretory balance of salts and water in mosquitoes are also noteworthy.

From the width of the field covered by his numerous researches, it can be said that Wigglesworth is the 'father' of insect physiology. He has realized the potentiality of the insect as a medium for physiological research, and carried that view into practice with a mastery of observational and experimental methods.

### Davy Medal : Prof. H. W. Melville, F.R.S.

Prof. H. W. Melville occupies a prominent position among those who have developed the extremely important field of the chemistry of macro-molecular substances. He has made many valuable contributions to the study of the mechanisms of the reaction in which such substances are formed, and has devise new experimental methods for the purpose. His earl work on the examination of the various explosio limits in mixtures of phosphorus vapour and oxyge confirmed and extended important results bearing o the early development of the theory of chain reactions especially the role of diffusing atoms and radicals With the discovery of deuterium he examined number of reactions in which the replacement o hydrogen by deuterium contributed to the elucidatio of the mechanism. His work on photochemica reactions sensitized with mercury vapour greatl advanced and clarified this problem.

With this background Melville took up the study o the more complex processes of polymerization and t this field he has made important and lasting contributions. He devised new techniques for the study of th elementary processes which make up the overall chai reaction, and he applied the device of the rotatin sector to the determination of the life-time of transien entities. This work has formed the basis of th quantitative study of free-radical reactivity both fo polymerization and oxidation systems and in man other reactions. Melville and his collaborators hav also made valuable contributions to the methods o synthesis and study of new polymeric systems including recently the interesting group of 'blac polymers'.

Melville's achievements have contributed much t our knowledge of the intricacies of chemical change and his development of new methods and technique for research have had an influence far beyond th confines of his own laboratory.

### Sylvester Medal : Prof. E. C. Titchmarsh, F.R.S.

E. C. Titchmarsh's early work was in the theory o Fourier series and integrals. From this he passed o to a profound study of the special properties of th Riemann zeta-function, a subject which he made ver much his own over a period of many years. His systematic use of Fourier integrals, and in particular o Parseval's formula, led to formulæ that would no have been suggested naturally by other methods, an these formulæ proved to be remarkably fruitful fo the development of new properties of the function.

Some of his work on the order of magnitude of th zeta-function was based on developments of method of estimating trigonometrical sums, due originally t Weyl and van der Corput. He applied these ideas t other problems also, and in particular he effecte significant improvements in the estimation of th error terms in lattice point problems by extending va der Corput's method to double trigonometrical sums

His more recent work has been in the field of eigenfunction expansions associated with second-orde differential equations.

Prof. Titchmarsh has also written a number o important treatises on the various fields within whic he has worked.

### Hughes Medal : Prof. H. S. W. Massey, F.R.S.

Prof. H. S. W. Massey has added greatly to ou knowledge of collision processes between electrons neutral particles and ions. His early work was concerned with elastic and inelastic collisions betwee electrons and atoms. With Bullard he was responsib for some of the early experiments demonstratin iffraction effects. He carried out and directed a rge number of detailed calculations, and, in parti- ular, he exploited the variational method with great horoughness, and did much to give a pattern to the xperimental results by emphasizing the significance f the near-adiabatic conditions.

He was the first to apply the theories of attachment nd recombination to problems of the ionosphere, nd he led the way in reviewing the results of the adio experimenters and in trying to explain them. The difficulties in the way of explanation led him to nvestigate and discuss a wide range of atomic and molecular processes possible in the upper atmosphere. His work, and that of his pupils, is far in advance of any other in this field and has revolutionized our deas about atomic processes in the ionosphere.

Prof. Massey is also the joint author of two important books on the subject of "Atomic Collisions" and of "Electronic Impact Phenomena".

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## FUNCTIONS OF THE ROYAL SOCIETY

A Royal Medal was awarded ten years ago to Sir Edward Salisbury for his contributions to botanical science. To-day if there were an appropriate medal we ought to give it to him for his contributions in a wider field, as Biological Secretary of the Royal Society. His term of ten years ends at this meeting. We shall all miss the wise counsel he has given the Society, and I count myself extremely fortunate to have held office with a colleague who has endeared himself to Officers and Fellows alike by his kindly understanding of our needs.

We rely on our Secretaries for much more than the supervision of meetings and publications, for they are constantly surveying our activities and must see to it that they are adapted to changing needs. Sir Edward's initiative has widened the scope of our meetings, he has maintained and extended our role in relation to the Commonwealth, and in the field of publications his care in the administration of the Parliamentary Grant-in-Aid has been largely responsible for the improved position enjoyed not only by urselves but also by many other societies as well.

On behalf of the Society, therefore, I thank Sir lward Salisbury for the valuable service he has dered to science during his tenure of office as logical Secretary.

he past year has seen a development in scientific ity which may have great consequences for all and I shall deal with it now because we are ate in having evidence of it at this meeting. I the striking change which has come about in d of international scientific effort. We have d at Geneva a conference on the use of energy at which the experts from every could exchange information in the atmo- nuine scientific co-operation. The geo- onomers, meteorologists and geo- nation have already taken the mbined operations for the ear, and our own Lieutenant-Com- its way to the scene of so much remote parts of the now exchanging eedom, and we our- by the visit of the President of the U.S.S.R. Academy of Sciences and his colleagues during the past fortnight and by their presence at our Anniversary Meeting to-day.

We ought to think of our future rather than our past, but this is an occasion when we cannot be blamed for recalling our long history. When Peter the Great was in London at the end of the seventeenth century, he may well have attended some of the Society's meetings, but unfortunately the names of our visitors then were not recorded. In 1714, however, his fellow-countryman, Prince Alexander de Menzikoff, was admitted a Fellow of the Society, and the notice of his election was signed by our president, Sir Isaac Newton.

When we turn to the record of scientific achievements in the past year it is more difficult to select those which would really justify the use of that overworked epithet 'outstanding'. The passenger who is driven in a modern car along an open road will expect the milestones to recur every minute and will feel that something has gone wrong if they do not. In the past year nothing has gone wrong with the progress of scientific research, in fact the pace is faster than ever; but we are already so used to it that we have come to think more of the danger signals than of the milestones. It is, of course, unfortunate that knowledge can be dangerous, and it would certainly be a disaster if this became an excuse for preferring ignorance; but the danger signals have already attracted world-wide notice and the Society will not need to be reminded of them.

The milestones may have attracted less notice than they deserve: each of us can think of important advances in the field he knows best; but there are two which deserve mention now because our own Fellows have made them and because they are signs of what is likely to be a new phase in our understanding of Nature. I refer to the recent elucidation of the structure of two highly complex molecules, those of insulin and of vitamin $B_{12}$. Both these substances are formed in living cells and play an important part in the vertebrate economy, insulin in sugar metabolism and $B_{12}$ in the formation of the blood cells. Their existence has been known for many years, the use of the naturally occurring products has already saved a great many lives, and there is no immediate prospect of replacing the natural product with one made synthetically. But both are composed of very large molecules with a structure which has presented formidable problems to the chemist, and the solution of these problems cannot fail to enlarge our understanding of biochemical events.

The insulin molecule has a weight of more than 5,000, with two polypeptide chains of unequal length linked by sulphur groups: it has taken Dr. F. Sanger and his collaborators more than ten years to map the entire structure. The molecule of $B_{12}$ has one atom of cobalt and sixty-three of carbon. Dr. Dorothy Hodgkin's X-ray analysis of the crystals has been a remarkable demonstration of the value of this method for mapping such complex molecules: another example of the same thing has been the research on hæmoglobin which Dr. M. Perutz has carried out at the Cavendish Laboratory under the inspiration of Sir Lawrence Bragg, and on the other hand, we have Sir Alexander Todd's studies of the $B_{12}$ group and of the nucleo-proteins, as well as Sanger's of insulin, to show that the organic chemist has not yet lost the power to work out his own salvation by classical methods.

The structural formulæ of these molecules seem terribly elaborate to those of us who are not within the pale. We can applaud such triumphs of chemistry; but they force us to realize how much the living cell must depend on the interplay of very large molecules in which the detailed arrangement of the atoms is of truly vital importance. We may wonder how many such elaborate structures will have to be mapped before we can see the way to general principles; though we are glad to have passed the stage when all that was known of the biochemistry of protoplasm was contained in the two words 'anabolism' and 'catabolism'.

At all events, since the difficulties now are largely technical, it is a comfort to know that the attack on one technically arduous problem has always made it far easier to deal with others of the same order. The successful mapping of large molecules has needed courage and persistence as well as imagination; but the way to further maps will be made plainer. It is a comfort, too, to know that we can confidently expect the unexpected, the advance which may give these problems a new turn. Yet in spite of that, the biologist has little hope of escaping the immense variety of his material. Even when the molecular structures are mapped there will be the organisms to deal with, the vast range of plant and animal form and in the end the differences between one man and another.

Biology, however, is not the only field where there are large territories to be explored in detail before we reach the next eminence. In fact the present course of progress in natural science, rapid though it is, does not suggest that scientific research is likely to change its present specialized character. The regions to be covered become greater and greater, and most of them can only be dealt with by the particular group of experts who know their way into the area.

This brings me back again to an appropriate theme for our annual meeting, namely, the part which the Royal Society should play to fulfil its task of improving natural knowledge.

At the end of his term of office, it is to be expected that your President will have ceased to marvel at his presumption in accepting so exalted a position and will have had time to consider its responsibilities. He will not have had much time, for the work of the Society grows apace; but in spite of that the duties of the President are certainly less arduous than most people might suppose. He is supported at every turn by the knowledge of a great Society at his back and by the Council and the whole staff at Burlington House inspired by an Assistant Secretary with a genius for tactful and effective administration. In fact, the President is so well cared for that it is a wise regulation which sets a limit to his reign.

Fellows will not need to be told of the many fields of activity in which the Royal Society is now engaged. It dispenses grants, awards medals, publishes journals and holds its scientific meetings; but I am convinced that the most important thing it does now is to exist and to perpetuate its existence by electing new Fellows.

Our meetings and periodicals are no doubt the best evidence of our existence; but they are scarcely essential to it. Indeed, their scope needs constant adjustment if they are not to be submerged in the present flood of scientific activity. Every subdivision of science has now begun to organize its special conferences and lectures. With so many subdivisions and so much to publish, the customary medium for printed communications is either a journal devoted to one special field or one which will take the shorter pape and publish them with the least delay. I am no suggesting that our own meetings and journals coul be abolished without great loss, but rather that w should continue our policy of arranging some meeting where the specialist is encouraged to state his cas before an audience of fellow scientists who are not a fellow specialists. That is certainly an important task

In electing new Fellows, however, we perform task which becomes more and more important a natural science expands and subdivides. It is essentia to its progress here that there should be a council o scientists of acknowledged reputation able to form a impartial judgment on the claims of every field an on the merits of those who work in them. Scientifi issues are now of great concern to those who fram the laws and policy of the State, and there must b some independent body to advise on them.

Statesmen and lawgivers are not likely to nee advice on the latest developments of scientifi thought; if they were, they might get better advic from the younger generation who have been trained i modern ideas and techniques and are used to th present scale of laboratory work. What is needed however, is not an academy to pronounce on th controversial points of scientific theory but one wit a reasonable knowledge of the direction in whic research is leading.

We as a Society have never aspired to an organize control of scientific research: even in times of grav national emergency, we have preserved our status as a private body willing to co-operate with the Stat but unwilling to forfeit our independence. It is, o course, true that the Fellows of the Society hav always played a large part in directing research int fruitful channels; but they have done so as heads o laboratories, teachers and leaders of research teams. It is true also that we control funds entrusted to u by past benefactors and that many of these fund must be used for the furtherance of particula branches of science. The value of the funds we hold now amounts to more than a million pounds, and w have also to administer yearly government grants more than £50,000 for aiding scientific researc scientific publications and international activiti These sums, however, are small compared with total which must be spent annually by any cou dependent on machinery, and with the poli system of Great Britain it seems far better fo Royal Society to keep itself outside the State o ization. The larger this becomes, the more imp will it be for us to maintain our status as an pendent body of scientists whose chief obliga the advancement of knowledge.

It is neither necessary nor desirable for the to give any official ruling on scientific issues, are settled far more conclusively in the la than in the committee room. This principle recognized by the Royal Society since its f and it is stated specifically in the adver the *Philosophical Transactions* in 175 out "that the certainty of the facts of the reasonings contained in published must still re of their respective a on to say "that it i to which they w their opinion as Nature or Art, th position almost goes on: "A equently proposed from the chair, to be given to e authors of such papers as are read at their accus- med meetings, or to the persons through whose nds they have received them, are to be considered no other light than as a matter of civility, in return r the respect shown to the Society by those ommunications".

This stern insistence on our impartiality has not evented us from issuing reports from time to time hen the occasion seemed to demand them. There e, for example, the reports of the Food Committee ring the First World War. But it has never been ggested that the Society assumed any other sponsibility than that of choosing the committee of perts to draw up the report.

That, however, is the kind of obligation which the oyal Society should be specially fitted to discharge. is right that the State should obtain the best ientific advice on practical issues, and it must know here to turn for the best panel of advisers. There e, of course, numerous societies to deal with parti- ular fields, and some of these would be just as ompetent to nominate experts from their member- ip. But the fragmentation of science has left dis- uted borderlines as well as unclaimed territory, and our Fellows have been properly chosen we should e able to justify the claim to represent all branches science at the highest available level. Although we o not pronounce officially on matters of scientific ontroversy, we can say who are the leaders in any eld and we know what sort of people they are.

If this were our only, or our principal, function it ight seem to reduce our status to that of a scientific nployment agency ; but the applications of science e now of such consequence that the State must be rced to spend more and more of its income on ience and technology. With scientists in short sup- y it must expand research, teaching and develop- ent. It must be careful not to harness too many tive investigators to desks in Whitehall or to the ommittee rooms of universities, yet its administra- on must show an understanding of scientific needs. e cannot blame government departments and inisters for mismanaging scientific affairs if we are nwilling to assume our responsibility for aiding them.

How far then does our constitution and our present actice fit us for such responsibilities? This year arks the death two hundred years ago of a great olitical scientist, the Baron de Montesquieu, a ellow of the Royal Society who was renowned in ery country for his analysis of the principles of overnment. Montesquieu came to us from France d was impressed by the precautions against auto- acy inherent in the British constitution. It is true at his praise of the liberal form of government eveloped in Britain was linked with the suggestion at the weather had a great deal to do with it. He ys : "In a nation so distempered by the climate as to ve a disrelish of everything, even of life, it is plain at the government most suitable to the inhabitants that in which they cannot lay their uneasiness to a ngle person's charge". But his analysis of our laws ade him conclude that we were, or at all events had e opportunity to be, the freest country in the world d that it is in our nature to defend our liberties m autocratic control.

do not think our procedure for the election of new ows could be made more representative than it is It may not be strictly democratic, for the elec- must be made by the existing Fellows, but we from every field of natural science and our ages vary within reasonable limits. At present our youngest Fellow is thirty-one, and Council this morning authorized the dispatch of a letter conveying the congratulations of the Society to our colleague, Mr. H. N. Ridley, whose hundredth birthday falls on December 10. We have to be constantly on the watch to avoid neglecting the claims of scientists whose work cuts across the standard classification. But the machinery is elastic : I have seen it at work over a fairly long period and I have always been impressed by the individual capacity for honest judgment which goes to the formation of a collective opinion on scientific merit. It is certainly a responsibility which we do not take lightly, and it is right that it should occupy much of our time in the early months of the year. Whatever else we should be doing, this is time well spent.

But nowadays the Society has many other things to do, and I am not sure that we have evolved the system of self-government which enables us to give adequate consideration to all of them. Election to our Council must be governed by the need to keep a balanced representation of different branches of science. Council would soon become ineffective if its numbers were expanded to keep pace with every new development ; but with a body of only sixteen members, apart from the Officers, to represent our 560 Fellows, it is naturally difficult for more than a small proportion of the Society to gain any insight into the way in which its business is conducted. For those who are chosen to serve on the Council the volume of business to be decided must often seem far too great for meetings which can rarely last much longer than 1¼ hours and occur only twelve times a year. Naturally a great deal of the work falls on the Secretaries, who must be prepared with advice on many of the matters which do not involve major issues ; but even though the Council is willing to accept this advice without lengthy discussion, there are certain important decisions to be made at each meeting, and it is very difficult to find the additional time needed for the discussion of more general problems. With the present growth of scientific effort, problems of general policy are bound to be in our minds, and I know that the President must often have seemed unduly repressive when there is a long agenda and the Council meeting must be ended in time for the Ordinary meeting of the Society.

I have no solution to offer which would not involve more time spent in committee rooms and less in our laboratories. That may be a burden which we must accept. But I would urge the Society that it should act only as an adviser, and should not be willing to accept the kind of detailed administrative work which it is sometimes asked to undertake. Our difficulties arise from the fact that our responsibilities have grown. We must be constantly on guard to see that we have the leisure to survey them.

My successor with his new Officers and Council will have troublesome decisions to face ; but we need not fear that the Society will ever be in danger of becoming less representative of science as a whole or less important in the affairs of the country. Your President becomes increasingly aware of its importance as he learns the duties of his office. Some of them are onerous ; but it would be absurd to suggest that he has a thankless task in representing our great and ancient Society. So in conclusion all that I need add is the earnest hope that my successor will find his position as enjoyable as I have found it during these past five years.

# RESPONSES OF A FERN APEX TO DIRECT CHEMICAL TREATMENTS

By PROF. C. W. WARDLAW
Department of Cryptogamic Botany, University of Manchester

THE organization and morphogenetic activity of a fern apex, that of *Dryopteris austriaca* (*D. aristata*), have been further investigated by observing how it responds to direct applications of solutions of various organic substances. This work was undertaken, partly in an attempt to explore the concept of the apical meristem as a complex reaction system[1], and partly because the technique of organ-culture, though it has been a means of obtaining interesting and important information on growth, has thus far yielded little new information on the primary morphogenetic activity of the apical meristem. Thus, in aseptic culture media of highly diversified composition, the growth of excised fern apices may be increased, decreased or inhibited; but no fundamental change in their primary morphogenetic activity has been reported[2,3].

The present work was also prompted by the view that the important advances now being made in the chemical study of apices[4,5] should be complemented by experiments in which the more important metabolites disclosed by these and other studies should be applied directly to embryonic tissues (including embryos and meristems).

The first stage was evidently to ascertain if the fern apex does, in fact, react in novel ways to direct applications of different physiologically active substances. In the preliminary experiments briefly considered here, large apices of *Dryopteris austriaca* were laid bare, treated for periods up to about twenty days with solutions of substances such as 3-indole acetonitrile, dinitrophenol, maleic hydrazide, yeas extract, glutamine, etc., retained in small pads c absorbent cotton wool, and examined at frequen intervals under a binocular microscope, with sub sequent microscopic study of fixed and sectione materials. Some work along the same general line both on apices and embryos, has already bee reported by other investigators[6–9], and there is als a considerable literature on the morphogenetic effec induced by spraying physiologically active substanc on older regions of the plant. Among the advantag of my procedure are that the very earliest visibl evidence of any unusual morphogenetic developme can readily be observed and that reactions of transitory nature are not overlooked. (The gener term 'apex' here denotes the distal region of th shoot, comprising the conical apical meristem an the wide subapical region. The apical meriste consists of a superficial layer of distinctive embryoni cells occupying most of the terminal conical regio the youngest leaf primordia arising within th meristem.)

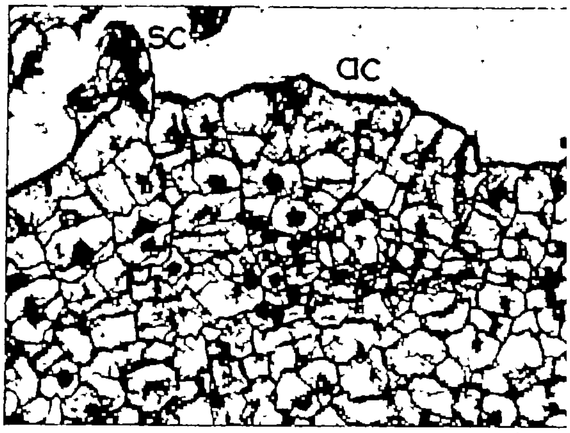


Fig. 2. Longitudinal median section of an apex treated with thiamine hydrochloride, showing the parenchymatization of the apical cell region (*ac*) and the precocious formation of scales (*sc*) over the meristem. (× *c.* 180)

(*Photos in Figs.* 2, 3, 5 *by Ernest Ashby*)

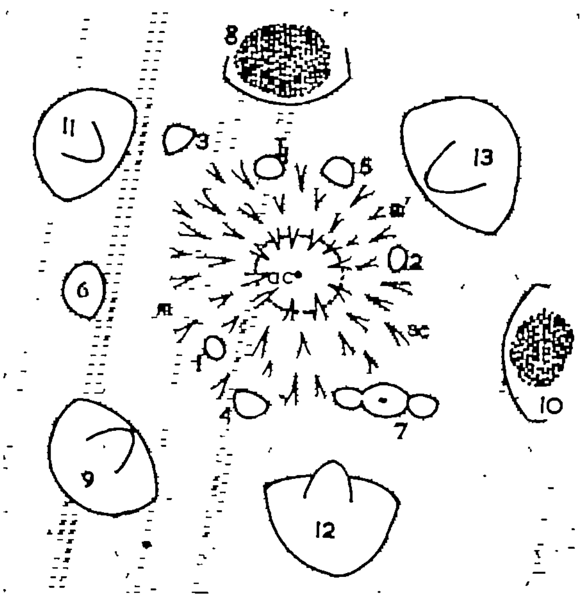
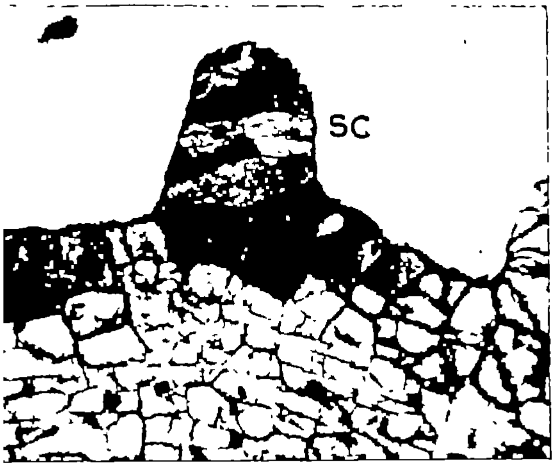


Fig. 1. *Dryopteris austriaca.* Apex as seen from above, after treatment with yeast extract. The original conical apical meristem, indicated approximately by ---$^1$, has become almost completely flat and scaly (*sc*) close to the apical cell (*ac*); primordia $P_1$–$P_7$ and the new primordium at $I_1$ have remained small and have become relatively widely separated; the apex of $P_7$ was slightly injured and two lateral primordia have formed; $P_8$ and $P_{10}$ were damaged at the outset; the broad subapical region is stippled. (× *c.* 17)

Thus far, it has only been possible to test a limite number of substances; but in most cases some re action was obtained, and already many developmen of morphogenetic interest have been observed. Thes include: an increase in the rate of growth in th subapical region; an arrest or slowing down growth in the apical meristem; the formation flattened and of sunken, cup-shaped apices; t formation of double, treble and quadruple primordia, of two primordia in a single leaf site, of centric (or radial) leaves; the occasional pression of primordia; the reversal of the phyllot spiral; the induction of buds on meristems wit uninjured apical cell; the promotion of root fo tion and growth; the formation of scales o apices of young leaf primordia and leaf sites, ar precocious formation of scales (which are not p



ʼig. 3. Longitudinal median section of an apex treated with ʼeast extract. The region of the apical cell has lost its distinctive ʼharacter: it is becoming parenchymatous and has given rise to a large spine-like scale (sc). (× c. 180)

ı the normal apical meristem but only on the ılarging subapical region) over the whole of the ›ical meristem, including the apical cell; and the ʼecocious parenchymatization of the meristem, ʼcluding the apical cell.

Although some treatments have resulted in extenʼve morphological changes, nevertheless it has ›come evident that certain aspects of apical organʼation and activity are not readily modified. Thus, hen apices were treated with yeast extract, or with ıiamine hydrochloride, the meristem became scaly l over and parenchymatous (Fig. 1), the apical cell so became much divided (Fig. 2) and sometimes ıve rise to a spine-like scale (Fig. 3). Buds, which ›ver occur on the normal intact apical meristem, ere sometimes formed on these apices. Neverthess, these and other apices, in which extensive .odifications were being induced, continued to give se to leaf primordia in normal positions for some me. In some, usually vigorously growing, apices, ıere was sometimes a return to the normal organoʼnic activity when the treatment had been dis›ntinued for some time.

The evidence thus far obtained indicates that the ʼocedure adopted may well yield information on the ʼganization and reactivity of the apical region that ıay not be forthcoming from organ- and tissueılture investigations. An example may be cited. ʼhen autoclaved yeast extract was an ingredient of ›lid culture media in which excised (or explant) fern pices were being grown, the overall growth of the ʼplant was greatly increased; but its morphological evelopment was quite normal[9]. But when the same oncentration of yeast extract (unautoclaved), or a ›lution of thiamine hydrochloride, was applied ʼirectly to the apex, the somewhat novel results ıdicated above were obtained (Figs. 1–3). It need ›arcely be said that much further work is necessary › explore adequately this interesting aspect.

In earlier work, it was shown that certain characʼristic morphological and histological developments ın be induced at will by appropriate surgical treatıents[10]. Comparable developments have now been ›btained by the direct chemical treatment of the ›ex. If, for example, the shoot apical cell is puncʼred, or if it remains intact and active but is isolated ʼm a young leaf primordium ($P_1$) or from a primordium site ($I_1$) by a deep and wide tangential incision, buds are usually induced in these and other positions[11]. In different chemical treatments (yeast extract, dinitrophenol, maleic hydrazide), in which the normal activity of the apical cell group was arrested or radically modified, buds were formed in $P_1$, $I_1$ and other positions (Fig. 4). On the evidence of the surgical experiments, the inhibition of buds in or near the apical meristem in the normal *Dryopteris* apex was attributed to the organization and growth of the apex as a whole and not to a *direct* inhibiting effect of an auxin, proceeding from the apical cell group, on a young primordium or primordium site[12]. The present experiments support this view: buds were not only formed around an isolated, intact apical meristem during continuous application of a range of physiological concentrations of 3-indoleacetonitrile and 3-indoleacetic acid, but also they grew vigorously and had a strong vascular development. Where the apex had been damaged, the vascular systems of these buds spread across the medulla of the parent shoot, Fig. 5.

In the normal development of *Dryopteris*, a steady relationship is maintained between the apical meristem and the subapical region, the embryonic cells near the base of the conical meristem being successively differentiated into the tissues of the subapical and maturing regions. Indeed, except for a gradual ontogenetic increase in size, the apex remains relatively unchanged in configuration and morphogenetic activity over many years. This steady relationship of the apical meristem and the subapical region, and the perennially embryonic condition of the former, have been more or less considerably modified by some of the direct chemical treatments given in these experiments. The effects observed can be referred, directly or indirectly: (1) to an increase in the relative rate of growth in the subapical region; (2) to an arrest of growth, or a greater relative

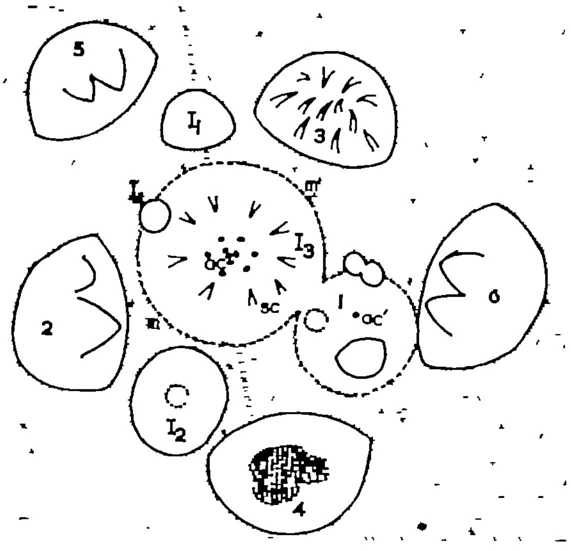


Fig. 4. Apex as seen from above, after treatment with dinitrophenol. Several of the primordia present at the beginning of the experiment have become double; the apex of primordium 3 ($P_3$) has become scaly; $P_1$ has become a bud, with three leaf primordia, the second of which is double; $P_4$ was damaged at the outset; the second new primordium ($I_2$) is centric and no primordium has been formed in the normal $I_1$ position; the apical meristem is becoming scaly (sc) and small scales can now be seen close to the apical cell (ac); the circular broken line ($mm^1$) indicates approximately the base of the apical cone; the broad subapical region is stippled. (× c. 7·5)

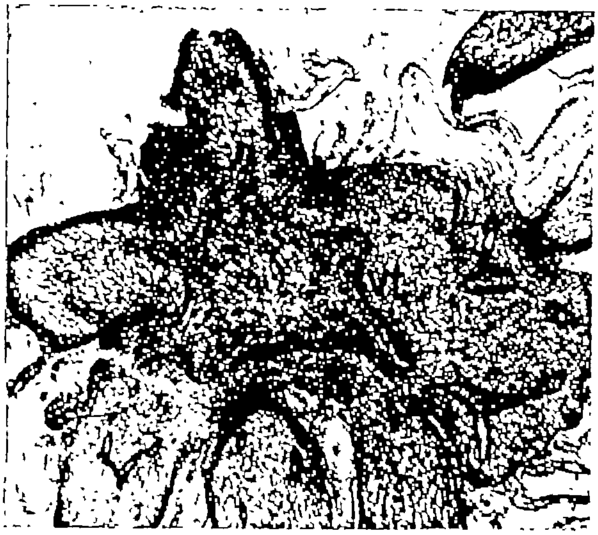


Fig. 5. Transverse section of a shoot in which the distal region of the apical meristem became damaged during treatment with 3-indoleacetic acid in lanoline. The several large buds which were formed close to the injured region have given rise to a large, stellate mass of vascular tissue (*vt*) in the medulla of the parent shoot. (× 12)

decrease in the rate of growth, in the apical meristem; (3) to a precocious parenchymatization of the meristem. In some instances processes (1) and (2) may both be involved. Where a rapid relative growth of the subapical region has been stimulated, as in treatments with indoleacetic acid and indoleacetonitrile, a depressed or cup-shaped distal region results, this being the normal conformation of the apex in some other large fern species. In (1) and (2) above, the young leaf primordia, which occupy positions in the transition zone between the slow-growing apical meristem and the more rapidly growing subapical region, may, in different instances, either participate in the enhanced development or be subjected to a tangential tensile stress. In both circumstances some abnormal tangential development of primordia is to be expected, and, in fact, tangentially extended primordia, double, treble and quadruple primordia, and two contiguous primordia occupying a single leaf site, have been observe These observations support my view on the causatic of the shape, symmetry and orientation of le primordia, based on direct observation and surgic experiments. According to this view, the characte istic phenomena of leaf formation and developme are referable : (*a*) to the inception of growth centr near the base of the conical apical meristem, ar (*b*) to the distribution of growth in that region, bot of these being functions of the organization of th apex as a whole.

In these experiments some of the substances ma have entered the superficial cells of the apical mer stem directly, they may have entered by way of th subjacent parenchymatous cells, or they may hav gained access by way of wounds. This aspect of th work, which carries its own interest, needs muc fuller investigation. Some preliminary investigatio have, in fact, been carried out. For the present, may be noted that many different substances ca enter the tissues of the apical meristem or the sul jacent region and induce changes in its norm functioning. Accordingly, an intensification an diversification of work along the lines adopted in th preliminary exploration may well yield substanti information on the reactivity of cells in differe regions of the apex and on the processes involved i the differentiation of embryonic cells. Contemporar investigations support the view that this is the kin of information that is now most needed if we ar to make progress in elucidating the problems morphogenesis.

A fuller account of these observations will be give elsewhere.

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# NEWS and VIEWS

## Royal Society: Officers and Members of Council

At the anniversary meeting of the Royal Society on November 30, the following officers and members of Council were elected: *President:* Sir Cyril Hinshelwood, Dr. Lee's professor of chemistry in the University of Oxford; *Biological Secretary:* Prof. G. L. Brown, Jodrell professor of physiology at University College in the University of London; *Physical Secretary:* Sir David Brunt; *Foreign Secretary:* Dr. H. G. Thornton, head of the Department of Soil Microbiology at Rothamsted Experimental Station; *Treasurer:* Sir Thomas Merton. *Other Members of Council:* Prof. T. A. Bennet-Clark, professor of botany in the University of London, King's College; Dr. B. Bleaney, demonstrator and lecturer in physics, University of Oxford; Prof. F. W. R. Brambell, Lloyd Roberts professor of zoology in the University of Wales at the Universit College of North Wales; Dr. Mary L. Cartwrigh mistress of Girton College and University lecturer i mathematics in the University of Cambridge; S Alan Drury, member of staff of the Agricultur Research Council; Prof. J. H. Gaddum, professor pharmacology in the University of Edinburgh Sir Claude Gibb, chairman and managing director C. A. Parsons and Co., Ltd.; Prof. L. Howarth, profe sor of applied mathematics in the University Bristol; Prof. W. B. R. King, formerly Woodwardi professor of geology in the University of Cambrid Prof. K. Mather, professor of genetics in the Univ sity of Birmingham; Prof. J. S. Mitchell, profe of radiotherapeutics, University of Cambridge, director of the Radiotherapeutic Centre, Add brooke's Hospital, Cambridge; Prof. N. F. M Cavendish professor of experimental physics in

University of Cambridge; Sir Rudolph Peters, professor emeritus of biochemistry in the University f Oxford; Prof. J. M. Robertson, Gardiner professor f chemistry in the University of Glasgow; Dr. B. F. J. Schonland, deputy director, Atomic Energy Research Establishment; Prof. M. Stacey, professor f chemistry, in charge of organic and biological hemistry, in the University of Birmingham.

## ir Cyril Hinshelwood, F.R.S., President of the Royal Society

This election of Sir Cyril Hinshelwood as president f the Royal Society will be acclaimed not only by his scientific colleagues, but also by the host of his past students, now dispersed in the chemical industry and elsewhere. As a fellow and tutor of Trinity College, and afterwards Dr. Lee's professor of chemistry at Oxford, his influence and inspiration have been profound. The dominant theme of his esearch has been the elucidation of chemical processes by kinetic methods, and much of it is characterized by a design which enabled him to obtain answers to questions of great complexity using elatively simple experimental technique. He first clarified the processes of molecular activation in homogeneous gas reactions, and made vital contributions to our understanding of thermal chain reactions. Similar considerations were then applied to eactions in the liquid phase. More recently, he has used the same systematic analytical approach in exploring the problems of bacterial growth, a method at first received with some scepticism by more professional biologists, but which has now led to results of fundamental value in connexion with processes of bacterial adaptation. His several authoritative books on these subjects are recognized by their eloquent clarity, and reveal his vividly philosophical approach towards the underlying unity and pattern of natural phenomena.

Sir Cyril's previous distinctions include the Davy and Royal Medals of the Royal Society, of which he has been foreign secretary for five years past, and others of the Chemical Society, of which he is a former president, as well as many other honours bestowed by foreign scientific academies. He has served on many government advisory bodies, was recently chairman of the Fuel Research Board, and s a member of the Advisory Council on Scientific Policy. To all these scientific qualities, Sir Cyril also adds a remarkable command of foreign languages, much achievement as a connoisseur of art and as a painter in oils, and a conversance with classical and modern literature in many tongues. Through his pursuit of natural knowledge and through his distinctive qualities, Sir Cyril is eminently fitted to uphold the high traditions of his new office.

## Genetics at Glasgow: Prof. G. Pontecorvo, F.R.S.

The establishment of a chair and the appointment of Dr. G. Pontecorvo as its first occupant complete the administrative arrangements for genetics at the University of Glasgow. A lectureship established in 1945, to which Dr. Pontecorvo was appointed, developed into a Department of readership status with increasing teaching commitments and with an active research school supported by the three Research Councils, the Nuffield and the Rockefeller Foundations and industry. The readership is now raised to the status of chair.

After graduating at Pisa—his birthplace—in 1928, Dr. Pontecorvo was engaged for about nine years in Florence in research on the applications of genetics to animal breeding. In 1938 he had to leave Italy as a consequence of political conditions, and found hospitality at the Institute of Animal Genetics, University of Edinburgh, then directed by Prof. F. A. E. Crew. There the opportunity of working on the genetic effects of radiations under the inspired leadership of Dr. H. J. Muller shifted his interests from applied to fundamental genetics. Since then Dr. Pontecorvo has held successive research and staff positions in Glasgow, Edinburgh, and finally in Glasgow again. His contributions to genetics are in several directions. He was one of the early investigators of the lethal effects of radiations in the first generation of irradiated individuals. With Muller he designed an ingenious method to investigate genetic differences between species the hybrids between which are sterile. With Prof. E. Hindle, he investigated the cytology of the human louse and the genetic mechanisms underlying its sex-ratios. In 1943 the demand for penicillin led him to work on the genetics of *Penicillium*. This marked the beginning of his interest in the genetics of fungi, both *per se* and as a powerful tool in investigating the ultra-microscopic organization of the gene. These two lines of interest have been pursued side by side for the past ten years by the research team led by Dr. Pontecorvo and including, among others, Dr. J. A. Roper. The work on the genetics of fungi has led to the discovery of alternatives to sexual reproduction in fungi in which this does not occur. The work on the gene has led to the view that it is a compound structure with many sites of mutation which crossing-over can distinguish from one another.

## Colonial Section of the Road Research Laboratory: Dr. R. S. Millard

Dr. R. S. Millard has been appointed head of the newly formed Colonial Section of the Road Research Laboratory with the rank of deputy chief scientific officer. Dr. Millard was educated at Queen Elizabeth Grammar School, Ashbourne, and at University College, London, where he obtained first-class honours in civil engineering in 1941. After experience with a civil engineering contractor, he joined the Bituminous Materials Section of the Road Research Laboratory, Harmondsworth, in 1944. In 1949 he was appointed officer-in-charge of the newly formed Scottish Branch of the Laboratory. In March 1951 he returned to Harmondsworth as head of the Bituminous Materials Section, and he has served in this capacity up to the present time. The tasks of the Colonial Section will be to apply the basic knowledge already available at the Road Research Laboratory to problems of road design and construction in the Colonies, and to extend this knowledge by research. The Section is being established at the Road Research Laboratory, Harmondsworth, where most of the laboratory work will be done. Field-work and full-scale road experiments in collaboration with the Colonies themselves will form an important part of the work of the Section.

## Textile Institute: Supplemental Royal Charter

The authority of H.M. the Queen has been given for the granting to the Textile Institute of a supplemental royal charter, extending the powers granted to it by the original charter of 1925. The supplemental charter authorizes fellows and associates of the Institute to practise and describe themselves as chartered textile technologists, and new by-laws provide that the Institute may elect 'companions', an honour conferred on members who, while not being chartered textile technologists, have yet advanced the general interests of the textile industry. The Institute is also now authorized to grant the status of licentiate to members who have attained the age of twenty-three and have obtained such certificate or diploma as the Institute may consider to provide sufficient evidence of education in textile subjects.

## Commonwealth Fund Grants for Medical Education in the United States

The Commonwealth Fund, New York, has given 7,150,000 dollars to ten university medical schools in the United States, to be used as the recipients deem wise, for strengthening their medical education programmes during the next few years. These special grants, which have been drawn from capital, are in addition to the Fund's annual contributions from its income, totalling 2 million dollars during the past ten years, to specific medical education projects, community health services and other traditional interests normally supported from current income. The medical schools receiving the new grants are: Chicago, 500,000 dollars; Columbia (Physicians and Surgeons), 750,000 dollars; Cornell, 750,000 dollars; Emory, 600,000 dollars; Harvard, 1,000,000 dollars; New York University, 750,000 dollars; Southern California, 300,000 dollars; Tulane, 750,000 dollars; Western Reserve, 1,000,000 dollars; and Yale, 750,000 dollars. The Commonwealth Fund was established in 1918 by Mrs. Stephen V. Harkness with the motto, "To do something for the welfare of mankind". During recent years its primary interests have been in the field of health, particularly in medical education, medical research and community health.

## Vannevar Bush Fellowships in Earth Sciences

The Department of Geology and Geophysics of the Massachusetts Institute of Technology and the Geophysical Laboratory of the Carnegie Institution of Washington are co-operating in the award of pre-doctoral fellowships in theoretical and experimental geology. The award will be known as the Vannevar Bush Fellowships in Earth Sciences, in honour of Dr. Vannevar Bush, who has given long service as professor and, later, dean and vice-president of the Massachusetts Institute of Technology and more recently as president of the Carnegie Institution of Washington. In general, recipients will spend at least three or four terms in the Carnegie Institution doing laboratory work and one or two terms in the Massachusetts Institute analysing and writing up their results. Throughout their work they will be registered full-time candidates for a Ph.D. of the Massachusetts Institute and will be under the supervision of a senior member of the Department of Geology and Geophysics there. The value of the fellowships will be 200–225 dollars a month. Further information can be obtained from the Chairman, Department of Geology and Geophysics, 24–302 M.I.T., Cambridge 39, Mass.

## Instrumentation and Accessories for Radioactive Isotopes

The Scientific Instrument Manufacturers Association, in collaboration with the United Kingdom Atomic Energy Authority, has published a most useful brochure, "Radio Isotope Instrumentation and Accessories" (pp. 124; from the Association, London; 1955), which will be of great assistance to the potenti user of radioactive isotopes in selecting electroni equipment to suit his special needs. Compiled b Dr. D. Taylor and Mr. A. G. Peacock, the brochur contains an introductory section in which fundamental data with regard to radioactive measurement and instrumentation are discussed and show graphically or in tabular form, followed by a serie of manufacturers' illustrated announcements an specifications of nucleonic and electronic equipment Details are given of the various detector element and associated apparatus used for radioactive assa and radiation monitoring, and of the availability o special equipment for research in nuclear physics an radiochemistry. Inquiries regarding the equipmen described should be addressed directly to the manufacturers concerned; but special inquiries may b sent in the first place to the Head of the Electronic Division, Atomic Energy Research Establishment Harwell. Information and advice concerning th availability and uses of the isotopes themselves ar not given in the brochure, but can be obtained from the Isotope Information Office at Harwell.

## Scottish Field Studies Association

The Scottish Field Studies Association has now been in existence for six years, and during that time and in face of great difficulties, has done much t extend interest in natural history in Scotland Perhaps less well known than the field centres i England and Wales, the Scottish Centre at Garth ha continued to develop in spite of the fact that us has to be made of a working youth hostel for accommodation and that a warden could only be appointe on a part-time and often voluntary basis. Beside five open courses, seven schools or colleges made us of the centre, giving a total of 1,450 student-day spent at Garth in 1954, an increase of 150 over 1953 The Association now feels that the arrangement a Garth is unsuitable, and one of its most activ members, C. I. C. Murdoch, makes a powerful cas for the setting up of a permanent centre in uppe Speyside between the three great hill masses of th Monadhliaths, the Grampians and the Cairngorms other members of the Association are keen o developing a centre in North Argyll. All who ar interested in the setting up of a permanent fiel centre in Scotland or wish to develop field studie are invited to get in touch with the secretary of th Association, B. W. Gibbons, Department of Botany The University, Glasgow, W.2.

## Schools Service of the National Museum of Wale

The Schools Service of the National Museum o Wales covers the whole of Wales and Monmouthshir and is thus national in scope. It began in 1949, an it is appropriate that an attractive illustrated brochur about it should now be published under the title o "The First Five Years" (pp. 12; from the Museum Cardiff; 1955; 6*d*.). The position to-day is tha there are five officers, and every term more than tw thousand exhibits are distributed between th secondary schools of the area served. The number o eligible schools is 365, of which more than half tak part in the Service. The personnel and administration have been added to the already crowded Departments of the Museum, though during the period unde review it has been found possible to construct special room for the craftsmen and also provide new garage for the two vans. Recently some basement accommodation was adapted to form a stor with its own entrance and assembly point. The service is intra-mural as well as extra-mural, and large numbers of school classes are received in the Schools Service Reception Room. Naturally, this part of the Service is of greatest use to the Cardiff schools. The aim of the Service is "to teach, to interest, and to inspire through objects". It is pleasing to note that this aim has been faithfully followed throughout the five years, for it is the fundamental aim of all museum work. Although the Service was designed to help the schools, it is also interesting to recall that it has been of reciprocal service to the Museum, and many objects of value have been offered by discerning children.

## Self-Inhibition in Germinating Rust Uredospores

It has been observed that germinating uredospores of rust fungi produce a volatile substance which, under certain conditions, inhibits the elongation of the germ tube. This phenomenon has now been investigated in greater detail by F. R. Forsyth (*Canadian J. Bot.*, 33, 5, 363; 1955). He reports that the self-inhibition of germination of uredospores of *Puccinia graminis* Pers. var. *tritici* Erikss. and Henn. has been consistently demonstrated in Warburg flasks. Four ways of overcoming the effect of the inhibitory substance have been discovered: the use of a sufficiently large volume of water in relation to weight of spores; the placing of a silver nitrate solution in the centre well; and the introduction of acetone or ammonia vapour into the flask atmosphere. The vapour of trimethylethylene inhibits germination of the uredospores in the same way that the natural inhibitor does, and the same means can be used for counteracting its effects. The similarity of the absorption spectra of the inhibitor and of trimethylethylene in acetone solutions indicates that trimethylethylene is the natural inhibitor. Cyclohexene has formative and inhibitory effects on the germ tubes, and these effects can be overcome by vapour of acetone.

## Physiological Genetics of the Garden Pea

In grafting experiments using early and late varieties of *Pisum*, D. M. Paton and H. N. Barber (*Austral. J. Biol. Sci.*, 8, 2, 231; 1955) have found that when genetically early scions of *P. sativum* var. Massey are grafted on to genetically late stocks of var. Telephone, flowering on a higher node results. In reciprocal grafts, the scions of the late variety flower at an earlier (lower) node. Control grafting, that is, scions to stocks of the same variety, has no effect on Massey scions but leads to flowering at a lower node in the Telephone scions. Removal of cotyledons as soon as possible after germination (3–7 days) has no effect on Massey but leads to earlier flowering in Telephone. The authors consider that these results are best explained on the assumption that the genetically later variety produces a flower inhibitor (or delaying) substance which can pass a graft union and alter the flowering behaviour of genetically early scions.

## Meteorological Observations of Solar Radiation during an Eclipse

A paper by R. Dogniaux on "Observations of the Solar Radiation during the Eclipse of the Sun on June 30, 1954" (Pub. No. 13, Sér. *B*, Institut Royal Météorologique de Belgique, Bruxelles) describes the results of determining the radiations of the sun during the greatest phase (0·774), at Uccle, of the eclipse of June 30, 1954. Six figures show the results under various conditions, and from them the reductions in brightness during the course of the eclipse were calculated. The direct solar radiation was reduced to 14 per cent at the instant of greatest phase, diffused radiation to 35 per cent, and the total brightness to 25 per cent. With the aid of photoelectric cells, similar observations of the radiations to which the human eye is sensible were made, and it was found that these were reduced to 20, 28 and 12 per cent for the total, diffused and direct radiation on a horizontal surface, respectively. One of the figures shows the temperature reductions during the eclipse under a ventilated shelter on a platform, at a distance of 1 cm. under bare ground and also at a distance of 1 cm. under grass. Although it is certain that the effect of the eclipse is shown in the changes of temperature, and in particular under the bare earth, as revealed by the first graph of this figure, it is impossible to decide what percentage of this was actually due to the eclipse. The variation of cloudiness was such that its effect was very pronounced; nevertheless, the results show that the propagation of the heat differed for air, bare soil, and soil protected by grass.

## Thirtieth International Congress of Americanists: Proceedings

The thirtieth International Congress of Americanists met at Cambridge in August 1952, under the presidency of Mr. J. Eric S. Thompson, the distinguished Maya epigraphist, and the proceedings have now been published (pp. 250. London: Royal Anthropological Institute). Americanist Congresses, which in the words of their statutes have for their object "the historic and scientific study of the two Americas and their inhabitants", normally take place every two years and alternate between the Old and the New World. The thirtieth Congress was the first to meet in England since 1912, when the eighteenth Congress met in London. The terms of reference of these Congresses admit a wide range of subjects, and only a few of the thirty-seven published papers can be mentioned here. By far the most interesting communication is an account of the recent explorations at the great Maya site of Palenque by Señor Alberto Ruz, in which he describes the discovery of an important burial chamber beneath the Temple of the Inscriptions, an outstanding instance of the rare practice of burying notable people beneath an American temple-pyramid. There are several other papers in the Maya field, including one on the Maya character by Mr. Thompson. Other interesting archæological papers are on the excavation of a shell mound, or sambaquí, in Brazil, by Prof. L. de Castro Faría, and on transport in Peru, by Dr. Paul Kosok. In linguistics there are two papers on Alaskan languages by Prof. L. L. Hammerich; in ethnology a study of the peyote cult by Dr. Ruth Underhill; and on the historical side a note by Dr. M. Ballesteros-Gaibrois on a manuscript of Fray Martín de Murúa, "Historia General del Perú", in the possession of the Duke of Wellington. Mr. Thor Heyerdahl has three papers relating to his theories of the population of Polynesia by voyagers from South America, which aroused some popular interest at the time of the Congress, although he had as 'rough' a time in the discussions as ever he had on the Kon Tiki raft. A feature of the Congress was a notable loan exhibition of nearly all the ancient Mexican manuscripts in Great Britain, to which was added a series of fine unpublished drawings from the North American and Brazilian expeditions of Maximilian, Prince of Wied. The papers include a comment on these by Dr. J. Röder and a biographical note on his ancestor by Karl Victor, Prince of Wied. The publication of these proceedings was considerably delayed, and the thirty-first Congress was held at São Paulo before they appeared. The thirty-second Congress, to be held in Copenhagen, has been announced for August 1956.

### Geographical Association: Annual Conference

The annual conference of the Geographical Association will be held in the London School of Economics, Houghton Street, London, W.C.2, during January 3–6, 1956. The presidential address, by Mr. L. S. Suggate, will be on "Aspects of Geography Teaching in Schools". In addition to the usual lectures, sectional meetings, excursions, etc., a joint meeting with the Royal Geographical Society and the Institute of British Geographers will be held in the former's premises in Kensington Gore, London, S.W.7, at which "Some Medical Aspects of Geography" will be discussed. Further information can be obtained from the honorary conference organizer, R. C. Honeybone, University of London Institute of Education, Malet Street, London, W.C.2.

The spring conference of the Association will be held at Brighton during April 3–7, 1956, and the programme and reservation leaflet for this meeting will be issued with the January issue of the Association's journal, *Geography*.

### Cloud Physics: Conference in London

A conference on "Cloud Physics", arranged jointly by the Physical Society and the Royal Meteorological Society, will be held in the Department of Meteorology, Imperial College of Science and Technology, London, S.W.7, during January 4–5. After an introductory talk by B. J. Mason (Imperial College) on the scope of cloud physics, the first half-day will be devoted to the atmospheric aerosol, with papers by C. Junge and H. Weickmann (both of the United States) on, respectively, the nuclei of atmospheric condensation and the constitution of non-precipitating clouds. For the remaining day and a half the microphysics of clouds will be considered, with papers by the following: B. J. Mason, R. Braham (United States), F. E. Ludlam (Imperial College), J. S. Marshall (Canada) and J. T. Wormell (Cambridge). The meeting will be open to non-members. Application forms, to be returned by December 15, can be obtained from Miss E. Miles, Physical Society, 1 Lowther Gardens, London, S.W.7.

### The Queen's University of Belfast

The following have been appointed to lectureships in The Queen's University of Belfast: Dr. R. J. Magee (inorganic chemistry), Dr. M. F. Grundon (organic chemistry), J. M. Gilchrist and Dr. W. F. K. Kerr (mechanical engineering), J. M. W. McBride (light electrical engineering), and Dr. D. S. McIlhagger (electrical engineering). The University has received the following grants: to the Department of Applied Mathematics, £2,250 from H.M. Treasury for a rocket research project with which the Department of Physics will be associated, and £1,200 in connexion with the International Geophysical Year; to the Department of Organic Chemistry, £500 a year from the Medical Research Council for work on branched-chain carbohydrates, and £450 a year from th British Empire Cancer Campaign for work on th synthesis of colchicine.

### Announcements

Sir Harold Roxbee Cox will deliver the twentiet Parsons Memorial Lecture at the Institution of Civ Engineers on December 13; he will speak c "The Development of the Gas Turbine".

Dr. E. J. Bourne, reader in organic chemistry i the University of Birmingham, has been appointe to the University of London chair of chemistr tenable at the Royal Holloway College in successio to the late Prof. Gwyn Williams.

The Massachusetts Institute of Technology ha appointed Dr. R. R. Doell and Dr. J. W. Winchest to be assistant professors in the Department c Geology and Geophysics. Their subjects are sei mology and geomagnetism, and nuclear geochemistr respectively.

The Meldola Medal, which is the gift of the Societ of Maccabæans, is being offered for award early i 1956 to the chemist who, being a British subject an less than thirty years old on December 31, 195 shows the most promise, as indicated by publishe chemical work brought to the notice of the Counc of the Royal Institute of Chemistry before Decembe 31. Communications should be addressed to th President, Royal Institute of Chemistry, 30 Russe Square, London, W.C.1, the envelope being marke "Meldola Medal".

Sir George Beilby Memorial awards, which ar considered at intervals by administrators representin the Royal Institute of Chemistry, the Society c Chemical Industry and the Institute of Metals, ar made to British scientific research workers, preferenc being given to investigations relating to the speci interests of Sir George Beilby, including fuel econom chemical engineering and metallurgy. In genera the awards are given to younger workers for origin investigations over a number of years. For award early in 1956, the attention of the administrator should be directed, before December 31, to ou standing work of the nature indicated, all commun cations being addressed to the Convener of th Administrators, Sir George Beilby Memorial Fun Royal Institute of Chemistry, 30 Russell Squar London, W.C.1.

A summer school on the applications of spectr scopy to chemical problems and on intermolecula forces and the properties of fluids will be held in th Department of Physical Chemistry, University c Cambridge, during August 18–25, 1956. Among th lecturers will be Prof. R. G. W. Norrish, Mr. R. I Bell and Prof. H. C. Longuet-Higgins. Full oppo tunity will be provided for discussions. Furthe information can be obtained from the Secretary c the Summer School, Department of Physical Chem istry, Free School Lane, Cambridge.

The Manchester and District Section of the Roy Institute of Chemistry is organizing an exhibition c laboratory apparatus and techniques with particula reference to instrumentation, to be held in the Ma chester College of Technology on January 4 (2–8 p.m and January 5 (10 a.m.–8 p.m.). Some thirty-fiv exhibitors are taking part, and there will be vario demonstrations (for example, glass-blowing an vapour-phase chromatography).

# INTERNATIONAL COSMIC RAY CONFERENCE

## MEXICO MEETING

SINCE the War, a series of international conferences on cosmic rays has been organized by the Cosmic Ray Commission of the International Union f Pure and Applied Physics. These conferences have een arranged at two-yearly intervals, the first being eld in Cracow in 1947, the second in Como in 1949, he third in Bombay in 1951, and the fourth in Bagnères de Bigorre in 1953. This last conference was almost exclusively concerned with the fundamental particle aspect of cosmic ray physics, although here was a small parallel meeting on time-variations f the cosmic ray intensity.

In contrast to the Bagnères de Bigorre meeting he topics chosen for the 1955 conference were the omposition and energy spectrum of the primary adiation, geomagnetic effects, variations of the ntensity with time and, finally, the problem of the rigin of the radiation.

The conference was held in Guanajuato, a beautiful ld Colonial town some 300 miles north of Mexico City, during September 5–13, and was made possible by generous grants from the Mexican Government and from Unesco. The meetings were held at the University of Guanajuato, where facilities were kindly provided by the rector, Lic. Antonio Torres Gomez. The detailed arrangements for the conference were made by Prof. M. S. Vallarta and the resident of the Cosmic Ray Commission, Prof. P. M. S. Blackett. In addition to some sixty cosmic-ay physicists working on the topics covered by the onference, a number of astronomers (Brown, Chandrasekhar, Gold, Kiepenheuer, Oort, Schluter, Unsöld and Van de Hulst) also attended, and the meeting provided a valuable opportunity for joint discussion of problems of common interest.

The first day of the conference was devoted to papers and discussion on the composition and flux of he primary radiation and on the influence of the earth's magnetic field on the intensity of the radiaion. Some recent work by the Iowa group was described which confirms the presence of a soft adiation in the auroral zone at altitudes greater han 50 km. It is believed that this radiation consists of electrons of rather low energy, which may belong to the high-energy tail of the auroral particle spectrum. The question of the abundance of lithium, beryllium and boron in the primary flux was discussed at some length, but the proportion of hese elements present is still in doubt. The results of a recent latitude survey carried out by the Chicago and Ottawa groups using shipborne neutron monitors and meson telescopes were reported. The position of he geomagnetic equator deduced from these measurenents appears to differ from that corresponding to he dipole field deduced from magnetic measurements, eading to an apparent discrepancy of as much as 7° n the geomagnetic latitudes of some stations.

The energy spectrum of the primary radiation was discussed on the second day. Data were presented by a number of workers on the low-energy end of the spectrum. In particular, the position of the knee in the intensity versus latitude curve was discussed; and evidence was presented showing that the position of the knee changes with time, being virtually absent at sunspot minimum, so that the intensity of the low-energy cosmic radiation was greatly increased at this time. The spectrum at high energies is deduced from measurements on large air showers, and several arrangements which are at present being used for the study of these showers were described. The radial density distribution of particles in showers of energy in the region of $10^{17}$ eV. has been investigated at Harwell and also by Russian workers using large counter arrays; some evidence was presented by the Harwell group for the existence of showers of energy $10^{19}$ eV. Some preliminary results were reported by the group from the Massachusetts Institute of Technology, which has recently completed a shower detector consisting of twenty large scintillator units. There was some discussion on the estimation of the primary-particle energy responsible for a given shower size, and there seemed to be general agreement among the different workers that the primary energy is given by the total number of particles in the shower multiplied by a factor of about $10^{10}$ eV.

The third and fourth days of the conference were taken up with the reporting and discussion of time variations of the cosmic-ray intensity. This session began with a discussion of meteorological effects on the sea-level intensity, in particular the relation between the intensity and atmospheric temperature. Then followed a series of contributions on the relation between the intensity and solar and geomagnetic activity. There were papers on cosmic-ray production associated with solar flares, intensity changes at the time of magnetic disturbances and the world-wide variation in the cosmic-ray intensity over the past solar cycle as recorded by the Carnegie Institution of Washington at a series of stations which have been in operation since 1936. Data from these stations show a variation in intensity during the solar cycle of about 4 per cent, maximum intensity occurring at the time of sunspot minimum. Discussion of the causes of these variations of intensity was mainly in terms of the possible effects of ejected solar material carrying magnetic fields out into interplanetary space, although there was no general agreement as to the precise way in which these fields produced the observed variations.

The fourth day was devoted to papers and discussion on the solar daily variation and its behaviour in relation to solar and geomagnetic activity, the sidereal daily variation and measurements on the isotropy of the high-energy particles producing large air showers. The anisotropy of the primary radiation in relation to the Sun, as evidenced by the presence of a solar daily variation, is well established; but as yet there is no general agreement on the existence of a sidereal daily variation. A new approach to the problem of the isotropy of the primary radiation at high energies lies in the measurement of the directions of arrival of large air showers, using techniques permitting an angular resolution of 5° or so. Some preliminary results of measurements of this kind were reported by the groups from the Massachusetts Institute of Technology and from the Imperial College of Science and Technology, London; but no definite anisotropy has so far been established with certainty.

The remaining time at the conference was allotted to contributions on theories of the origin of the primary radiation. This session began with introductory papers on the properties of the galaxy, the interstellar gas and the solar atmosphere. Prof. J. H. Oort described some recent work at Leyden confirming earlier results by Russian workers on the polarization of the light from the Crab nebula. The mean polarization over the central region of the nebula is 17 per cent; but there are indications that where a limited volume of the nebula can be isolated the polarization may be complete. Oort pointed out that it is possible to account for both the polarization at optical wavelengths and the observed intensity of radio noise if it is assumed that the emission is due to radiation from electrons of energy $\sim 10^{11}$ eV. spiralling in a magnetic field of $10^{-3}$ gauss. If this interpretation is correct, it opens up the interesting possibility that the Crab nebula may be a source of part of the cosmic radiation. The papers and discussion on the origin of the radiation left little room for doubt, however, that this problem still remains largely unsolved and is likely to feature as a subject for discussion at perhaps more than one cosmic-ray conference in the future.

The conference lasted for six days, and it will be appreciated that in a report of this length it has only been possible to mention a few of the many important contributions, selected in order to illustrate present trends in these fields.

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# SECOND INTERNATIONAL SEAWEED SYMPOSIUM

FOLLOWING the suggestion put forward at the first International Seaweed Symposium, held in Edinburgh in 1952 (see *Nature*, 170, 478; 1952), the Norwegian Institute of Seaweed Research (Norsk institutt for tang-og tareforskning) arranged the second such symposium in Trondheim during July 14–16, when about a hundred and twenty scientific workers and industrialists from all over the world attended. In his opening address, Prof. Trygfe Braarud, chairman of the Board of Management of the Norwegian Institute of Seaweed Research, welcomed the delegates to Norway.

At the first session, dealing with "Algal Chemistry", Dr. E. E. Percival (Scotland) opened the proceedings with a paper on the polysaccharide sulphuric acid ester of the green alga, *Cladophora rupestris*, hydrolysis of which revealed L-arabinose, D-galactose, D-xylose, L-rhamnose and D-glucose, this being the first reported occurrence of arabinose in a seaweed polysaccharide; attempts to elucidate the structure of this complex polysaccharide by standard procedures were described. Dr. E. T. Dewar (Scotland) discussed the preparation, estimation and use of sodium laminarin sulphate as a heparin-substitute for preventing blood from clotting. The production of antibiotic substances by seaweeds was the subject of a paper by Prof. C. G. C. Chesters (England), in which certain littoral and sublittoral seaweeds have been examined for bacteriostatic activity; *Polysiphonia fastigiata* and *Halidrys siliquosa* are particularly good sources, and there is evidence of seasonal variation of antibiotic substances. The distribution of microbiological growth factors related to vitamin $B_{12}$, folic acid, folinic acid, niacin and pantothenic acid in the Rhodophyceae, Phaeophycea Chlorophyceae and Heterokontae was discussed b Prof. H. Lundin (Sweden) in a paper with L.- Ericson. The red and green algae generally contai higher amounts of vitamins than the brown alga the maximum $B_{12}$ content being possessed b *Vaucheria dichotoma* (2·8 μgm./gm. dry weight). Th origin of vitamin $B_{12}$ factors is believed to be th bacteria living epiphytically on the plant, the alga merely concentrating and storing the vitamin bu not synthesizing it. The carotene and carotenoi content of seaweeds was dealt with in two pape (by A. Haug and B. Larsen, and S. Liaaen and N. A Sørensen). Mr. Haug (Norway) discussed the caroten content of *Pelvetia canaliculata*, *Fucus vesiculosu* *F. serratus* and *Rhodymenia palmata*, the quantity i the fresh algae being generally much higher than i the dried materials and commercial seaweed meals drying and storing conditions are important factor in carotene breakdown. Prof. Sørensen (Norway dealt with the carotenoids of fresh *F. vesiculosus* an conditions leading to the formation of zeaxanthin it is now believed that this pigment is formed fro violaxanthin, and not fucoxanthin as originally suggested. Low-molecular carbohydrates were reviewe by Dr. B. Lindberg (Sweden), who has shown tha the mono- and di-β-D-glucosides of mannitol ar characteristic of many Phaeophyceae, while *P* *canaliculata* also contains the corresponding glucoside of D-volemitol; brown algae possess 'laminitol', *O*-methyl inositol. The glyceric acid – mannos glycoside of red algae is proved to be 2-D-glyceric aci α-D-mannopyranoside, while two recently isolate glycosides are floridoside-α-mannoside and 'iso floridoside' (1-glycerol-α-D-galactopyranoside). Th taxonomical value of these compounds was discussed

Dr. F. T. Haxo (United States), in a paper wit C. O hEochdha, reviewed the constituents of *Porphyridium cruentum*, a unicellular red alga which grow well but not prolifically in mineral-enriched sea water. The culture medium becomes viscous due t the presence of extra-cellular mucilage, which consist in part of a sulphated polysaccharide containin glucose, galactose, xylose and a uronic acid. Pigments include chlorophyll *a*, β-carotene, zeaxanthi and possibly lutein, while chromoproteins consist of phycoerythrin and two phycocyanins. Three pape (by D. B. Smith, A. N. O'Neill and A. S. Perlin S. T. Bayley; and W. Yaphe), read by Dr. E. Gordo Young (Canada), were devoted to the structure an degradation of carragheenin. By fractionation wit potassium chloride, this polysaccharide has bee separated into a potassium-sensitive fraction (*K*-carragheenin) and a potassium-insensitive fractio (λ-carragheenin); the former contains 3 : 6-anhydro-D-galactose and sulphated D-galactose residues i nearly equal proportions, while the latter appears t be mainly a sulphated D-galactose polymer. It i interesting to note that this anhydro-sugar in carragheenin is the enantiomorph of that present in agar Useful information on the structure of the tw fractions has been obtained by X-ray and infra-re studies. Bacteria capable of hydrolysing carragheeni and agar have been isolated from sea-water an marine algae; the cell-free enzyme solutions ar specific for the respective polysaccharides, and hav been used to identify agar and carragheenin in re algal extracts. Examination of the breakdow products should yield fruitful results.

Dr. Young, in a paper with D. L. Vincent and D. A. I. Goring, described the comparison of sodium alginate samples from different species by examination of optical rotation, viscosity, ionic mobility and sedimentation-rate; viscosity is still the best criterion of degree of polymerization. Mr. A. Jensen (with I. Sunde, of Norway) gave details of the quantitative determination of alginic acid in seaweed samples by decarboxylating the mannuronic acid residues with 19 per cent hydrochloric acid and measuring the carbon dioxide potentiometrically. The method is convenient for routine analysis and is claimed to be more accurate than either the titrimetric or colorimetric procedure. The qualitative detection of small quantities of alginates in food, cosmetic and other products is often a matter of some difficulty, and consequently great interest was shown in a new method demonstrated by Mr. R. H. McDowell (England), in which the small quantity of alginate present is converted to calcium alginate, and the invisible precipitate is then rendered visible as characteristic blue flocs by the addition of the dye, 'night blue'; by this means, as little as one part of alginate in a hundred thousand of solution can be detected. The detection of alginic acid in tissues by means of polarization optics was demonstrated in a series of slides by Dr. G. Andersen (Germany), whereby alginic acid, by virtue of its unique birefringent properties, is proved to occur in the middle lamellæ and primary cell-walls of the Phaeophyceae and is not accompanied by insoluble admixed 'hemicelluloses'.

The reaction of stearyl chloride on alginic acid was discussed by Mr. L. F. de Keyser (Belgium), the resulting ester being fractionated with ether to give the distearate and lower ester fractions. The seasonal variation in chemical composition of brown algae was the subject of papers by Mr. A. Haug (Norway) and Dr. C. Primo (Spain, read by Dr. J.-M. Perelló), and the results were compared with those of previous workers. The decomposition of alginates and laminarin by micro-organisms occurring on decaying seaweed and in maritime muds was discussed by Prof. C. G. C. Chesters (England), the techniques used for assaying 'alginase' and 'laminarinase' activity being demonstrated. The results of chemical investigation of the decomposition products should yield valuable information on the structure of these two polysaccharides. The economics of the large-scale production of mannitol and laminarin from aqueous extracts of *L. cloustoni* frond were examined by Mr. K. C. Reid (Scotland), who concluded that these two chemicals could be made available to industry at a reasonable price provided the weed residue was also processed for alginate. The drying of freshly harvested *L. cloustoni* was discussed by Dr. R. G. Gardner (Scotland, with T. J. Mitchell).

At the session devoted to the use of seaweed meals in human and animal nutrition, Dr. H. C. Wood (United States) read a paper (with G. L. Seifert) on *Macrocystis pyrifera* as a source of trace elements in human nutrition, and Mr. A. A. McInnes (Scotland) stressed the importance of seaweeds as a source of trace elements for cattle, pigs, poultry and sheep. Sales of seaweed meal in the world to-day show that the claims of the seaweed producers are in fact real, although it may be difficult to prove these claims experimentally. The results of feeding *Ascophyllum*, *Laminaria* and *Alaria* meals to chicks and laying-hens were discussed by Prof. J. Høie (Norway); in general, the introduction of 3–8 per cent of seaweed meal into a basal ration which did not include any riboflavin-rich compounds led to increased growth and improved health in chicks and better-egg laying and hatching in pullets, although similar effects were obtained by the addition of yeast and grass meal. The iodine content of the eggs was considerably higher in seaweed-fed hens, and this was dealt with in greater detail in papers by I. Sunde (Norway, read by Mr. B. Larsen) and Prof. C. Romijn (Holland). The addition of 1 mgm. iodine as *Ascophyllum* meal per hen per day increased the iodine content of the egg about twenty times, while 20 mgm. per day as *Laminaria hyperborea* meal gave a 150-fold increase. The iodine is concentrated in the water-soluble fraction of the yolk and not in the protein and lipoid fractions.

The botanical session was opened by Prof. Y. Yamada (Japan) with a paper on the distribution of *Sargassum* on the coast of Japan and its neighbouring regions, in which he said that the seventy known species of *Sargassum* can be divided into two types from the distribution point of view, and most of these are utilized as fertilizer. Prof. A. A. Aleem (Egypt) described his underwater studies on the ecology of *Macrocystis pyrifera* on the coast of California by means of the Cousteau–Gagnan aqualung, by which maps and surveys of the kelp beds were made and correlated with surface observations by aerial photography; this would seem to be a very successful method of studying sublittoral ecology, and is by no means confined to seaweeds. Prof. W. E. Isaac (South Africa) reviewed the species occurring in the Saldanha–Langebaan Lagoon, off the south-west coast of South Africa, in which *Gracilaria confervoides* is cast up to the extent of about a thousand tons a year and forms the basis of a small agar industry. Miss B. T. Chiu (Hong Kong) discussed the seaweeds of economic importance in south China, where the abundant *Sargassum* species are harvested for use as fertilizer and animal feedstuff, and many brown and red algae are used in human foods, medicine and the textile industry. Variations in the standing crop of *Laminaria cloustoni* have been observed for three areas off the coast of Scotland, and the significance of these survey results was dealt with by Mr. W. D. Richardson (with F. T. Walker, Scotland); in general, there was a decrease in seaweed growth between 1949 and 1953, but 1954 showed a recovery in two out of the three areas.

Dr. A. D. de Virville (France) stressed the importance, both from a scientific and practical point of view, of having an accurate distribution map of marine plants of industrial value, and outlined a plan for the cartographical survey of the resources of the French coast; the Fucaceae, Laminariaceae, Gigartinaceae and Zostereae are represented by different colours on the map, which then shows the location of these plants with a fair degree of accuracy. The paper by Miss C. MacFarlane (Canada) on studies in the seaweed populations of economic importance in Digby Neck area, Nova Scotia, was read by Dr. E. Conway (Scotland) and illustrated with many beautiful slides; seventy-five miles of the shore of the Neck and islands support sixty thousand tons of harvestable rockweeds, chiefly *Ascophyllum nodosum*, and *Gigartina stellata* and *Laminaria* beds are also extensive although tidal and topographical conditions make for difficult harvesting on most Fundy shores. Growth control in the Fucaceae and growth rings in stipes of *Alaria esculenta* were discussed by Dr. E. M. Burrows (England) and Dr. E. Baardseth (Norway), respectively, the latter also reading two papers (by H. Printz) dealing with the phenology and recolonization of *Ascophyllum nodosum*. During recent years reports have been received from various parts of the world that *Ascophyllum* is on the point of being exterminated due to its exploitation for seaweed meal, and this question of recuperation and recolonization aroused much interest among delegates; the best methods of harvesting this species were discussed in detail. Dr. H. Blackler (Scotland) discussed the time of reproduction and the rate of growth in certain Fucaceae, while Miss M. Naylor (England) dealt with the cytology of three British species of *Laminaria*, for which chromosome counts have been made both on the sporelings and the gametophytes. The resistance of *Gracilaria confervoides* to hydrogen sulphide was the subject of a paper by Mr. K. Stokke (Norway), who described experiments confirming the high resistance of the alga to this poison; the species was first recorded in Norway in 1935 and is frequently found in waters contaminated with hydrogen sulphide.

Many delegates contributed to the discussions following each paper, and it is hoped that the proceedings of the symposium will contain a résumé of these discussions together with the complete text of the papers presented. The meetings were held in the Norges Tekniske Høgskole, and three excursions were arranged in the Trondheimsfjord, when ample opportunity was given for studying the marine flora of the three localities. An excursion was also made to Molde and the west coast, and the delegates were able to view the coast at Hustad and to examine the littoral flora at Bud, where a delightful boat-trip was made to the archipelago of Bjørnsund.

It was unanimously agreed that similar symposia should be arranged in the future. Canada, France, Ireland and Spain were suggested as possible venues, and it was tentatively proposed to hold the third International Seaweed Symposium in Ireland in 1959 and the fourth in Spain in 1962. It was decided to appoint a standing committee to arrange the next Symposium.

E. T. Dewar

## SCIENTIFIC MANAGEMENT

A NOTE in the programme of the National Conference on Science and Management arranged by the British Institute of Management and held at Harrogate during November 2–4 reads: "So fundamental are the changes with which the scientists are confronting us at the moment that many people are already talking in terms of a second industrial revolution. At the same time it is obvious that the face of Britain cannot be changed overnight. The responsibility for transferring new knowledge from the research laboratory to the production floor must rest with management. The British Institute of Management has therefore chosen as the theme of its National Conference for 1955 'The Impact of Science on Management in the Future'."

The conference embraced a wide range of subject-matter. The 'impact' of the scientist was naturally most noticeable in the field of technology, and on the purely technical side managers had the opportunity of learning about such topical matters as the new materials and processes made practicable within the past few years and the uses and limitations of radioactive isotopes in industry. Discussion, however, was by no means limited to material and practical problems of production. The economics and the 'human implications' of technical innovation each formed the subject of a separate panel debate, while a further panel discussed the function of the research association.

Papers presented by individual speakers indicated how scientific techniques could be applied to such operations as retailing and the analysis of market trends, while spokesmen for such specialities as accounting, sociology and economics each in their turn found time to wonder whether their own particular contribution could truly be described as 'scientific'. Looming behind each topic and linking together the whole conference was one important basic question: to what extent is the function of management itself based on scientific principles? For most of the managers attending, this question did not represent a new consideration. In the course of a very full programme they received added confirmation and demonstration of the means whereby the scientist can make a valuable contribution to the everyday task of management in industry, commerce and local government.

In a paper circulated to delegates but unfortunately, due to illness, not delivered in person, Prof. George C. Homans, of Harvard University, underlined the value of the general approach of the scientist. "The practical value of any science", he said, "is that by making experience subject to explicit intellectual control it speeds up the learning process and so sets intuition and judgment free to work on new ground rather than old. In something as important as management, anything that even begins to get us free of empiricism, or to set empiricism free for new advances, makes a contribution." Prof. Homans was referring in particular to the contribution of the sociologist. In a paper on "Operational Research", Sir Charles Goodeve, director of the British Iron and Steel Research Association, had some more general remarks to make about the application of the scientific method to management's task of planning for the future. "Getting rid of illusions about science and scientists", he said, "is one of the first essential steps in the whole field of the application of science, whether on the technical or the operational side of industry." Curves and diagrams of all types should be critically examined before acceptance by people other than those who produced them. "I have seen many examples", said Sir Charles, "of managers being overawed by curves. This is a more dangerous attitude than that of the opposite extreme. You should copy the approach of the scientists and disbelieve anything you are told until you can independently come to the same conclusions. A scientist always asks questions and will never believe the answers he is told. He will not accept an authoritative answer and is always demanding experimental proof of at least some reliable observations. The scientist believes that managers can make better decisions if they have the facts and an objective appreciation of the effects of the various sources of action open to them. It might pay the manager to wait for the scientist to do all this if he does not take too long over it."

That most unscientific word 'automation', receiving its due measure of attention within the theme of the conference, proved to be less alarming in its implications than might otherwise have been suspected. Under the treatment of Mr. John Diebold, who had travelled from the United States especially to speak at Harrogate, the subject appeared indeed to be concerned with the same fundamental and stematic approach to management—in this case e management of production—as had been out- ded by Sir Charles Goodeve. "Automation", said r. Diebold, "is a way of thinking, a way of 'looking ' as much as a way of doing. It is an attitude—a hilosophy of production' rather than a particular chnology of electronic devices. It is something as volutionary in its way as Henry Ford's concept the assembly line. It is a very simple fact that the ost efficient use of machines has little to do with e most efficient division of human skills. Until cently, this was simply one of the paradoxes herent in mechanization. With the introduction the new concept and technology of self-regulating stems, it is no longer necessary to design the pro- uction processes around the limitations of human ills. It is here that we begin to reach the heart of e true meaning of automation."

John Diebold, who at the age of twenty-eight is escribed in the United States as 'the elder statesman automation', proved to be highly conscious of his are of the responsibility for introducing this word to general currency. It is not, he said, a very eautiful one, but he has yet to find any satisfactory bstitute for it. "For a long time", he added, "I have arched for a definition of automation that would be use to me in an operational way. In the course this conference I am sure we will all gain some ew insights into the problem. In the meantime, offer the following for your consideration: 'Auto- ation is a means of analysing, organizing and con- olling our production processes to achieve optimum e of all of our productive resources, mechanical nd material as well as human'."

The need for a scientific use of the machines which e scientists have provided was emphasized by Dr. . V. Bowden in a paper devoted to the electronic rocessing of data for management. More important an a machine's ability to do arithmetic, said Dr. owden, is its ability to organize its data. "How any managerial decisions", he asked, "rest on umerical criteria which may have been applied nsciously or unconsciously by the executives? ow many of them could be made by a machine?" isting many successful applications of electronic mputers to industry, Dr. Bowden had one very lling point to make. "We were once asked", he id, "to mechanize certain commercial calculations hich had occupied five people for about three weeks ery month. We found that the calculations could done on the Manchester machine in a couple of urs; but further study showed that they could done by hand in three hours if they were properly ganized and simplified in a manner which the athematician's analysis suggested. It is a very lutary experience", continued Dr. Bowden, "for y company which imagines that its accounting stem is simple and well understood by the staff to y to programme the work so that it can be done an accounting machine."

Besides the formulation of principles for the future, e conference was also concerned with the communi- ation of those principles not only to present-day anagers but also to those undergoing training for anagement. Education for management was one the most urgent issues discussed at Harrogate, d the problems of training managers in science and ientists in management received special attention two sectional meetings. Among those attending ere was a strong appreciation of the vital need for ore trained men in the future. This need was expressed very forcefully by Mr. R. Craig Wood in a paper entitled "The Influence of the Increasing Rate of Scientific Development on Future Management Requirements". "To make progress and succeed in the technological revolution", he said, "we will need more and better *human* management. We must upgrade our basic human material. There is no more exacting need for human management than in the development of the individual to new skills, higher abilities, greater responsibilities. The upgraded working force will need a higher level of management. Sheer technical brilliance will be no substitute for human leadership. . . . Mankind can enjoy the fruits of technical progress", concluded Mr. Craig Wood, "only so fast as it can learn to *manage* their production and distribution."

# PSYCHOLOGY AND THE FILM

A ONE-DAY conference on the film in training and research in psychology and psychological medicine was held in University College, London, on October 22. This conference, which was attended by about a hundred and fifty people, was organized by the British Universities Film Council, a body founded in 1948 to promote the production, distribution and use of films in university teaching and research, and which has already organized conferences on the film in relation to language teaching, to the teaching of arts-faculty subjects, and to chemical engineering. Section A of the conference dealt with films in psychology and Section B with films in psychological medicine, the morning sessions being devoted to films in training and the afternoon sessions to films in research. Although papers were read, a feature of the conference was the showing of a great number of films. This led to critical discussion on the individual films, as well as providing the most practical form of demonstration of the various functions films can fulfil.

At the commencement of Section A, Mr. A. Watson spoke of the danger of biased or false presentation through films; but, as conference members remarked during discussion, this danger is not peculiar to the film medium. A film on the cerebral cortex of the monkey was shown. Dr. M. Gunther then read a paper on babies' first feeding responses, using a film made by her and part of a film by Dr. Tinbergen on the pecking responses of a newly hatched gull. A film on cats reared in darkness, a subject which is of interest in connexion with miner's nystagmus, showed the rotations and oscillations of the eyes of cats. Another film, entitled "Warning in the Dark", showed that the capacity of some blind persons to avoid obstacles is due to their sensitive reaction to reflected sounds.

The Department of Psychology of the University of Reading has given some attention to problems of film presentation. Mr. D. Bruce, of the Department, in a paper entitled "Immediate Recall of Film Material", said that the film is suitable for memory experiments, because for these experiments meaningful, and consequently 'life-like', material is desirable, and also material the presentation of which is capable of exact repetition. He showed a film, "Fidelity of Report". Mr. S. Laner, of the same Department, is engaged in comparing the effectiveness of films with other visual media, as aids to learning. In his experiments he uses two versions of a film, and these were projected at the conference. One version portrayed the making of a paper barge with movement—in the normal film manner—and the other a series of static views at essential points in the operation. His experiments so far show the advantage of movement, and also of repeated film showings and of commentary. A coloured sound film, introduced by Dr. D. Fry, revealed movements of the tongue during speech of a surgical case whose cheek had been removed. It has been used in the teaching of students of physiology and of psychology, as well as phonetics.

Dr. D. Hill, presiding at the opening of Section B, said that little use has been made of films so far in psychological medicine teaching, and stressed again the need for specific objectives in teaching films. He asked conference members to consider whether films showing common or rare cases are the more valuable, and whether it might not be equally important to show the home as the clinical situation.

Dr. R. Mackeith introduced and provided commentary to the film "Hemispherectomy for Sturge–Weber Syndrome". This film, which was silent and coloured and the tempo of which (intentionally for teaching effectiveness) was slow, showed a child patient before and after hemispherectomy. The two films next projected were sound films, speech in them being an essential part of the portrayal; they were straightforward records of interviews of patients with a doctor: "Depressive states—1", and "Folie à deux". There was little change of point of view, and a minimum amount of expression through editing. In contrast, Dr. R. Spitz's film, "Grief", showing the condition of infants consequent on separation from their mothers, was the product of a high degree of selective editing.

In the afternoon Prof. P. Russell summarized the advantages of using films when studying behaviour. Films are permanent records; they facilitate measurement (including opportunity for deciding on appropriate measurements), the forming of hypotheses, and a complete analysis. A film "Function of Parietal Lobes" showed the behaviour of monkeys after lesions had been made; there was no loss of motor power of the monkeys, or of tactile discrimination, but impairment in learning from visual cues. Another interesting film—"Animal Studies in the Social Modification of Organically Motivated Behaviour"—showed the social behaviour of rats, in various circumstances of feeding. Dr. P. Sainsbury illustrated a paper on a method of measuring spontaneous movements by time-sampling motion pictures, by a film made in the course of research. A concluding paper on the use of the film as a thematic apperception test, by M. G. Cohen-Séat, of the Institut de Filmologie, Paris, was illustrated by some films made at that Institute.

The films shown at the conference illustrated the great variety of forms of record and of communication possible through cinematography. If the conference has led to an increased awareness of this, and therefrom perhaps of the value of research on the film itself, one useful purpose will have been served. Some of the films—in photography and matters of technical film detail—did not come up to the standards of the professional film-maker; but this can only emphasize the benefit which would result from better film-making facilities at universities and institutions where psychological films are made. The conference was well planned to show a number of ways in which the film can contribute to psychology training and research. Credit is due to the Britis Universities Film Council and to its representative Miss G. Keir and Mr. D. Bruce, who were responsib for the detailed arrangements. C. DENIS PEGG

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# INTERNATIONAL RESEARCH IN RADIO ASTRONOMY

IN an account of a General Assembly of the International Scientific Radio Union held in Sydney i 1952 (see *Nature*, 171, 628; 1953), reference was mad to the fact that the Union had commenced th publication of some special reports on radio topic of international interest. During the past year, No 3, 4 and 5 in this series have been published wit the financial help of Unesco, and are obtainable fro the General Secretary of the Union, at 42 rue de Minimes, Brussels*.

These three reports, which deal with differen portions of the field of radio astronomy, have bee prepared by small sub-committees of expert researc scientists working in Australia, France, Great Britain the Netherlands and the United States, assisted b various members of the Union under the gener auspices of Commission V (Radio Astronomy), which Dr. M. Laffineur is the chairman.

Report No. 3 is entitled "Discrete Sources of Extra-Terrestrial Radio Noise", and comprises a clear summary of the considerable volume of research whic has been carried out, principally in Great Britain an Australia, since the inception of this field of work le than about ten years ago. The report deals in deta with the results of surveys of the distribution sources of radiation, the effects of the ionosphere i producing scintillation and refraction, the detectio of sources against background radiation and receive noise, and the determination of their positions an angular band-widths.

The fourth and fifth reports in the series are boun in one cover. No. 4 is entitled "The Distribution Brightness on the Solar Disk", and summarizes th progress made in this portion of radio astronomy sin the publication of Report No. 1 in 1950 under th more general title of "Solar and Galactic Radio Noise' The present report (No. 4) deals with the problem measuring the relative intensity of radio emissio from different parts of the solar disk, and the resul of observations carried out with receiving system operating at centimetre, decimetre and metre wave-lengths. These results are discussed in relation to study of the physics of the Sun, which has confirme in broad outline the conclusions drawn from optic observations concerning the solar atmosphere. Th radio work has, however, arrived at the stage providing more accurate estimates of electron tempe ature and density in the solar chromosphere an corona than have been available previously.

The exciting story of the prediction, and detectio seven years later, of radiation from hydrogen in inte stellar clouds on a wave-length of 21·1 cm. is discusse in cold scientific language in Report No. 5, entitle "Interstellar Hydrogen". A description is given of th mechanism of excitation of the hydrogen molecule, th measuring apparatus used, and the method of detern ing the distribution of hydrogen in the galaxy. he significance of the observations and the deduc-ions which may be drawn from them are briefly iscussed; and the report concludes with a list of the cientific institutions engaged in research on the 1-cm. line.

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* International Scientific Radio Union. Special Report No. Discrete Sources of Extra-Terrestrial Radio Noise. Pp. 56; Belg. fr., 11s. 0d., or 1·5 dollars. Special Reports Nos. 4 and 5: T Distribution of Radio Brightness on the Solar Disk; Interstell Hydrogen. Pp. 72; 100 Belg. fr., 14s. 6d., or 2 dollars. (Brussel International Scientific Radio Union, 1954.)

All three reports contain a comprehensive, but elected, list of references to the specific portions of he field of radio astronomy to which they refer. he fact that they were prepared by small groups of nternational workers makes them invaluable to all ho are studying or pursuing research in this subject.

R. L. SMITH-ROSE

# BIOLOGY AND HUMAN AFFAIRS

CHANGES in educational thought and practice are usually so slight that they are scarcely disernible from one year to another; as time goes n they may build up into something formidable. wenty years ago, for example, the teaching of iology in British schools was on a small scale. In any girls' schools botany was thought to be the nly suitable biological subject, while in boys' schools otany was thought to be a subject suitable for girls, nd little, except a smattering of 'nature study', was aught.

In 1935 the British Social Hygiene Council (now he British Social Biology Council), a voluntary rganization formed originally to combat the venereal iseases, took the long view and turned to the ducational service as a means of giving children ational information about the workings of their own odies. It was expecting that actions based on this nowledge would lead to higher standards of health, nd was hoping that a deeper insight into biology ould endow men and women with a clearer appreiation of themselves as human beings; when ssociated with the understanding provided by the ther life sciences, this would form the basis for etter moral behaviour, particularly in relation to ex. The Council decided that its long-term objectives ould best be achieved by promoting and supporting he development of biology teaching in schools. ublic meetings were organized, as well as conerences, courses for teachers and summer schools. journal, then called *Biology*, was launched, and ow, under the name of *Biology and Human Affairs*, celebrating twenty years of uninterrupted pubcation.

During those twenty years changes in three ifferent directions have been accompanied by orresponding changes in the nature of the journal self. First, there has been a remarkable increase in he amount of biology teaching in schools. To-day he subject is taught in many grammar schools, and is becoming firmly established in secondary modern nd primary schools, although in some of these there a tendency to offer it only to boys, while girls are usy with domestic science. Secondly, there has been marked improvement in the content of the subjectatter. It is developing into a genuine natural ience, having depth as well as breadth; botany as been largely displaced by biology, a unified bject drawing its material and principles from oth plants and animals.

The third direction in which progress has been arked is in the field of sex education. From its ception in 1914 until it ceased to be a semi-official body in 1942, the British Social Hygiene Council's main function was to act as a central organization for public enlightenment in relation to venereal disease. It was with this object in mind that the Council embarked on a vigorous campaign in favour of sex-education. At first it met with bitter opposition, particularly from religious bodies and official organizations, and sometimes from the schools, while those most favourably disposed towards this new development but who were least able to make their views effective were the children themselves. Bit by bit, however, the opposition was won over, and when in 1943 the Ministry of Education issued its pamphlet on "Sex-Education in Schools and Youth Organizations" the campaign might be said to have achieved its object. It would, of course, be presumptuous for the founders of *Biology* to claim credit for all these advances; they deserve their proportionate share.

To-day, *Biology and Human Affairs* appears as the journal of an organization, the British Social Biology Council, which is committed to promote and encourage the teaching of human biology as a cultural and practical subject; to preserve and strengthen the family as the basic social unit; and to encourage the dissemination of biological knowledge as a means of emphasizing the social responsibilities of individuals, the implications of population problems, the removal of conditions conducing to promiscuity, the elimination of commercialized vice, and a reduction in the incidence of social diseases, particularly the venereal diseases. The contents of its anniversary number indicate the broad catholic way in which those responsible for the production of the journal are seeking to implement the aims of its parent body. Articles include one on the adaptation of farm animals to their environment, by Dr. John Hammond; the fauna of built-up areas, by Dr. E. J. Popham; the natural history of the 'spiv', by Dr. P. D. Scott; the breeding behaviour of toads; a progress report on poliomyelitis; and the adventures and vicissitudes of a laboratory technician, by F. C. Taylor, senior laboratory steward at Eton College.

# HOSPITAL IN-PATIENT STATISTICS IN ENGLAND AND WALES

AS part of the Registrar General's statistical review of England and Wales for the two years 1950–51, a "Supplement on Hospital In-Patient Statistics" has been published* which makes available a fresh selection of material from a hospital in-patient inquiry started in 1949. The chief purposes of the inquiry were to assist hospital administrators by a more detailed analysis of the diseases treated and the types of patients involved; and also to increase the information available about the general pattern of ill-health in the community obtainable from mortality and morbidity data. Since the inquiry has, up to the present, been largely experimental, it has covered only a proportion of hospitals; and, moreover, different selections of tables are presented for the several years analysed. Sufficient experience has now been gained to put the project on a more permanent and comprehensive basis.

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* The Registrar General's Statistical Review of England and Wales for the two years 1950–51: Supplement on Hospital In-Patient Statistics. Pp. iv+151. (London: H.M.S.O., 1955.) 7s. 6d. net.

Attention is focused in this supplement on the patients' length of stay in hospital, and a variety of different types of analysis have been made involving various cross-classifications by hospital group, diagnosis, sex, age and social class. Admissions for childbirth and diseases of pregnancy have been excluded from the main tables; but a separate analysis of length of stay according to birth-weight is provided. There is also one appendix listing the participating hospitals with an age-and-sex distribution of discharges; and another giving the same type of distribution for patients actually in National Health Service hospitals on the night of the 1951 Census.

It is particularly gratifying to a statistician to see emphasis being laid on statistical frequency distributions as opposed to mere averages. Theoretical studies of fluctuations in waiting-lists, for example, are dependent on knowing the actual form of the distribution of length of stay. Again, variations in the latter with district, social class, the elapse of time, etc., are also of clinical importance. One curious point in connexion with the grouping of the frequency distributions is perhaps worth directing attention to. In Table 2, for example, the grouping is by single days up to 20, and then in tens up to 100, with coarser grouping in the tail. This seems quite reasonable and enables one to see the general shape of the curve at a glance. Tables 5 and 6, on the other hand, employ two different arrangements, each involving a mixture of intervals grouped in 1, 2, 3, 4, 7, 21, etc., days. Although one cannot say that this is wrong, a more uniform presentation would certainly make the tables easier to use and interpret.

It is, of course, most valuable to have this material on the distribution of length of stay, especially as it may be more comprehensive in future. At the same time, it must be pointed out that much more than this is required by administrators using hospital statistics to gauge the efficiency with which the demand for in-patient care is being met. Valid conclusions have to be based on considering several inter-related items, including bed allocation, bed occupancy, turnover interval, discharges and deaths (or admissions), and waiting lists as well as length of stay.

Norman T. J. Bailey

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# ROCKEFELLER FOUNDATION AWARDS

Among the grants recently made by the Rockefeller Foundation, New York, are the following:

## Royal Institution, London, and Cavendish Laboratory, Cambridge

An award of 30,300 dollars has been made to the Davy Faraday Laboratory of the Royal Institution and one of 40,000 dollars to the University of Cambridge for the Medical Research Council's Unit in the Cavendish Laboratory, to aid the researches on proteins at these centres.

It is now more than twenty years since Prof. J. D. Bernal and Dr. D. Crowfoot announced in *Nature* that they had obtained X-ray diffraction photographs of a protein crystal. To interpret these photographs and get information about the structure of molecules which contain thousands of atoms has for long seemed a task of such complexity that one could scarcely hope for success. Quite recently, however, the most formidable obstacle has bee overcome. M. F. Perutz has shown that heavy atom or groups can be attached at definite places in th hæmoglobin molecule without disturbing the crysta line structure, and that by measuring the consequen changes in the intensity of diffraction, the phases c the reflexions can be determined and the structur computed. This opens up a vast new field for cryst analysis which is now being explored at a number c laboratories. New ways of attaching heavy group to various parts in the molecule are being discovered and these groups can be located. A beginning can b made in the task of mapping out the positions in th molecule of certain amino-acid residues or othe groups, and eventually of linking them up by th intervening structure.

The Unit at Cambridge, under Dr. M. Perutz an Dr. J. C. Kendrew, and the group at the Dav Faraday Laboratory under my direction are workin in complete collaboration on these problems, studyin in particular the structures of hæmoglobin and myc globin. Quite apart from the new insight which wi certainly be gained into the part which these mole cules play in living matter, the solution of th technical problem of applying X-ray analysis to suc vast molecules is very thrilling indeed.

Lawrence Bragg

## Chemical Crystallography Laboratory, Oxford

Over the past twenty years I have been intereste in the possibility of using X-ray crystallographi methods to find the arrangement of the atoms i protein molecules and particularly in insulin. One c many possible approaches to solving this proble seems to be the crystallographic study of naturall occurring peptides such as the gramicidins an tyrocidine or oxytocin and vasopressin. These al have molecules much smaller in size than even th smallest protein molecules; some indeed are smalle than vitamin $B_{12}$, of which we have already found i possible to obtain the kind of information we require

Dr. R. L. M. Synge has accordingly prepared fo us a series of heavy-atom derivatives of gramicidin and we are now making some progress with th detailed X-ray analysis of one group of these. W already have evidence that there may be a connexio between the way the peptide chain is folded i gramicidin *S* and the way it is folded in part of th molecule of insulin. But even if later we find tha the connexion in chain configuration is less close tha we at present suppose, we think that the atomi arrangement in these peptide molecules is itsel of great interest and some importance. Paralle with the work on peptides, we are beginning agai to examine the crystal structure of insulin in th light of Dr. Sanger's evidence of its chemical structure

The present grant from the Rockefeller Foundatio (£3,000, during a three-year period) is the renewal c a grant made to me over a number of years fo research assistance in connexion with these problems

Dorothy Crowfoot Hodgkin

## Department of Chemical Pathology, St. Mary's Hospital Medical School, London

A grant of £4,600 has been made to the Universit of London for the purchase of special equipment suc as a 'Spinco' preparative ultracentrifuge and a electrophoresis apparatus by the Department c Chemical Pathology at St. Mary's Hospital Medic school. This Department has only been created this year, and I am the first holder of the chair. My ecent interests have centred on the chemistry and metabolism of proteins and the biogenesis of porphyrins, and it is expected that the work of the new Department will largely proceed along the lines mentioned. In the protein field, studies on the whole animal with the aid of isotopically labelled aminocids will be supplemented by investigations on *in vitro* systems, particularly relevant enzymes. Of pecial concern to the Department will be the proteins f connective tissue, and in this connexion the ynthesis of collagen will receive close attention.

In the porphyrin field the main pathway of synthesis seems reasonably well established; but the enzymes responsible for the various steps are still largely unknown, and further research in this field is likely to yield interesting results.

A. NEUBERGER

### Department of Zoology, University College, London

The grant of £2,700 made to me is for the purchase of a single piece of apparatus, namely, a 'Spinco' preparative vacuum ultracentrifuge, and it will be used for the preparation and analysis of various tissue fractions in connexion with the work of R. E. Billingham, L. Brent and myself on the mechanism of transplantation immunity.

P. B. MEDAWAR

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# RADIOLYSIS OF LIQUID *n*-HEXANE AND SOLUTIONS OF ANTHRACENE IN *n*-HEXANE

By Dr. F. H. KRENZ

Department of Natural Philosophy, The University, Edinburgh

A STUDY has been made in this laboratory of the radiolysis in vacuum of pure, liquid *n*-hexane and of solutions of anthracene in hexane by γ-rays from a cobalt-60 source. The principal products of the radiolysis of the hexane were hydrogen, methane, ethane and an unsaturated hydrocarbon with approximately the same volatility as *n*-hexane. $C_3$- and $C_4$-hydrocarbons were also detected, but in amounts which were negligible compared with hose of the principal products. A $C_5$ fraction was never satisfactorily separated from hexane, but did not appear to contain any important product.

Hydrogen, methane, ethane and the unsaturated iquid hydrocarbon were formed in amounts which were directly proportional to the energy absorbed rom the γ-rays up to the highest concentrations of products measured (*c.* $10^{-4}$ *M*). The yields, *G*, in erms of the molecules of products per 100 eV. of γ-ray energy absorbed by the hexane (determined by errous sulphate actinometry, using $G_{\mathrm{Fe}^{3+}} = 15\cdot5$) were:

$$G_{\mathrm{H}_2} = 4\cdot89 \pm 0\cdot2 \qquad G_{\mathrm{C=C}} = 4 \pm 2$$
$$G_{\mathrm{CH}_4} = 0\cdot41 \pm 0\cdot1 \qquad G_{\mathrm{C}_2\mathrm{H}_6} = 0\cdot69 \pm 0\cdot1$$

The radiolysis in vacuum of solutions of anthracene n hexane showed that anthracene in concentrations p to $10^{-3}$ *M* had no measurable effect upon the yields of hydrogen, methane or ethane, but caused a iminution in the yield of unsaturated products. $G_{\mathrm{C=C}}$ decreased with increasing anthracene concentration toward a minimum value of approximately 2. The radiolysis of the solutions was accompanied by fading' of the anthracene absorption spectrum. The bands between 300 and 380 mμ gradually disappeared, nd were replaced by a new spectrum between 200 nd 280 mμ, superimposed upon the very intense nthracene band at 256 mμ. The new spectrum losely resembled that of dianthracene (Weiss, J., rivate communication; I am indebted to Dr. Weiss or the absorption spectrum of dianthracene in thanol). $G_{-\mathrm{A}}$, the number of anthracene molecules isappearing per 100 eV. of γ-ray energy absorbed y the hexane, was described within the experimental rror by the function:

$$G_{-\mathrm{A}} = 3\cdot6 \left\{ \frac{3 \times 10^3 M}{1 + 3 \times 10^3 M} \right\}$$

where *M* is the concentration of anthracene in moles per litre.

The results above are explained by a simple mechanism resembling that which has been established for the mercury-photosensitized photolysis of paraffin hydrocarbons in the gas phase[1]. The principal primary step in the radiolysis of hexane is considered to be

$$R\mathrm{H}^* \rightarrow R\cdot + \mathrm{H}\cdot \qquad (1)$$

$R\mathrm{H}^*$ represents an electronically excited molecule of hexane resulting from primary absorption processes[2], $R\cdot$ a hexyl radical and H· a hydrogen atom formed by the rupture of a C—H bond in hexane. The rupture may impart considerable kinetic energy to the fragments, particularly to H·, which probably reacts immediately with the surrounding hexane:

$$\mathrm{H}\cdot + R\mathrm{H} \rightarrow \mathrm{H}_2 + R\cdot \qquad (2)$$

The hexyl radical must disappear, in the absence of competing reactions, by

$$R\cdot + R\cdot \rightarrow R_2 \qquad (3a)$$

or

$$R\cdot + R\cdot \rightarrow R\mathrm{H} + R_= \qquad (3b)$$

$R_2$ is the dimer, dodecane, and $R_=$ is an unsaturated compound formed by the disproportionation of two hexyl radicals, that is, it is one of several possible isomeric hexenes.

The relatively small amounts of methane and ethane found among the products may result from (*a*) the primary rupture of a C—C bond in $R$H, (*b*) H· atom 'cracking' of hexane[3] as an alternative to reaction (2), or (*c*) dissociation of an excited radical produced in the primary step (1). The methyl or ethyl radicals so formed probably undergo reactions analogous to (2), forming methane and ethane respectively[4]. The reason for the relative unimportance of processes of this type is not apparent.

In solutions of anthracene, reactions (3*a*) and (3*b*) must compete with the following reaction:

$$R\cdot + A \rightarrow RA\cdot \qquad (4)$$

Here $A$ represents a molecule of anthracene, and $RA\cdot$ is a new free radical resulting from the addition of $R\cdot$ to $A$, probably at the 9- or 10-position. $RA\cdot$ may react with a second $R\cdot$ to form $RAR$, or may form a dimer analogous to $R_2$, namely, $RAAR$. In either case a stable product is formed having an electronic structure similar to that of dianthracene.

The results summarized above are in substantial agreement with the results of earlier studies of the radiolysis of paraffin hydrocarbons[5], and the theory successfully describes the earlier results. The yield, $G_R$, of free hexyl radicals given by the theory is

$$G_R = 2\,G_{H_2} + G_{CH_4} + G_{C_2H_6}$$
$$= 10\cdot 9$$

On the same basis, the yield of radicals of all kinds (excluding H· atoms) is at least 12. These values are in agreement with values of $G_R$ ranging from 9·9 to 14·3 recently found by Magat and co-workers[6] for *n*-heptane, *n*-octane and *cyclo*hexane, using an independent method of measurement.

More recently, Schuler and Allen[7] have noted th the yield, $G_{H_2}$, of hydrogen from liquid *cyclo*hexa decomposed by energetic radiation was independen of the linear ion density of the radiation. Such a effect is explained in terms of reactions (1) and ( above, since the separation between successive io izations (or excitations) would have to be of molecul dimensions before recombination of atoms coul compete effectively with reaction (2).

A complete account of the present work has bee submitted for publication in the *Canadian Journal* *Chemistry*. I am grateful to Prof. N. Feather f support and encouragement and to Drs. N. Mill and R. A. Back for much help and advice in th course of the work.

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[2] Dainton, Ann. Rep. Chem. Soc., **45**, 5 (1948). Magee and Burto *J. Amer. Chem. Soc.*, **72**, 1965 (1950).

[3] Schiff and Steacie, *Can. J. Chem.*, **29**, 1 (1951).

[4] Trotman-Dickenson, *Quart. Rev. Chem. Soc.*, **7**, 198 (1953).

[5] Lind and Bardwell, *J. Amer. Chem. Soc.*, **48**, 2335 (1926). Schoep and Fellows, *Indust. Eng. Chem.*, **23**, 1396 (1931). Honig a Sheppard, *J. Phys. Chem.*, **50**, 119 (1946).

[6] Prévot-Bernas, Chapiro, Cousin, Landler and Magat, *Disc. Fara Soc.*, **12**, 98 (1952).

[7] Schuler and Allen, *J. Amer. Chem. Soc.*, **77**, 507 (1955).

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# NUCLEUS AND CYTOPLASM IN CELLULAR INHERITANCE

By PROF. J. F. DANIELLI, DR. I. J. LORCH, DR. M. J. ORD and MISS E. G. WILSON

Department of Zoology, King's College, London, W.C.2

THE relative importance of nucleus and cytoplasm in cellular inheritance is uncertain. We have studied this problem by transferring nuclei of one species of *Amoeba* into the cytoplasm of another species. In such heterotransfers the resultant animal usually lives for up to a month, may undergo a number of divisions, and very occasionally will give rise to a clone of animals of viability and vigour comparable with the parent animals. We have previously reported on the characters of heterotransfers for the first month after the transfer operation. In this period the characters follow the cytoplasmic type closely, although some influence of the nuclear species can be detected[1]. The present report is concerned with a study, over a period of six years, of a heterotransfer clone which originated from the transfer of an *Amoeba proteus* nucleus into the cytoplasm of an *Amoeba discoides*. This clone is known as $\overrightarrow{P_nD_c}(1)$. Similar studies are in progress with other heterotransfer clones, but are not sufficiently advanced to warrant present reporting.

The characters studied fall into three groups: (1) observations made on individuals taken from mass cultures of $\overrightarrow{P_nD_c}(1)$; (2) observations made by transferring nuclei from $\overrightarrow{P_nD_c}(1)$ to cytoplasms of clones similar to the parent clones, and by replacing the nucleus in $\overrightarrow{P_nD_c}(1)$ amoebae with a *proteus* or *discoides* nucleus from clones similar to the parent clones; (3) observations on antigens.

Quantitative measurements of the following characters were made on individuals taken at random from mass cultures: shape when moving; average nuclear diameter; frequency distribution of nuclear diameters; division rate. As shown in Table 1, th shape of the animals when moving is intermediat between the shapes of the two parent species. O the other hand, the nuclear diameter, the frequenc distribution of nuclear diameters and the rate c division are very much more like those of the cyto plasmic parent than like the nuclear parent. Th shape when moving and the two nuclear character were measured about three months after this clon was first obtained, in 1949, and have been re-measure at intervals of a year or less. Over this period of si years there has been no change in these character outside the limits of experimental error.

When the nuclei from individuals of $\overrightarrow{P_nD}$ (1) ar back-transferred to *proteus* cytoplasm ($P_c$) or *discoide* cytoplasm ($D_c$), it is possible to make quantitativ observations of the frequency of reactivation as we as of the other characters. When an *Amoeba* i enucleated it tends to round up and become covere with small short blunt pseudopodia. When renucleate successfully the *Amoeba* resumes amoeboid movemen with a concomitant change of shape: it is this retur to normality which is termed reactivation. Nucle from $\overrightarrow{P_nD_c}(1)$ reactivated $P_c$ and $D_c$ equally well. O the other hand, when the frequency of divisions an the probability of clone formations were observed the behaviour of these individuals after reactivatio was more like that which would have been foun after renucleation with $D_n$ than with $P_n$. Thus, afte a long sojourn in *discoides* cytoplasm, *proteus* nucle are modified so as to resemble *discoides* nuclei i some respects. When the cytoplasm of individual from the clone $\overrightarrow{P_nD_c}(1)$ was renucleated with $P_n$ o $D_n$, the cytoplasm behaved more like *discoides* tha

Table 1

this table the various characters of the culture $\overrightarrow{P_nD_c}(1)$ are com-
red with the same characters in the parent species $P_nP_c$ and $D_nD_c$

| Character | Like $D$ | Like $P$ | Balanced |
|---|---|---|---|
| $A$. Measurements on $\overrightarrow{P_nD_c}(1)$ | | | |
| Division rate | + | | |
| Shape | | | + |
| Nuclear diameter | + | | |
| Distribution of nuclear sizes | + | | |
| $B$. Results of back transfers | | | |
| Nuclei from $\overrightarrow{P_nD_c}(1)$ to $P_c$ or $D_c$ | | | |
| Reactivation | | | + |
| Frequency of divisions | + | | |
| Clone formation | (+) | | |
| Nuclei from $P$ or $D$ to cytoplasm from $\overrightarrow{P_nD_c}(1)$ | | | |
| Reactivation | | | + |
| Frequency of divisions | + | | |
| Clone formation | (+) | | |
| $C$. Reactions to antisera | | | |
| Antisera to *proteus* | | | |
| Toxicity | + | | |
| Shape | | + | |
| Division rate | | + | |
| Antisera to *discoides* | | | |
| Toxicity | | + | |
| Shape | | + | |
| Division | | + | |

ke *proteus* cytoplasm. Although this was so, there as a considerable difference between cytoplasm om $\overrightarrow{P_nD_c}(1)$ and cytoplasm from the original *iscoides* clone, especially so far as frequency of lone formation was concerned.

The general conclusions which may be drawn from he ten morphological and physiological characters eported in Table 1 are: (*a*) that after six years the ytoplasmic influence on all these characters is always s strong as the nuclear influence, and for most haracters the cytoplasmic influence is very much ore pronounced, and (*b*) both nucleus and cytolasm have changed to a significant degree. The egree to which these changes in nucleus and in ytoplasm are reversible has yet to be investigated.

Over the past eighteen months we have studied he reactions of $\overrightarrow{P_nD_c}(1)$ to cytolytic antisera prepared rabbits. It is usually supposed that cytolytic ntisera cause specific cytolysis by combination of ntibody with antigen in the plasma membrane. ntisera prepared to *discoides* and *proteus*, respectely, are specific for the species to which they are repared. When an *Amoeba* is placed in a dilute olution of a toxic antiserum it takes up a shape haracteristic of the amoeba species, becomes imobilized and in sufficiently concentrated antibody ill ultimately die. In lower concentrations of antiody the animal may recover, feed and divide. In able 1 is recorded the behaviour of $\overrightarrow{P_nD_c}(1)$ in ntisera prepared from *A. proteus* and from *A. iscoides*. We have measured the toxicity (determined y the proportion of animals killed after twenty-four ours exposure to dilute antiserum), the shape of nimals in antiserum and rate of division after covery in antiserum. In five out of six characters udied with antisera, the influence of the nuclear pecies is far greater than that of the cytoplasmic pecies. Thus the surface antigens, that is, some of e macromolecules making up the surface of an moeba, have characters at the macromolecular level hich are mainly determined by the nuclei.

The general outcome of this study of sixteen characters is that, whereas there is a strong predominance of cytoplasmic influence determining morphological and physiological characters, there is an equally strong predominance of nuclear influence determining antigenic, that is, macromolecular, characters. From the time of the original heterotransfer to the most recent measurements summarized in Table 1, the clone $\overrightarrow{P_nD_c}(1)$ had undergone not less than five hundred consecutive cell divisions, so that the molecules present in the original heterotransfer have been diluted by a factor of the order of $2^{500}$. On the average the amoebae which now constitute this clone cannot contain even one molecule of the proteins, nucleic acids or polysaccharides which were present in the original nucleus and cytoplasm at the time of heterotransfer. Consequently, it is impossible to explain even a modest degree of persistence, at the present time, of either nuclear or cytoplasmic traits by the passive carry-over of macromolecules from the original nucleus and cytoplasm. All persistent characteristics which are now present in this clone must be present as a result of often repeated duplication.

We cannot here set out the numerous alternative hypotheses with which the facts reported above are compatible. The hypothesis which appears to us to be the most interesting to investigate is that the nucleus determines the specific characters of the macromolecules which are present in a differentiated cell, whereas the organization of these macromolecules into functional units depends to a very marked degree upon cytoplasmic inheritance. The nucleus may exert its influence in a variety of ways: for example, the actual synthesis of antigenic macromolecules may be nuclear, or the nucleus may supply to the cytoplasm complex enzymic units which carry out syntheses of macromolecules in the cytoplasm, or the nucleus may provide some other active unit, possibly pentose nucleic acid, which can leave a nuclear imprint upon the products of cytoplasmic synthesis, etc. This hypothesis, like most other hypotheses which might be advanced to account for the distribution of nuclear and cytoplasmic inheritance, does not account directly for the fact that nucleus and cytoplasm interact and change one another.

The amoebae used in these studies have been kept, so far as possible, in constant environmental conditions. We have evidence that discontinuous changes may take place in some of the characters we have studied as a result of variation in environmental conditions.

We must add that undue importance should not be attached to observations on one heterotransfer clone. Most heterotransfers do not become stabilized and give rise to clones, and despite much painstaking study we cannot yet define the circumstances which decide whether a heterotransfer will become stable. A variety of other heterotransfer clones must be studied before we can tell whether the results summarized in Table 1 are typical. Additional heterotransfer clones are now being investigated; but it will be a number of years before the complete picture is established.

*Note added in proof*. Serological studies of a second interspecific clone have now been obtained which agree closely with those reported on $\overrightarrow{P_nD_c}(1)$.

[1] Lorch, I. J., and Danielli, J. F., *Nature*, 166, 329 (1950); *Quart. J. Micro. Sci.*, 94, 445 (1953).

# LETTERS TO THE EDITORS

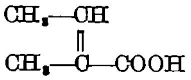
*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Configurations of Tiglic and Angelic Acids: an X-Ray Determination

PROF. S. STENHAGEN recently directed our attention to the need for a direct determination of the configurations of tiglic and angelic acids, because in recent synthetic work on certain 2-methyl-alkenoic acids the assignment of geometrical configuration has been based primarily on the correlation of their spectral data with those of the simplest acids of the series, tiglic and angelic.

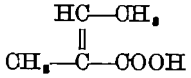
Tiglic acid has generally been assigned the *trans*-configuration (*cis*-methyl) mainly from a study of the rates of esterification of tiglic and angelic acids under similar conditions[1], and from a comparison of the physical properties of these acids with the *cis*- and *trans*-crotonic acids[2]. This evidence is certainly indirect; but more conclusive chemical evidence has recently been obtained by Dreiding and Pratt[3] from a study of the carboxylation of *cis*- and *trans*-2-butenyl lithium, a reaction which is considered to afford a stereospecific synthesis of tiglic and of angelic acid.

Although the combination of all the above evidence may be regarded as conclusive, we still felt that it was desirable to attempt a completely direct determination of the structures of these acids by the method of X-ray crystal analysis. This has now been carried out. In the case of tiglic acid, all the atomic positions have been ascertained with considerable accuracy (see Fig. 1) and the results establish the *trans*-configuration, with the doub bond in the α–β position of the butenic acid chain



$$\begin{array}{l} CH_3\!-\!CH \\ \phantom{CH_3-}\| \\ CH_3\!-\!C\!-\!COOH \end{array}$$

Our work on angelic acid is not yet complete; bu the results so far obtained are sufficient to show quit conclusively that this acid has the expected ci configuration:



$$\begin{array}{l} \phantom{CH_3-}HC\!-\!CH_3 \\ \phantom{CH_3-}\| \\ CH_3\!-\!C\!-\!COOH \end{array}$$

Crystals of tiglic acid are triclinic, with $a = 7{\cdot}7$ $b = 5{\cdot}23$, $c = 7{\cdot}42$ A. (all ± 0·02 A.), $\alpha = 96$ $\beta = 87{\cdot}7°$, $\gamma = 74{\cdot}5°$ (all ± 1°). The volume of th unit cell is 286 A.$^3$ and it contains two molecul (density observed, 1·163, calculated 1·162). Th space group $P\bar{1}$ has been assumed, with the cent of inversion between the carboxyl groups of tw molecules hydrogen bonded to form a symmetrica dimer. On the basis of these assumptions, the prob lem was attacked by the molecular Fourier tran form method, with projections along the short $b$-axi The transform evaluated for the *cis*-molecular stru ture could not be fitted to the weighted recipro lattice net; but with the *trans*-structure an excellen fit was soon obtained. The phase constants of th ($h0l$) structure factors obtained by this process enable an electron-density projection to be evaluated. Aft several refinement processes, the map shown in Fig. was obtained, with all the carbon and oxygen atom clearly resolved.

This projection is consistent with a coplana structure and with bond-lengths and valency-angle

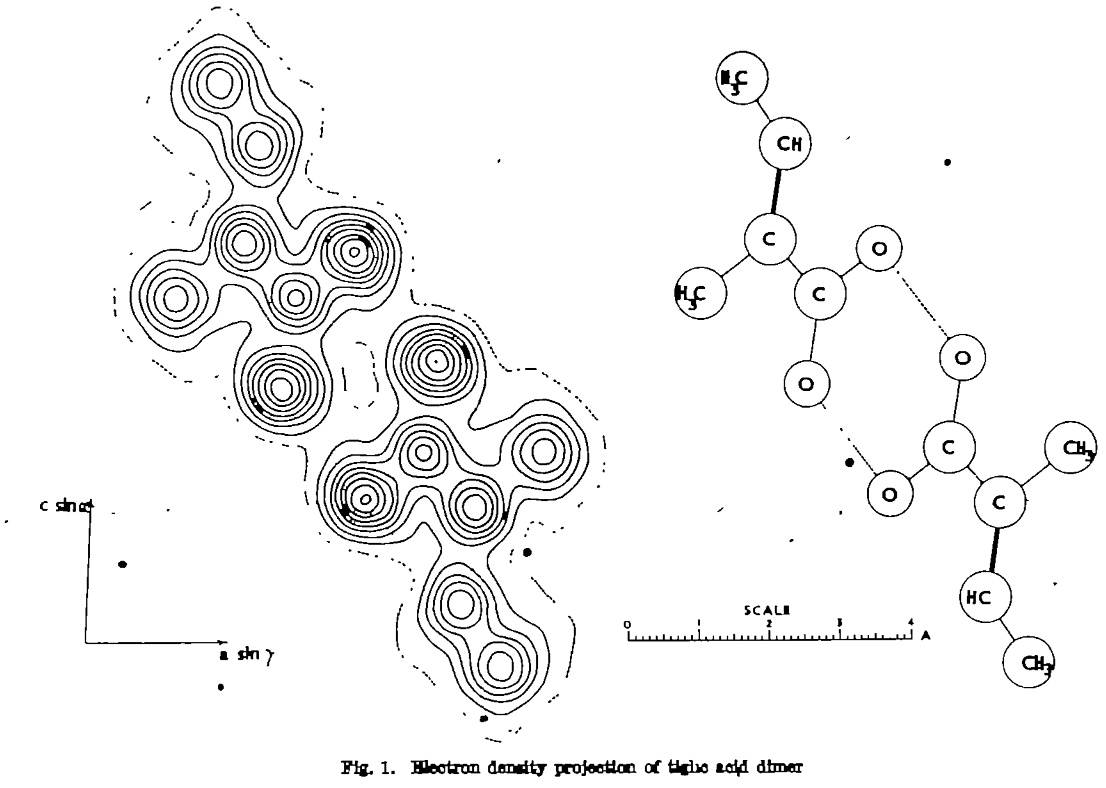


Fig. 1. Electron density projection of tiglic acid dimer

the expected magnitudes, except that there is some idence of repulsion between the methyl groups tached to the α- and β-positions. The β-methyl oups at the extreme ends of the picture appear o be somewhat displaced in position. Whether the hole structure is accurately coplanar or not must wait a more accurate evaluation of the third co-dinates of the atoms, which are perpendicular to is projection plane. In the meantime, it may be oted that difference syntheses based on this pro-ection indicate clearly the number of hydrogen toms attached to each carbon and thus show that e double bond is in the α–β position and not in the de-chain.

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## The Free Amino-Groups of Soluble Feather Keratin

FEATHER keratin can be made soluble by extraction ith urea and reducing agents or by oxidation with erformic acid, and it has been shown that the esulting solutions contain particles with a small istribution of weight and charge and a molecular eight of 10,000[1,2]. Rougvie[3] oxidized feather eratin directly with peracetic acid and similarly ound the soluble particles to have a molecular weight f 10,000. He also made the important observation hat fibres reconstituted from the oxidized material ave X-ray diffraction patterns with much of the etail of those of the original feather.

This communication is concerned with the results f an end-group analysis of oxidized feather keratin ysteic acid – keratin) prepared according to the ethod already described[2]. The interpretation of the nd-group analysis of other keratins has been difficult ecause the molecular weight of the reacting material as not been known. We do not have this complication in the case of feather keratin.

After reaction of cysteic acid – keratin with fluoro-initrobenzene (24 hr. in 50 per cent ethanol and per cent sodium bicarbonate) and subsequent ydrolysis in 5·8 $N$ or 12 $N$ hydrochloric acid, the initrophenyl derivatives of aspartic acid, serine, reonine, glutamic acid, glycine, alanine and valine an be detected; ε-dinitrophenyl lysine is also resent. However, the total amount of α-dinitro-henyl amino-acids corresponds to only 0·1 equiva-nts/mole of protein, and similarly the concentration f dinitrophenyl lysine is 0·1–0·15 mole/mole protein. oupling of cysteic acid – keratin with fluorodinitro-enzene, in 2 $M$ guanidine in 50 per cent ethanol, r in aqueous solutions at pH 11·5, gives a similar roduct to this. Traces of dinitrophenyl amino-acids n also be found in the ether extract of the acidified initrophenyl-keratin before hydrolysis, and it is ossible that the few end-groups result from degrada-on during coupling.

Cysteic acid – keratin, treated with cation and nion exchange resins to remove small ions, combines with less than 0·2 equivalent hydroxyl ion/mole protein between pH 6 and 8·5. Between pH 8·5 and 10·5, 0·2 equivalents of $OH^-$ ion are bound by each mole of protein. Hence few ε-amino-groups of lysine, α-amino-groups or imino-groups in each protein molecule are available to the hydroxyl ion.

The molecular weight of cysteic acid – keratin is known unambiguously and the gross composition is consistent with the absence of a non-protein prosthetic group, so the failure of the α-amino-groups to react with hydroxyl ion or with fluorodinitrobenzene is evidence that the protein has a cyclic structure.

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## Electron Microscopic Observation of Monolayers of Synthetic Linear Polymers

WHEN monolayers of some synthetic linear polymers at air/water interfaces are compressed to less than a certain area, bright streaks can be observed under dark-field illumination[1]. Subsequent compression gives rise to tiny visible striations running across the width of the trough and finally produces fibrous threads which can be picked up from the water surface. Since little is known about the structure of these heterogeneities, we have carried out an electron microscopic examination of spread films of synthetic polymers, and obtained, especially in the case of nylon, interesting pictures exhibiting the structure of the spread films.

A sample of 6-nylon (poly-ε-capramide, *D.P.*153) was spread from its mixed solution in benzene–phenol (3/1 v/v) on the surface of distilled water in a Langmuir trough. The uncompressed and compressed films were transferred to a collodion support by using a lifted film technique[2] for building up films on a slide. They were then shadow-cast with chromium at an angle of 12° to the surface and examined in a Hitachi *HS*-II type electron microscope. Micrographs are shown in Figs. 1 and 2. A blank water sample, which was transferred from the trough to a collodion support, is shown in Fig. 1,*a*.

When 6-nylon films were initially spread at an area of 80 A.$^2$/monomeric unit, unspread material was seen in the form of winding microfibrils (Fig. 1,*b*). The mean microfibrillar thickness was estimated to be 30 A. from the width of the shadow. The bare portions may contain film molecules that are less densely packed. When compressed to 30 A.$^2$/monomeric unit, the film produced a large number of microfibrils oriented approximately at right angles to the direction of compression and linked together to form a network (Fig. 1,*c*). This network may account for the elasticity which had been found with these films[3]. Further compression to 2 A.$^2$/monomeric unit brought about visible striations on the films. The film structure in this region exhibited an

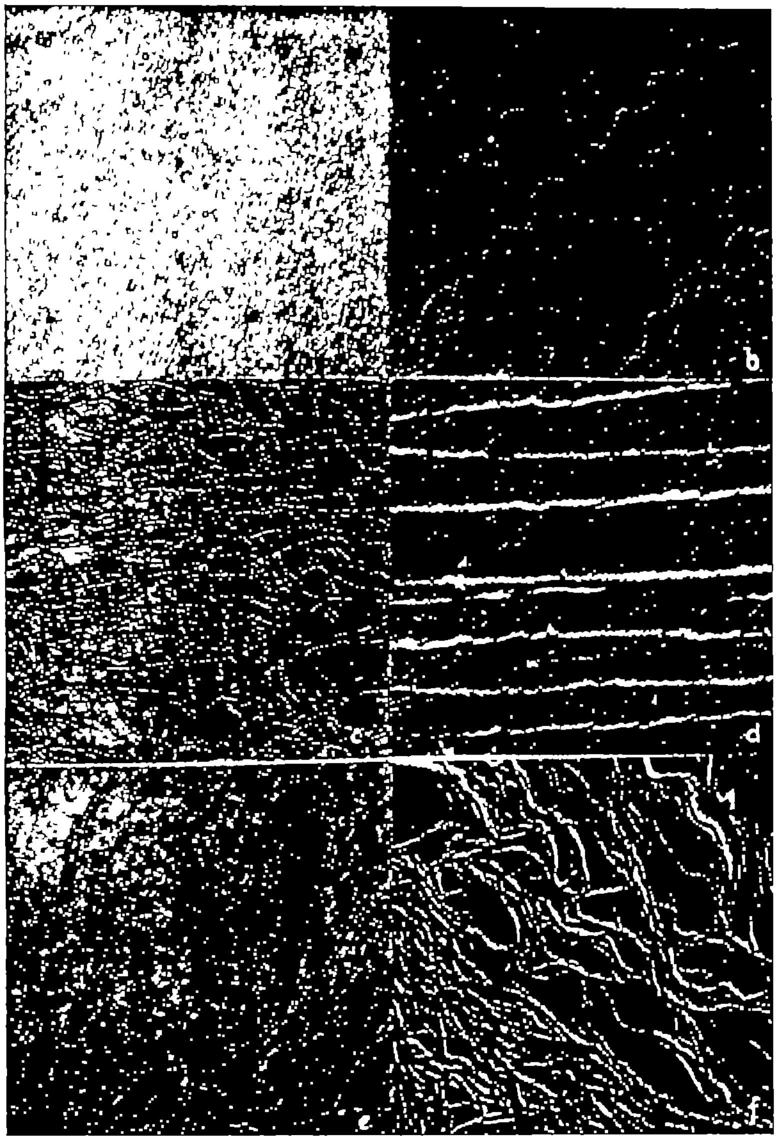

Fig. 1. Electron micrographs of monolayers of 6-nylon

(a) Blank, no film, magnification 13,500; (b) uncompressed films at 80 A.$^2$, magnification 13,500; (c) compressed films at 30 A.$^2$, magnification 13,500; (d) compressed films at 2 A.$^2$ (after collapse), magnification 8,100; (e) uncompressed films at 18 A.$^2$, magnification 10,700; (f) uncompressed films of low molecular fraction at 18 A.$^2$, magnification 10,700.

Arrows indicate the direction of compression

array of parallel microfibrils oriented at right angles to the direction of compression (Fig. 1,*d*).

Uncompressed films initially spread at a small area, for example, 18 A.$^2$/monomeric unit, gave winding microfibrils which had no sign of orientation (Fig. 1,*e*).

From the above results, it is evident that compression of the film gives rise to the formation of a large number of microfibrils which adopt an orientation at right angles to the direction of compression. It is to be noted that the mean size of the microfibrils remained almost unchanged during compression.

The effect of the degree c polymerization on the structur of surface films is also reveale by the electron microscope. I Fig. 1,*f* is shown the structur of uncompressed films of 6-nylo (*D.P.*8) spread at an area c 18 A.$^2$/monomeric unit. Compai ison of Figs. 1,*e* and 1,*f* show that the fraction of low mole cular weight produced thicke microfibrils than the fraction c high molecular weight.

Similar investigations have als been made with other crystallin polymers, for example, cellulos acetate and polyvinyl alcoho Secondary products of cellulos acetate (Celanese No. 3, wood-pul source) were dissolved in aceton and the hazy solution thus obtaine was spread on distilled water. Th uncompressed films, initially sprea at an area of 70 A.$^2$/monomeri unit, contained a large numbe of granules, the mean size of whic was estimated to be about 100 A but no fibrils (Fig. 2,*a*). Thes granules decreased in number cor siderably when the acetone sol tion was spread after centrifugatior so it is possible that they might b partly responsible for the haze i the solution[4]. Another sample c cellulose acetate, produced fror cotton linters (Celanese No. 1 also gave similar granules. Whe these films were compressed to les than 10 A.$^2$/monomeric unit, thi microfibrils appeared with a orientation at right angles to th direction of compression (Fig. 2,*b* Compressed films of polyviny alcohol also gave a similar fibrilla picture.

On the other hand, amorphou polymers, for example, polyviny acetate and polymethylmethacry ate, even when their films were con pressed to a very small area, ex hibited folds only, without an regular fibrillar substructure.

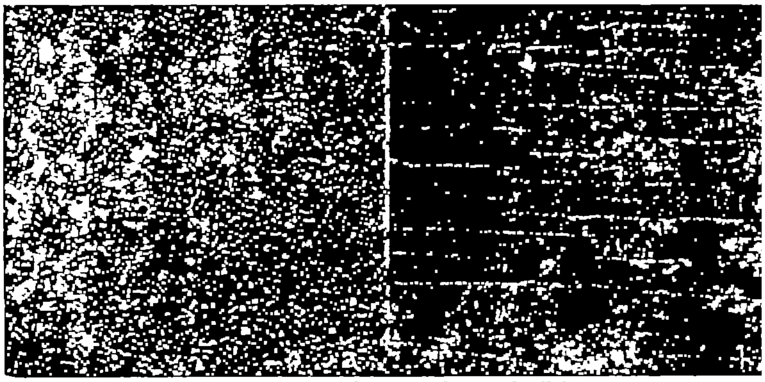

Fig. 2. Electron micrographs of monolayers of cellulose acetate

(a) Uncompressed films at 70 A.$^2$, magnification 13,500; (b) compressed films at 10 A.$^2$, magnification 10,700. Arrow indicates the direction of compression

Full details of this work will be published elsewhere.

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## egative Thixotropy of Aqueous Solutions of Polymethacrylic Acid

SUFFICIENTLY concentrated aqueous solutions of lymethacrylic acid (about 8–15 per cent, depending the degree of polymerization) form clear stiff gels room temperature. At somewhat lower concentra- on, such systems are sols. On heating, these sols n be converted into gels ; on cooling, the gelation completely reversible, the gels reverting to sols hich reach their original consistency after about hour.

A remarkable characteristic of these sols is their action to shear. A several hundred-fold increase consistency is easily induced by stirring or shaking. or example, a 5 per cent solution of polymethacrylic id of degree of polymerization 10,000 shows a 0-fold increase in apparent viscosity (from 5 poise 1,750 poise) after subjection, for about one minute, a rate of shear of 10 sec.$^{-1}$. More concentrated sols –10 per cent) will actually set to firm gels while ing stirred with a glass rod or simply when the ttle in which they are contained is shaken[1]. The ansformations are completely reversible, and the stems reach the original state about an hour after irring has ceased. Increase in the degree of poly- erization and higher temperature enhance the effect. his behaviour represents, to our knowledge, by far e most pronounced instance of 'negative' thixo- opy yet described in the literature[2].

Negative thixotropy is here understood to denote reversible isothermal increase in consistency during echanical treatment. In negatively thixotropic stems, the field of flow displaces the equilibrium the system from its state as a sol, at rest, to a gel ate of higher free-energy content which, on standing, ontaneously reverts to the sol state. Negatively ixotropic behaviour, therefore, is the exact opposite normal thixotropic behaviour, in which the state lower free energy, to which the system reverts ontaneously upon cessation of mechanical agita- on, is the gel state. Negative thixotropy should also distinguished from the well-known phenomenon work hardening, in which shearing only enhances e rate of the spontaneous process of crystallization, d from the phenomenon of dilatancy, described Osborne Reynolds, which is due to a special arrangement of rigid particles in a suspension.

The phenomenon of negative thixotropy is rarely countered. Even among those water-soluble lymers such as polyacrylic acid and polyacrylic d polymethacrylic amide, the structure of which is osely related to that of polymethacrylic acid, we iled to find signs of such behaviour. In fact, ost aqueous polymeric systems, for example, latine[3] and methylcellulose solutions[4], show normal ixotropy.

In our opinion, negative thixotropy in polymethacrylic acid systems is probably due to the fact that, *a priori*, more intermolecular bonds are likely to be formed in a field of flow than in a system at rest. During flow, the collision frequency between groups of different polymer molecules increases, permitting, other things being equal, the formation of a network, and the consequent appearance of gel behaviour. Since in a concentrated polymer solution we expect an equilibrium between intra- and inter-molecular bonding, the effect of the field of flow will be to shift this equilibrium towards a greater amount of cross-linking by intermolecular bonds.

The field of flow, however, acts in two ways. It not only builds up structure, as described above, but it also breaks intermolecular bonds that are insufficiently strong. Indeed, in the usual thixotropic systems, this second effect predominates. Apparently it is only in solutions of polymethacrylic acid, at the rates of shear investigated, that the first effect so largely predominates.

The intermolecular cross-links in polymethacrylic acid solutions seem to be hydrogen bonds between carboxyl groups on neighbouring chains. These bonds are indeed relatively strong, but their strength cannot be the only factor accounting for the negative thixotropy. As noted above, other substances strongly hydrogen-bonded, such as the polyamides and polyacrylic acid, do not form sols with negative thixotropy. Additional factors such as, for example, the relative stiffness of the polymethacrylic acid molecule, which may permit local, crystallite-like accumulations of hydrogen bonds, probably play a decisive part.

Despite their relative strength, the hydrogen bonds are breaking and re-forming at a considerable rate ; when mechanical agitation ceases, the initial state, with a higher degree of intramolecular bonding, is gradually approached. The gel structure thus breaks up and the original sol is re-formed.

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## Photo-elastic Dispersion in Cubic Crystals

CRYSTALS of classes $T_d$, O and $O_h$ are characterized by the strain-optical coefficients $p_{11}$, $p_{12}$ and $p_{44}$, whereas those of the classes $T$ and $T_h$ have an additional coefficient[1] $p_{13}$. Using standard methods described elsewhere[2,3], the $p$ values at three wave-lengths of light for a few cubic crystals have been determined and are given in Table 1. In Table 2 the values obtained by me for some optical glasses are entered.

It is interesting to note that : (1) cubic crystals, in general, show photo-elastic dispersion ; (2) the values of $p_{11}$ and $p_{12}$ in potassium chloride and bromide increase with increasing wave-length, whereas in all other crystals their behaviour is opposite. The dis-

Table 1

| Substance | $p_{11}$ $\lambda_1$ | $p_{11}$ $\lambda_2$ | $p_{11}$ $\lambda_3$ | $p_{12}$ $\lambda_1$ | $p_{12}$ $\lambda_2$ | $p_{12}$ $\lambda_3$ | $p_{13}$ $\lambda_1$ | $p_{13}$ $\lambda_2$ | $p_{13}$ $\lambda_3$ | $p_{44}$ $\lambda_1$ | $p_{44}$ $\lambda_2$ | $p_{44}$ $\lambda$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Potassium bromide | 0·212 | 0·208 | 0·194 | 0·165 | 0·162 | 0·151 | — | — | — | 0·022 | 0·022 | 0 0 |
| Potassium chloride | 0·216 | 0·211 | 0·182 | 0·159 | 0·156 | 0·134 | — | — | — | 0·024 | 0·024 | 0 0 |
| Lithium fluoride | 0·020 | 0·020 | 0·020 | 0·130 | 0·130 | 0·130 | — | — | — | 0·045 | 0·051 | 0 0 |
| Lead nitrate | 0·309 | 0·348 | 0·398 | 0·608 | 0·666 | 0·742 | 0·476 | 0·537 | 0·613 | 0·039 | 0·045 | 0 0 |
| Ammonium alum | 0·378 | 0·403 | 0·418 | 0·465 | 0·496 | 0·514 | 0·454 | 0·479 | 0·497 | 0·009 | 0·009 | 0 0 |
| Potassium alum | 0·250 | 0·259 | 0·268 | 0·330 | 0·342 | 0·345 | 0·321 | 0·332 | 0·342 | 0·005 | 0·006 | 0·0 |

$\lambda_1 = 5893$ A. $\lambda_2 = 5461$ A. $\lambda_3 = 4358$ A.

Table 2

| Glass | $p_{11}$ $\lambda_1$ | $p_{11}$ $\lambda_2$ | $p_{11}$ $\lambda_3$ | $p_{12}$ $\lambda_1$ | $p_{12}$ $\lambda_2$ | $p_{12}$ $\lambda_3$ |
|---|---|---|---|---|---|---|
| I | 0·214 | 0·243 | — | 0·371 | 0·374 | — |
| II | 0·223 | 0·225 | 0·240 | 0·331 | 0·334 | 0·369 |
| III | 0·126 | 0·127 | 0·129 | 0·227 | 0·229 | 0·234 |
| IV | 0·173 | 0·177 | 0·180 | 0·238 | 0·244 | 0·248 |
| V | 0·164 | 0·156 | 0·159 | 0·210 | 0·223 | 0·227 |

$\lambda_1 = 5893$ A. $\lambda_2 = 5461$ A. $\lambda_3 = 4358$ A

persion for these two coefficients in lithium fluoride is negligible[3]. The direction of variation in $p_{44}$ is the same in all crystals. The magnitude of dispersion of this coefficient is usually of the order found in glasses, except in lithium fluoride and lead nitrate, where it is large, being 60 to 80 per cent.

I thank Prof. S. Bhagavantam, under whose direction this work was undertaken.

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## Site of Inhibition of Trypsin by Diethyl *p*-Nitrophenylphosphonate

THE inhibition of proteolytic enzymes by organophosphorus esters has been the subject of intensive study in recent years[1]. Thus, the reaction of trypsin with di*iso*propyl fluorophosphonate[2] or diethyl *p*-nitrophenylphosphonate[3] has been shown to be accompanied by a loss in its esterase and proteolytic activity. Still unanswered, however, is the question whether these inhibitors combine with trypsin at the site responsible for enzymatic activity, or at another site, which, because of its strategic location, may interfere sterically with the enzymatic centre.

We recently reported[4] that trypsin remains enzymatically active in high concentrations of urea. At the same time an increase in the solubility of the enzyme in trichloroacetic acid was noted which suggested that perhaps some profound change in the structural configuration of the molecule may have occurred. In this event, some alteration in the normal spatial relationship of active centres that may be present might likewise be expected. The results reported here indicate that diethyl *p*-nitrophenylphosphonate does in fact react with trypsin treated with urea at a site which can be distinguished from the site responsible for proteolytic activity.

The trypsin used in this study was a twice-crystallized product (Worthington Biochemical Corp., Freehold, N.J.) which was freed of salt by dialysis against 0·001 *N* hydrochloric acid, followed by lyophilization. Diethyl *p*-nitrophenylphosphona was kindly provided by Dr. William Summerson, the Army Medical Center, Md.

The experimental procedure was as follow 1 mgm of trypsin was dissolved in 4 ml. of 0·05 borate buffer, *p*H 7·6, containing 8·3 *M* urea, a immediately treated with 1 ml. of $6 \times 10^{-3}$ *M* dieth *p*-nitrophenylphosphonate in *iso*propanol (one hu dred-fold excess on a molar basis). The mixture w allowed to stand at 25° C. A similar system fro which urea had been omitted contained 0·02 calcium chloride to minimize self-digestion of t enzyme. 1 ml. of *iso*propanol replaced the dieth *p*-nitrophenylphosphonate solution in controls set u to measure losses in activity not attributable diethyl *p*-nitrophenylphosphonate. Enzyme-fr controls were likewise necessary to correct for t spontaneous hydrolysis of the diethyl *p*-nitropheny phosphonate during the course of the reaction. A various intervals of time, the liberation of *p*-nitr phenol, the product of the reaction between tryps and diethyl *p*-nitrophenylphosphonate, was measure by the method of Hartley and Kilby[5]. Proteolyt activity was measured concurrently by the case digestion technique of Kunitz[6]. The results of th experiment are shown in Fig. 1.

In the absence of urea, the rate at which *p*-nitr phenol was liberated closely paralleled the loss proteolytic activity, a finding which is in comple accord with that of Kilby and Youatt[7]. In the pre ence of urea, a similar rate of release of *p*-nitrophen was observed. The maximum amount of *p*-nitr phenol liberated per given amount of trypsin w very nearly the same in the presence or absence urea. Of particular interest, however, is the fact th in the presence of urea the proteolytic activity of t

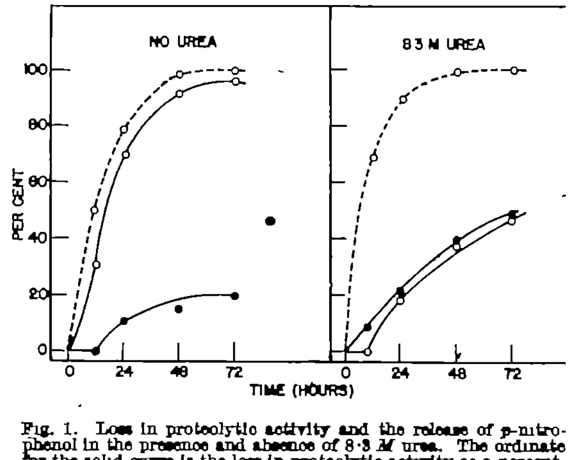

FIG. 1. Loss in proteolytic activity and the release of *p*-nitrophenol in the presence and absence of 8·3 *M* urea. The ordinate for the solid curve is the loss in proteolytic activity as a percentage of its initial value, and the ordinate for the broken curve is *p*-nitrophenol liberated as a percentage of its maximum value. ○, with diethyl *p*-nitrophenylphosphonate; ●, in the absence of diethyl *p*-nitrophenylphosphonate

zyme was essentially unaffected by diethyl p-nitro- enylphosphonate. The loss in activity that did sue may be attributed to the instability of the zyme which was apparent even in the absence of ethyl p-nitrophenylphosphonate (see curves drawn rough the solid circles).

In line with these results, it may be mentioned at inactive diethyl phosphoryl trypsin was prepared allowing trypsin to react with an excess of diethyl nitrophenylphosphonate followed by dialysis and ophilization. The proteolytic activity of this pre- ration could be partially restored (15–20 per cent) treatment with 8·3 *M* urea under certain con- tions.

These observations are in accord with a hypothesis at the site at which diethyl p-nitrophenylphosphon- e reacts with trypsin is not identical with the site hich is involved in the combination of trypsin with e protein substrate. Normally, the configuration the enzyme molecule is such that the site of action with diethyl p-nitrophenylphosphonate is in ose proximity to the enzymatic site, so that chemical odification of the former interferes sterically with e accessibility of the second site for substrate com- nation. The effect of urea, however, may be so to ter the configuration of the trypsin molecule that ese two sites are separated and free to exert their aracteristic activities. Whether the structural odification effected by urea involves an unfolding the molecule or fragmentation into smaller units a problem now under consideration.

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## pectroscopic Observations on Commercial Preparations of Cytochrome c

It is generally agreed that reduced cytochrome *c* ows absorption bands in the visible spectrum at 0 mμ (α-band) and at 520 mμ (β-band); in fact, e presence of these two absorption bands is the incipal means of detecting reduced cytochrome *c* a biological object. Keilin and Hartree[1] have served the absorption bands of cytochrome *c* solved in 50 per cent glycerol and in the vitrified devitrified states at the temperature of liquid air oxygen, a procedure by which the absorption bands n be intensified and sharpened; under these nditions they report that a fine satellite band pears next to the α-band on its short-wave side, d the β-band appears to be a complex of several aks. In connexion with studies on the cytochrome sorption bands of Protozoa[2], we have examined e absorption bands of two commercial preparations cytochrome *c* (beef heart, salt-free, Sigma Chemical .; Boehringer und Söhne, Mannheim) using the liquid-air cooling technique of Keilin and Hartree. A 0·07 per cent (w/v) solution of Sigma cytochrome *c* and a 0·2 per cent (w/v) of Boehringer cytochrome *c* in 70 per cent (v/v) glycerol buffered at pH 7·0 with 1/50 *M* phosphate were either oxidized with potassium ferricyanide (2·5 m*M*) or reduced with sodium sulphoxylate (in excess) and examined in the liquid state (23° C.) and after cooling to − 196° C. in liquid nitrogen in a flattened 'Pyrex' tube (light path approximately 5 mm.). The higher concentration of the Boehringer cytochrome *c* was necessary in order to reach the same degree of absorption (O.D. 0·4) as the Sigma preparation at 550 mμ. 70 per cent glycerol proved to be more satisfactory than the 50 per cent used by Keilin and Hartree for observation of the absorption lines. The observations were made with a Zeiss Mikro-Specktralokular (Abbe) using a carbon arc lamp (Phywe 8150) as the source of light, and placing the cytochrome preparation above the microscope condenser. With the vitrified material the observations were completed within 30 sec. after removal from the liquid nitrogen. The spectroscope scale was standardized against the mercury line at 546 mμ. Both commercial preparations of cytochrome *c* showed exactly the same extinction bands, and the results in Table 1 therefore apply to both.

Table 1

| Bands | Absorption lines in the visible spectrum for commercial cytochrome *c* | | | |
|---|---|---|---|---|
| | Reduced | | Oxidized | |
| | Liquid (23° C.) | Vitreous (−196° C.) | Liquid (23° C.) | Vitreous (−196° C.) |
| | 509 mμ | 500 mμ<br>508 ,,<br>511 ,, | very weak, darkening between 520 and 545 mμ and also between 560 and 565 mμ | very weak, darkening between 525 and 538 mμ and also between 560 and 565 mμ |
| β | 522 mμ<br>528 ,, | 517 mμ<br>519 ,,<br>523 ,,<br>528 ,, | | |
| | 540 mμ | 538 mμ | | |
| α | 545–552 mμ | 544 mμ<br>549 ,, | | |

In the reduced state, even at room temperature, very faint bands appeared at 509, 528 and 540 mμ in addition to the usual intense α- and β-bands. Observed in the Beckman *DU* spectrophotometer, these three weak bands appear as shoulders on the absorption curve. Cooling in liquid nitrogen results in striking changes. In addition to a sharpening and intensification of the bands seen at room temperature, a number of new bands appear. There are now very intense and sharp bands at 544 and 549 mμ, fainter but very sharp bands at 508, 517 and 519 mμ, slightly more faint bands at 523, 528 and 538 mμ, and finally two very faint and sharp bands at 500 and 511 mμ. The α-band has been resolved into two bands (544 and 549 mμ) of nearly equal intensity. Maximum intensification of the bands requires about 20 min. immersion in the liquid nitrogen. For unexplained reasons we did not achieve the intensification of the absorption bands by devitrification described by Keilin and Hartree[1]. The same preparation viewed in the glassy state (− 196° C.) with only a tungsten microscope lamp (9 V., 6 amp.) revealed only the 549, 544, 517–19, 528, 523 and 508–11 mμ bands in order of decreasing intensity. A reduced 0·2 per cent (w/v) Sigma cytochrome *c* solution containing

1/15 *M* phosphate, *p*H 7·0, and observed with the same lamp at 23° C. showed absorption bands at 544–552, 519, 528, 509 and 540 mμ.

We are not in a position to say whether these extra bands belong to cytochrome *c* itself, or to partial degradation products of cytochrome *c* [2], or whether they result from the presence of other cytochromes in the preparation. In any event, to our knowledge, these accessory bands have not been previously reported.

The Sigma cytochrome *c* reduced with hydrogen plus palladium–asbestos according to the method of Smith[4] became autoxidized with a first-order rate constant of $3 \times 10^{-3}$ min.$^{-1}$ (*p*H 7·0, 1/15 phosphate, 22° C., $pO_2$ equal to 0·2 atm., measured as decrease in optical density at 550 mμ).

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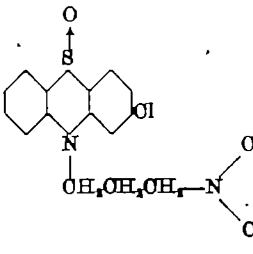
# Identification and Pharmacological Properties of a Major Metabolite of Chlorpromazine

CHLORPROMAZINE is widely used in the treatment of mental illness, but little is known about its metabolic fate. This communication describes the discovery in the urine of dog and man of the sulphoxide derivative and some preliminary studies of its pharmacological properties.

The metabolite was extracted from alkaline urine with ether, separated from chlorpromazine by counter-current distribution, and isolated as the picrate. The empirical formula of the metabolite differed from that of chlorpromazine by one additional oxygen atom. The ultra-violet absorption spectrum of the hydrochloride showed a series of peaks similar to those reported for the sulphoxide of phenothiazine[1]. Identification of the urinary product as the sulphoxide of chlorpromazine:



was established by comparison with the synthetic product. Identity was shown by melting point (207–209° C.) and mixed melting point determination of picrates, and by comparison of ultra-violet and infra-red absorption spectra. Sulphoxide formation is an unusual type of drug bio-transformation, and so far as we know has not been reported; furthermore, the sulphur atom in the metabolite represents a centre of asymmetry[2].

The urinary excretion of chlorpromazine and its metabolite were measured by ultra-violet spectro-

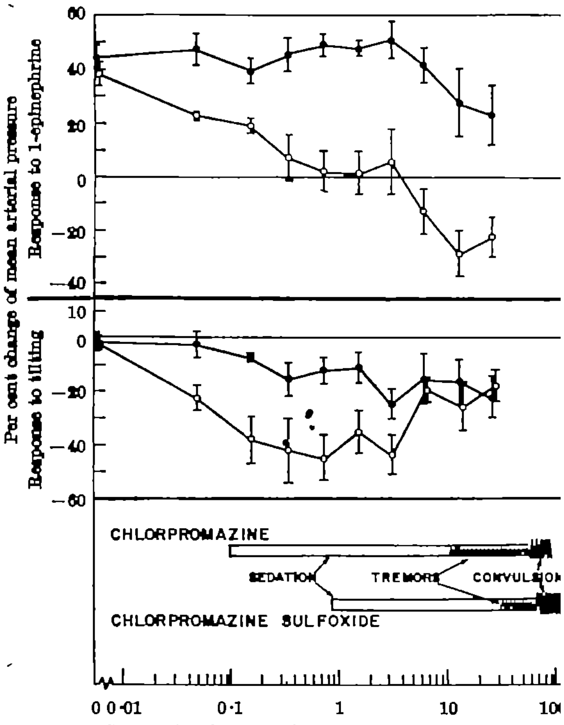


Fig. 1. Effects of chlorpromazine and chlorpromazine sulphoxid on unanaesthetized dogs. Each point represents mean respons of four dogs with standard error of the mean depicted by vertica bars. Open circles, chlorpromazine; closed circles, chlorpromazin sulphoxide

photometry (Salzman, N. P., Greenberg, B., a
Brodie, B. B., unpublished work). Following t
intravenous injection of chlorpromazine (20 mgn
kgm.) into dogs, about 1 per cent was excret
unchanged and about 12 per cent as the sulphoxic
The sulphoxide was also shown to be extensive
metabolized *in vivo*; thus, following administrati
of the metabolite, only about 20 per cent appear
in the urine unchanged. It is probable, therefo
that sulphoxide formation represents a major pat
way of chlorpromazine metabolism. Studies wi
patients receiving chlorpromazine indicated th
significant quantities of sulphoxide, but little or
chlorpromazine, were excreted in urine.

Pharmacological actions of chlorpromazine and
sulphoxide were compared in dogs. The compoun
were given intravenously in geometrically increasi
doses at 15-min. intervals, and vasomotor respons
to adrenalin and to tilting recorded. The compoun
were qualitatively similar, producing sedation, relax
tion of the nictitating membrane, adrenergic bloc
ade, orthostatic hypotension, excitement, tremo
and finally clonic and tonic convulsions. The do
response relationships are illustrated in Fig. 1. T
dose of sulphoxide which produced minimal sedati
was about eight times that of chlorpromazine, b
the sulphoxide caused relatively little adrener
blockade and postural hypotension at sedative dos
Because of the difficulty in evaluating sedati
quantitatively, the values given in Fig. 1 for t
minimal sedative doses are only approximate, wi
no attempt to measure the degree of sedation.

Since chlorpromazine potentiates barbiturates
a central action[3], the effectiveness of the two co
pounds in potentiating hexobarbitone anaesthe

s compared. Dogs were anæsthetized with hexo- -bitone and on awakening were given chlorprom- -ne or the sulphoxide intravenously. Resumption anæsthesia, indicating potentiation, was observed th both compounds, the sulphoxide being about -eighth as active as chlorpromazine. In contrast its activity in dogs, the sulphoxide produced only nimal sedation and potentiation of hexobarbitone mice, rats and rabbits.

Since chlorpromazine sulphoxide induces sedation dogs with relatively little of the orthostatic hypo- sion observed with chlorpromazine, it is planned test the drug in man in the treatment of mental ness.

We wish to thank Dr. Glenn Ullyot, of the Smith, 'ine and French Laboratories, for supplying lorpromazine sulphoxide.

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## Function of Heparin

BOTH heparin[1] and histamine[2] are now known to concentrated in the tissue mast cells, and it might us be expected that the release of histamine caused damage to the mast cells would be accompanied the release of heparin and a consequent increase the clotting time of blood. So far this dual effect s been observed in only one species, the dog, in ich an intravenous injection of peptone or of a emical histamine liberator such as compound /80 can release sufficient heparin to render the ood incoagulable. In the rat, however, although mpound 48/80 releases histamine from the numerous ast cells in the subcutaneous connective tissue, the otting time of the rat's blood remains unchanged. e have therefore attempted to discover what ppens to the heparin in the rat following a maximal lease of histamine by compound 48/80.

Two groups of eight female Wistar rats, of 200– 0 gm., were used. The first received intra- ritoneally over a period of five days progressively creasing doses of compound 48/80 in saline, by ich time 1 mgm. per 100 gm. body-weight could given without eliciting signs of shock. The second oup was given equivalent volumes of saline intra- ritoneally as a control. Whole blood-clotting times re measured repeatedly by the capillary tube ethod, and samples of urine, collected on filter per, were tested for metachromatism with a weak lution of toluidine blue. At the end of five days, e two groups were killed and skinned, and as much bcutaneous connective tissue as possible was raped off. Representative tissue spreads were amined histologically for mast cells, the remaining bcutaneous tissue (about 60 gm.) in each group ing then pooled and assayed for histamine and parin as previously described[3], except that on this occasion we used the thiocyanate method[4] for the initial extraction before finally purifying the heparin by the method of Charles and Scott[5].

Compound 48/80 in the dosage used produced widespread degranulation and disruption of the mast cells in the subcutis of rats, and almost complete loss of its tissue histamine—a drop from 26 to 1·5 μgm./gm. tissue (94 per cent loss). On the other hand, the total heparin content fell only from 10·0 to 4·7 I.U./gm. (53 per cent loss), and even this loss was unaccompanied by any sign of the release of heparin into the circulating blood; the clotting time remained normal and no metachromatic material appeared in the urine. That the heparin extracted from the control series did in fact possess anticoagulant activity was confirmed by its action on normal rat blood *in vivo* and *in vitro*.

Thus the almost complete release of histamine from the subcutis of the rat by compound 48/80 is accompanied by a loss of only half the associated heparin. Some of the metachromatic material from the disrupted mast cells may be disposed of locally by macrophages[6,7], some may adhere to adjacent connective tissue fibrils[8] or cells[9], while some may be bound by the basic histamine-liberator itself[10]. Although these same basic compounds can release active heparin into the blood stream of the dog[11], they fail to do so in the rat; the rabbit and the guinea pig appear to be similar to the rat in this respect[12]. This suggests that the function of heparin may be concerned rather with events in the tissues than with the coagulability of the circulating blood.

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## Inactivation of Phenyl Mercuric Acetate in Groundwood Pulp by a Mercury-resistant Strain of *Penicillium roqueforti* Thom

AN investigation was started in December 1954 into the storage qualities of groundwood pulp impregnated with 25–35 p.p.m. of phenyl mercuric acetate, compared with unimpregnated pulp made at the same time. One object of this work was to follow the course of infection of the pulps by blueing and wood-rotting fungi (Basidiomycetes), the latter frequently being responsible for the condition known as 'red-rot', and also to try to discover why phenyl mercuric acetate, although toxic to many Basidiomycetes at low concentrations, frequently fails to protect groundwood pulp from attack by 'red-rot' after a few months storage. Some significant conclusions have now been reached.

Phenyl mercuric acetate is highly toxic to many fungi at 2–10 p.p.m. mercury, but it has been known[1,2] for some years that a strain of *Penicillium roqueforti* Thom can tolerate very much higher concentrations. This mould commonly stains mercury-treated pulp quite badly, but it is not cellulolytic. It is mainly infection by Basidiomycetes that causes pulp to deteriorate.

We have shown experimentally that *P. roqueforti* isolated from pulp impregnated with phenyl mercuric acetate can absorb mercury into its mycelium. The mould was grown on liquid media containing 20 p.p.m. of phenyl mercuric acetate. After a month, the mycelium was filtered off, washed and analysed for mercury. About 75 per cent of the weight of mercury found on analysis was present in the fungal pellicle. This suggested that the mould might be able to prevent this fungicide from behaving as a thiol reactor towards more harmful fungi known to be very susceptible to phenyl mercuric acetate *in vitro*.

Monthly examination of bales of both untreated and mercury-treated pulp (manufactured in December 1954) showed that *P. roqueforti* stains first appeared in the treated pulp about eight weeks after manufacture. We have very seldom isolated this mould from untreated pulp. The stains gradually spread farther into the bales month by month; but, unlike the unprotected bales, no evidence of 'red-rot' attack was then apparent. Five months after manufacture, the untreated bales were badly rotted, and the treated bales were extensively stained by *P. roqueforti*. One impregnated bale examined contained a few consecutive sheets having, in addition to the *Penicillium* stains, a small brown stain at one edge, typical of a Basidiomycete. Attempts to isolate the causal fungus failed at this stage.

A suitable bio-assay technique had meanwhile been found for determining the amount of biologically active mercury present in groundwood pulp. Chemical analysis showed that the normal concentration of 25–35 p.p.m. of mercury was present in the pulp sheets; but bio-assay tests showed that the concentration of biologically active mercury fell from 12–13 p.p.m. mercury in the unstained central areas, to 3·4 p.p.m. one inch beyond the border of the *P. roqueforti* stains, and was zero in the stains themselves. The difference in concentration of bio-active mercury compared with total added mercury in the uninfected areas of the sheet is presumably due mainly to partial inactivation by some natural constituents of the pulp. In no case has any biologically active mercury been found in *P. roqueforti*-stained regions of impregnated groundwood pulp containing 25–35 p.p.m. mercury.

Six months from the date of manufacture, the outer regions of the treated bales were quite badly infected by 'red-rot', and *Stereum sanguinolentum* was isolated on a specially developed selective medium which is designed to inhibit fast-growing contaminating moulds, such as *Trichoderma viride*, without affecting the growth of Basidiomycetes.

After seven months, 'red-rot' due to *Stereum sanguinolentum* was well established, and no bio-active mercury was detectable anywhere in the infected sheets. The normal content of mercury w found by chemical analysis.

The evidence obtained shows that: (*a*) the str of *P. roqueforti* Thom normally present in mercu treated pulp is able to absorb a relatively la amount of mercury from nutrient media containi phenyl mercuric acetate; (*b*) progressive infecti of groundwood pulp by this mould reduces c currently the concentration of biologically acti mercury to nil in the stained areas, without affecti the concentration of mercury determinable by che ical analysis; and (*c*) the loss of biologically acti mercury in the pulp studied was followed by seconda infection by *Stereum sanguinolentum*, which cause typical 'red-rot'. It is therefore suggested that *roqueforti* Thom is able to render phenyl mercu acetate inactive as a fungicide, and hence reduce value as a pulp preservative against seconda infection by wood-rotting fungi.

It follows that more efficient protection agai rot should be conferred by using either a no mercurial toxicant, or a mixed toxicant containi a non-mercurial, to which *P. roqueforti* is susceptil at concentrations lethal to Basidiomycetes. Succe ful treatment on these lines has already been reporte

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## Use of the Glees Silver Technique in th Hypothalamus

ONE of the most important advances in technic procedures for determining the course and distrib tion of fibre tracts in the central nervous system the method based on the recognition of termin degeneration by silver impregnation. As the autho of these methods have emphasized, however, th need to be used with care and discrimination in ord to avoid possible fallacies of interpretation. We ha recently observed that in certain (but not all) of t cell groups of the hypothalamus and preoptic regi in a number of normal brains (human and macaq monkey) stained by the Glees technique, the appe ance of apparently typical terminal degeneration present. This is particularly the case with the dor medial and ventromedial hypothalamic nuclei. T reason why these nuclei should show this appe ance of 'degeneration' is not clear; but it may related to the peculiar metabolic activities which a known to modify the appearance of axons in so of the hypothalamic nuclei. This observation is importance since it is probable that some investigat have, in the past, mistaken this appearance seen sections of normal brains for true terminal degene tion, and on this basis have described fibre co nexions with widely different parts of the brain.

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## Blocking of Lead Tetraacetate–Schiff actions in Tissue Sections by Boric Acid

CURRENT histochemical techniques for carbohydrates depend on the fact that many of these subnces possess groupings capable of being oxidized yield aldehyde residues, which can then be made ible with Schiff's reagent. Glegg, Clermont and blond[1] showed that when lead tetraacetate (in cial acetic acid) replaced periodic acid as the oxiant, the histological distribution of the reaction th Schiff's reagent was similar although the ensity at some sites differed. If this difference in intensity of the Schiff reactions were due to ferential oxidation of *cis* α-glycol groupings by d tetraacetate[2], then boric acid, which readily mplexes with *cis*-hydroxyl groups (for example, in rbohydrates)[3], might be expected to block the idation of such groups and thus modify the bsequent Schiff reaction.

Sections of mouse tissues were treated with a er cent w/v solution of lead tetraacetate (L. Light and Co.) in glacial acetic acid containing 0·1–0·001 *M* boric acid. Controls were processed without boric acid. The presence of boric acid reduced or completely prevented the subsequent reaction with Schiff's reagent only in certain structures, for example, mucus-secreting cells (Figs. 1 and 2). This effect was better demonstrated with ethanolic Schiff's reagent[4]. If sections were successively treated with boric acid in glacial acetic acid and lead tetraacetate, the Schiff reaction was not blocked, nor was the effect of a solution containing both reagents enhanced.

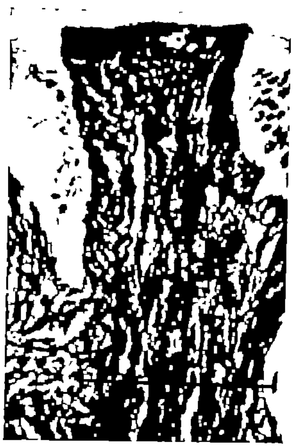
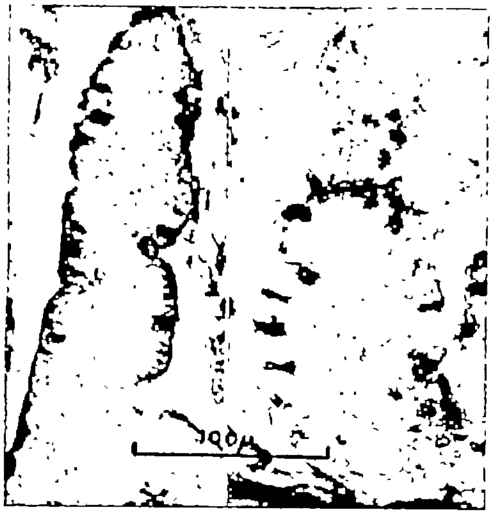


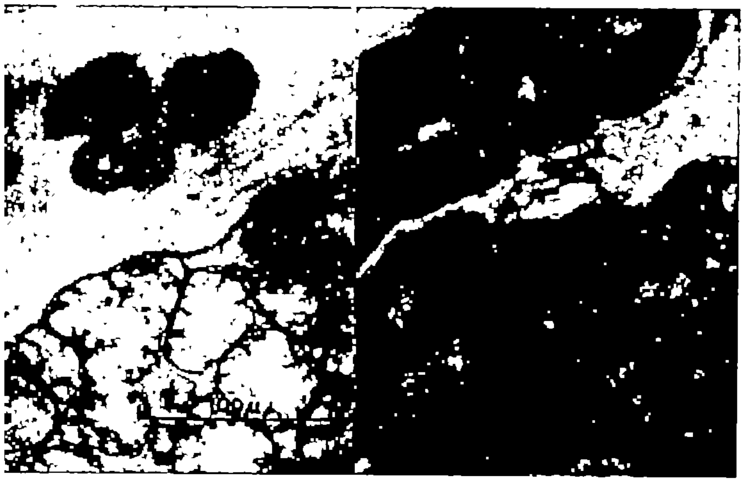
Fig. 3. Gingiva from a patient with phenytoin sodium gingival hyperplasia, stained by Gomori's method, showing collagenous and reticular fibres in the lamina propria between two epithelial ridges



(a) (b)

'ig. 1. Goblet cells of small intestine, in ethanolic Schiff's eagent after 4 hr. at 23° C. 1 per cent lead tetraacetate; (a) containing 0·01 *M* boric acid, (b) without boric acid

'Model' experiments with galactogen[5] and glycogen (Kahlbaum) incorporated in gelatin films have shown that, histochemically as well as chemically[2], lead tetraacetate oxidizes adjacent *cis*-hydroxyl groups more rapidly than adjacent *trans*-hydroxyl groups: and that boric acid modifies the subsequent Schiff reaction, probably by forming oxidation-resistant complexes with adjacent *cis*-hydroxyl groups of carbohydrates. Since these groups are present in several animal glycoproteins[6], these results may also apply to the tissue sections.



(a) (b)

Fig. 2. Mucous glands of larynx, in ethanolic Schiff's reagent, as in Fig. 1

Sections of a gingival biopsy from a case of phenytoin sodium gingival hyperplasia (Fig. 3), in which there is increased production of collagen[7], were placed in a 0·8 per cent w/v solution of pectinase (L. Light and Co.), *p*H 4·2, for 21½ hr. at room temperature; after washing, they were treated first with lead tetraacetate solution and then with aqueous Schiff's reagent. The action of the pectinase was similar to that reported for dermis[8]; but it was found that with boric acid present in the lead tetraacetate solution, little or no staining took place. This suggests that 'pectinase' releases the α *cis*-hydroxyl structure from collagenous and reticular fibres, presumably from carbohydrate components[8,9], and also illustrates a possible application of the boric acid blocking technique in studies on enzymes of unknown specificity acting on complex substrates.

Further work is in progress, and will be reported elsewhere. I wish to thank Dr. D. J. Bell for a specimen of galactogen, and Dr. L. N. Owen for advice and encouragement.

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## Role of Glutamine in Urea Synthesis

In 1939, it was suggested by one of us[1] that the amide-nitrogen of glutamine was a source of urea-nitrogen and that urea formation was paralleled by a continuous re-synthesis of glutamine. Evidence has now been obtained for a reaction between bicarbonate (as the source of urea-carbon) and the two nitrogenous groups of glutamine. This appears to represent the first of the sequence of reactions leading to urea synthesis. The evidence for this step is based on the observation that when liver slices are incubated with glutamine in absence of added bicarbonate, not only was urea synthesis practically suppressed but also neither the glutamine-amide-nitrogen nor the amino-nitrogen of glutamine was utilized to any extent. On the other hand, in the presence of bicarbonate a considerable synthesis of urea occurred with the simultaneous utilization of amide-nitrogen and of amino-nitrogen (Table 1). The small quantities of ammonia derived from glutamine and formed during the incubation were unaffected by bicarbonate and therefore appear to be unrelated to urea synthesis. That glutamine rather than ammonia or ammonium glutamate acted as a direct source of urea-nitrogen was demonstrated in several ways: first, by the fact that the rate of urea synthesis from glutamine was directly proportional to the substrate concentration, whereas this was not so when ammonia served as a substrate (Fig. 1). A slight inhibitory effect of ammonia was observed at the highest concentrations tested. Secondly, inhibition of glutaminase by sulphophthaleins had no effect on the synthesis, whereas activation of glutaminase with pyruvate almost completely inhibited urea formation. Finally, evidence was obtained by paper chromatography for a considerable formation of glutamine from ammonium salts in liver slices. These observations provide evidence for the role of glutamine, as distinct from ammonium glutamate, in urea synthesis and suggest that urea formation from ammor may depend upon a transitory formation glutamine.

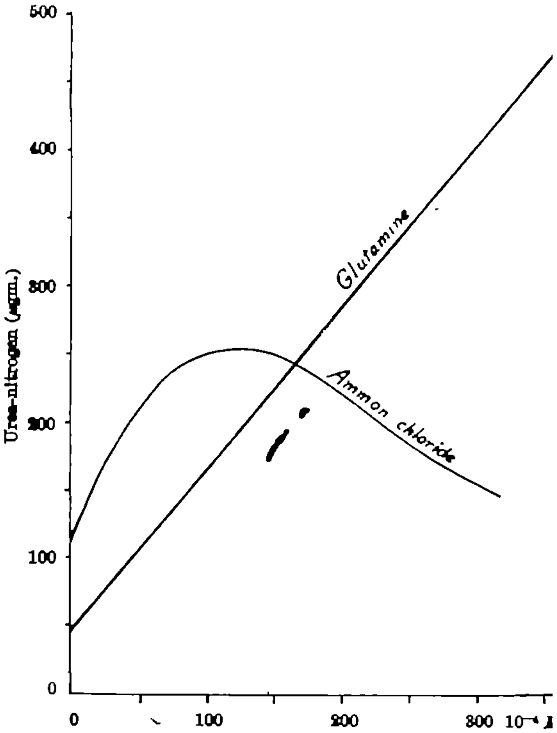


Fig. 1. Urea synthesis from glutamine and ammonium chlorid in rat liver slices; incubation time 90 min. at 37°; 200 mgm slices in bicarbonate Ringer. The positions of the lines on th graph were calculated from the results of approximately 20 experiments

Attempts to replace glutamine in urea synthe by other amides such as asparagine, glycineamide oxamide were unsuccessful. However, prelimina experiments with *iso*glutamine (II) showed a gre superiority of this compound over glutamine, phenomenon which may be significant for the int pretation of the synthesizing mechanism discuss below.

Table 1. Effect of Bicarbonate on the Utilization of Glutam Nitrogen for Urea Synthesis

200 mgm. liver slices incubated with glutamine (0·02 *M*) in 4 Ringer solution buffered at pH 7·4

| | Utilization of glutamine | | Formation of | |
|---|---|---|---|---|
| | Amide-nitrogen (μgm.) | Amino-nitrogen (μgm.) | Ammonia-nitrogen (μgm.) | Urea-nitroge (μgm |
| With bicarbonate | 170 | 145 | 37 | 287 |
| Without bicarbonate | 66 | 25 | 36 | 34 |

Table 2. Contribution of Glutamine-Nitrogen to Ur Nitrogen

Figures represent averages of eight experiments: conditions as Table 1

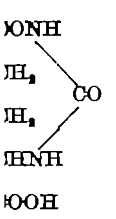
| Contribution from: | | | Formatio of urea-nitrogen |
|---|---|---|---|
| Amide-nitrogen | Amino-nitrogen | Total glutamine-nitrogen* | |
| 166 μgm. | 156 μgm. | 281 μgm. | 264 μgm. |

* Corrected for small quantities of ammonia-nitrogen libera during incubation

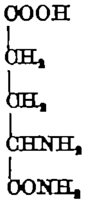
In a further series of experiments, the urea formed ɔm glutamine and bicarbonate in liver slices, was timated side by side with the disappearance of cide-nitrogen and amino-nitrogen. These balance periments (Table 2) showed that the contribution amide-nitrogen to urea-nitrogen approximately [ualled that of the amino-nitrogen. They further vealed that the sum of the contributions of amide- trogen and amino-nitrogen, corrected for the small antities of free ammonia formed during the incuba- on, was of the same order as the total urea-nitrogen nthesized. It is therefore concluded that the follow- g equation represents the overall synthesizing echanism :

glutamine-amide-nitrogen + 1 glutamine-amino-nitrogen = 2 urea-nitrogens

Experiments with sodium bicarbonate($^{14}C$) and ith other monocarbon compounds confirmed the iginal view of Krebs and Henseleit[2] that bicarbonate the principal, if not the only source of carbon for ea. Thus, as described above, it is bicarbonate or derivative which reacts initially with the nitrogenous oups of glutamine. Whether this reaction is directly ıked with the ornithine cycle of Krebs and Henseleit[2] as not investigated in this work.



(I)



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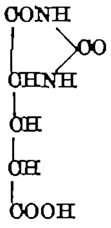

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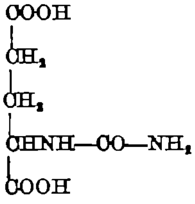
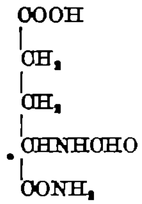
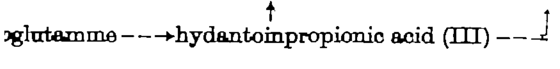


(IV)



(V)

As a result of the initial reaction, the formation a ureido-compound of type (I) could be envisaged. owever, in view of the strong effect of *iso*glutamine ı urea synthesis, it is also possible that *iso*glutamine ther than glutamine may act as the principal source nitrogen. In this case the subsequent formation hydantoinpropionic acid (III) could be postulated. hydrolytic split of the amide-nitrogen linkage or ı oxidative split of the amino-nitrogen linkage the compounds (I) and (III) would lead to the rmation of carbamyl derivatives. If the hydrolytic ılit occurred first, N-carbamylglutamic acid (IV) ould arise from either compound, an intermediary hich has been reported to act as a catalyst in urea nthesis[3].



The transitory formation of hydantoinpropionic acid (III) from *iso*glutamine (II) in urea synthesis is particularly worthy of consideration, since it has been claimed that these two compounds as well as the closely related formyl*iso*glutamine (V) occur as intermediates during the degradation of histidine[4], which is one of the strongest urea-synthesizing amino-acids[5].

A detailed account of this work will appear elsewhere.

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[1] Bach, S. J., *Biochem. J.*, 33, 1833 (1939).

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## Hæmagglutinins of *Glycine soja*

The hæmagglutinins of *Glycine soja* (synonyms: *Glycine max*, *Soja hispida*, *Dolichos soja*, *Soja angustifolia*), stated to be inactive against human erythrocytes but active against certain animal cells, particularly those of the rabbit[1], have been found to agglutinate human red blood corpuscles non-specifically in the cold[2].

I observed[3] that when extracts of the seeds of *Glycine soja* (var. Bansei) were absorbed in the cold with human erythrocytes of group *O*, until they were no longer agglutinated, the extract could still agglutinate *A* and *B* cells, not only in the cold, but also at 37° C. Subsequent absorption with corpuscles of group *A* left residual activity for those of group *B*. The anti-*O* component of these extracts appeared to suppress the activity of the anti-*A* and anti-*B* components.

Further studies of *Glycine soja* extracts have now been conducted which have shown that the extracts contain incomplete agglutinins for human red blood corpuscles, since albumin suspensions of human erythrocytes and papainized human red cells are agglutinated non-specifically at laboratory temperatures and at 37° C.

*Glycine soja* therefore appears to contain: (i) agglutinins acting powerfully, even at 37° C., on rabbit erythrocytes suspended in saline; (ii) non-specific cold agglutinins for human erythrocytes suspended in saline; (iii) incomplete agglutinins for human erythrocytes, acting both in the cold as well as at higher temperatures.

Absorption and elution experiments, to be described elsewhere, have shown that the same agglutinins are responsible for the diverse serological reactions indicated above.

It appears that the thermal amplitude of *Glycine soja* agglutination is not entirely a property of the agglutinins, because the same agglutinins have widely differing thermal amplitudes for human and rabbit erythrocytes. It appears that cell receptors play a part in determining the thermal amplitude of *Glycine soja* agglutination.

It is conceivable that a mixture of complete cold agglutinins and incomplete warm agglutinins can give rise to the suppression phenomenon[3]. However, as the cold agglutinins and the incomplete agglutinins appear to be identical, the mystery of the separability of component agglutinins for *O*, *A* and *B* erythrocytes and the increased thermal amplitude after absorption with red corpuscles of group *O* remains to be solved.

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## Production of Diphtheria Toxin in Submerged Culture

WE have shown[1] that diphtheria toxin with a value of 150–200 flocculating units per ml. can be obtained by growing the Park–Williams No. 8 strain of *C. diphtheriae* as a submerged culture, using a tryptic digest medium based on that described elsewhere[2]. The volumes employed were 10–14 litres of medium, and the vessels were of glass, with stirrers made of either 'Birmabright' (a magnesium–aluminium alloy) or aluminium.

In recent developments of this technique, we have used 80-litre tanks, made from commercial aluminium, which offer many advantages over glass vessels for routine toxin production. They permit of a much better control of temperature during the growth of *C. diphtheriae* and are more suitable for sterilization of the culture medium. Vortex stirring[3] has been used, and sterile air at a rate of 0·05–0·15 litre per min. per litre of culture medium has been found satisfactory.

The time required for maximal toxin production has been found to be very dependent on the size of the initial inoculum employed. For routine toxin production a growth period of the order of 48 hr. is very convenient, and for this an initial inoculum of 200 ml. of a 48-hr. shaken culture of *C. diphtheriae* for a volume of 50–60 litres of medium has been found satisfactory. If a much larger inoculum is used, for example, 10 litres of 24-hr. culture produced in a small seed-tank, peak toxin production is obtained in about 28 hr.

As an alternative method, we have withdrawn approximately half the culture when the peak toxin value has been reached and replaced it with an equal volume of fresh sterile medium. After this replacement, the toxin production is a maximum in 24 hr., and this procedure may be repeated many times, thus giving in effect a semi-continuous daily toxin production of 30 litres per tank. Unfortunately, the initial purity of the toxin, which is of the order of 1,500 Lf. units per mgm. protein nitrogen, is not maintained, and for this reason we prefer to harvest single batches of toxin rather than to run a semi-continuous process. An example of a result obtained in this way is shown in Table 1.

With the equipment and methods now in use, we have been able to produce large volumes of culture filtrates from *C. diphtheriae* having an Lf. value of the order of 180–250 units per ml. The advantages of submerged culture methods over the older surface-culture technique are very obvious. Toxin production in shallow layers of culture medium necessitates the manipulation and inoculation of hundreds of bottles —a laborious process where comparatively lar amounts of culture filtrate are required. By th submerged culture method, however, large volum of medium can be handled with ease and it is possibl for example, to take uniform samples at frequen intervals (for example, 2-hourly) throughout th growth period so that determinations of total growt toxin production, and metabolic changes may b studied. Observations on these points and oth factors which influence toxin production will b reported later.

Table 1. SUBMERGED CULTURE NO. 187
Aluminium tank with vortex stirrer, capacity 80 litres. Cult medium. 50 litres of tryptic digest medium. Inoculum: 10 lit of a 24-hr. growth of *C. diphtheriae* prepared in a small submerg culture tank. Air flow: 6 litres per min. across the surface. Te perature: 35° C

| Growth time (hr.) | *p*H | Lf (U./ml.) | Protein nitrogen (mgm./ml.) | Purity (Lf./mgm. pro tein nitrogen) |
|---|---|---|---|---|
| 0* | 7·85 | 15 | | |
| 2 | 7·65 | 17 | | |
| 4 | 7·72 | 22 | | |
| 6 | 7·80 | 34 | | |
| 8 | 7·82 | 51 | | |
| 10 | 7·87 | 69 | | |
| 12 | 8·05 | 85 | | |
| 23 | 8·30 | 206 | 0·138 | 1,490 |
| 25 | — | 212 | | |
| 28† | 8·40 | 235 | 0·154 | 1,510 |
| 29 | 7·98 | 117 | | |
| 30 | 7·88 | 114 | | |
| 32 | 8·06 | 133 | | |
| 34 | 8·10 | 155 | | |
| 36 | 8·18 | 164 | 0·126 | 1,320 |
| 47 | 8·32 | 252 | | |
| 49 | 8·49 | 259 | 0·195 | 1,330 |

* Initial values after inoculation

† At 28 hr., 35 litres of culture were removed and replaced 30 litres of sterile culture medium.

Previously[1], we stated that vessels made fro commercial aluminium showed signs of attack o continued use, accompanied by a decrease in tox production. The vessels now in use (of modifie design) have not shown this attack, and there ha been no decrease in toxin production on continue usage. Possibly a difference in composition of th aluminium used for the first experimental tan accounted for this finding.

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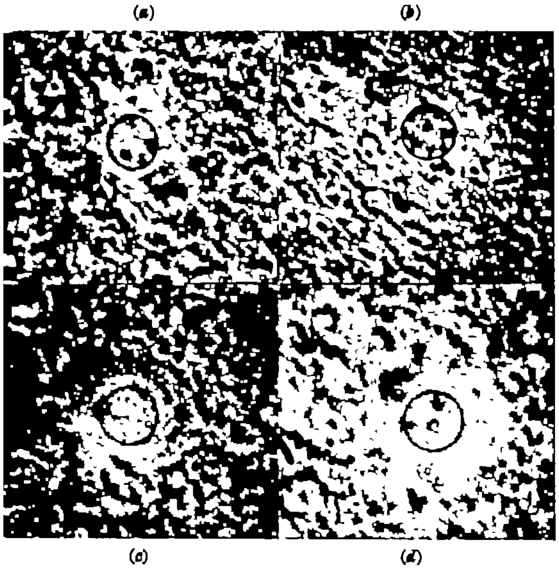
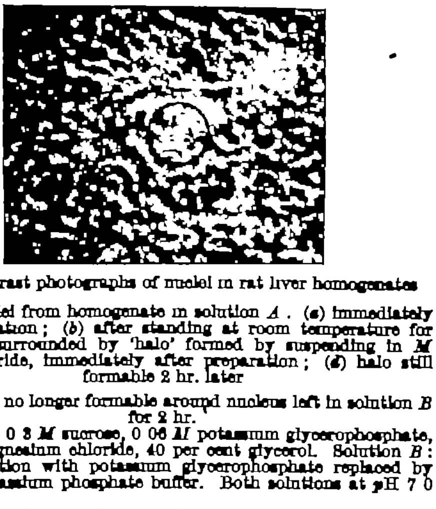
## Preservation of Rat Liver Nuclei by Potassium Glycerophosphate

Appelmans and de Duve[1] found that the 'osmoti activation' or lysis undergone by rat liver mitc chondria in hypotonic media could be prevented b the presence in the medium of 0·25 *M* sucrose; th sucrose could be partly replaced by an iso-osmola quantity of β-glycerophosphate. They showed tha mitochondria released certain enzymes as a resul of osmotic activation. If deoxyribonuclease, whic





Phase-contrast photographs of nuclei in rat liver homogenates

Fig. 1. Nuclei from homogenate in solution *A*. (*a*) Immediately after preparation; (*b*) after standing at room temperature for 2 hr.; (*c*) surrounded by 'halo' formed by suspending in *M* sodium chloride, immediately after preparation; (*d*) halo still formable 2 hr. later

Fig. 2. Halo no longer formable around nucleus left in solution *B* for 2 hr.

Solution *A*: 0·3 *M* sucrose, 0·06 *M* potassium glycerophosphate, 0·001 *M* magnesium chloride, 40 per cent glycerol. Solution *B*: Control solution with potassium glycerophosphate replaced by 0·005 *M* potassium phosphate buffer. Both solutions at *p*H 7·0

chneider and Hogeboom[2] have shown to be largely ssociated in liver with mitochondria, is also released y osmotic activation, this might explain the effectiveess of sucrose in media for the isolation and preservaion of nuclei. Anderson[3] has shown that sucrose revents 'bleb' or bubble formation on the nuclear urface, and that bleb formation occurs on nuclei reated with deoxyribonuclease.

We have tested the effectiveness of potassium -glycerophosphate as a complete or partial subtitute for 0·3 *M* sucrose in preserving nuclei in the resence of mitochondria. The criteria used were: a) preservation of the original degree of contrast f the nuclei under the phase-contrast microscope, nd (*b*) formation of 'haloes' (Fig. 1,*c*) around the uclei when suspended in *M* sodium chloride, inicating that deoxyribonucleic acid was still present n a form that is extractable and sufficiently iscous to push the mitochondria away from the ucleus. The other components of the medium were 0 per cent glycerol, 0·001 *M* magnesium chloride, nd 0·005 *M* potassium phosphate buffer *p*H 7·0, here there was no glycerophosphate present for H buffering. Under these conditions, 0·16 *M* otassium glycerophosphate was more effective than ·3 *M* sucrose for preserving nuclei; but it caused them to clump, probably through partial dissociation of nucleohistone. 0·12 *M* and 0·09 *M* were also more effective than sucrose, the higher concentration being better than the lower; their effectiveness was independent of whether sucrose was also present. 0·06 *M* glycerophosphate was effective only if 0·2 *M* sucrose or more was also present, so at this level the effects seem to be additive.

The best combination (solution *A*) appeared to be 0·3 *M* sucrose + 0·06 *M* potassium glycerophosphate, plus the other components mentioned above (Figs. 1,*a* and *b*). When this mixture was used, viscous deoxyribonuclease was still extractable after leaving nuclei in the presence of mitochondria at room temperature for periods up to 24 hr. (Figs. 1,*c* and *d*). Fig. 2 shows that this was not the case when glycerophosphate was replaced by 0·005 *M* potassium phosphate buffer (solution *B*). It is not clear why potassium glycerophosphate should be more effective than sucrose; but the results fit in with de Duve's findings, and suggest that the protective action of both substances on nuclei may be due to their prevention of the liberation of deoxyribonuclease from mitochondria. With all mixtures used, the fewer mitochondria there were present, the longer the nuclei were preserved.

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# Inability of Varied-Carpet Beetle Larvæ (*Anthrenus verbasci* L.) to digest Chitin

A few animals are known to possess in their digestive juices a chitinase enabling them to digest chitin. The occurrence of a chitinase in the gut of the snail (*Helix pomatia* L.) was demonstrated long ago[1]. A similar enzyme is present in the intestinal tract of different earthworms[2], eelworms[3], snails and slugs[4], and in the terrestrial isopod *Porcellio scaber* Latr.[5]. Among the snails, and probably also other terrestrial pulmonate gastropods, the intestinal chitinase is not produced by the glands of the animal, but appears to be of microbial origin[4].

It is often thought by entomologists that pests of collection specimens digest chitin and live on a diet containing a high percentage of chitin. However, it has never been demonstrated that this chitin is actually utilized. The following investigations were carried out using varied-carpet beetle larvæ (*Anthrenus verbasci* L.) (Coleoptera, Dermestidae), in order to check their view.

(1) *Absence of chitinase in glycerol extracts of digestive tracts.* Larvæ of *A. verbasci* were reared on dried insects. Fully grown larvæ (about 5 mm. long) were cleaned and carefully dissected under a binocular microscope. Sixty-four isolated digestive tracts were ground in a small mortar with 5 ml. of 5 per cent glycerol and clean sand, at 0° C. After centrifugation, the chitinolytic activity of the clear supernatant fluid was tested, using both nephelometric and chemical methods previously described[4].

After 22 and 72 hr. of incubation, at $pH$ 6·5 and 36° C., under aseptic conditions, no chitinolytic activity could be detected.

(2) *Absence of chitinolytic bacteria in the digestive tract.* Four larvæ, grown on dried insects, were cleaned and aseptically dissected in a sterile chamber. The digestive tracts were ground in a sterile mortar and suspended in 2 ml. sterile distilled water. 1 mgm. of excreta of larvæ was similarly suspended in 2 ml. distilled water.

The suspensions were then added to a sterile agar–agar medium containing finely powdered chitin, and plated in Petri dishes[6]. After ten days, no chitinolytic bacteria could be detected: no typical clarification of the medium, such as that usually observed with all chitinolytic bacteria of different sources[4,6], was noticed. Digestive tracts and also excreta are particularly poor in micro-organisms, and seem to be entirely devoid of chitinolytic bacteria.

(3) *Chitin balance in the diet of larvæ reared in controlled conditions.* When reared on a diet consisting of dried insects (adults of *Musca* sp., *Palomena prasina* and *Doryphora decemlineata*), larvæ of *A. verbasci* are able to utilize a maximum of 30 per cent (in dry weight) of the available diet. Two sets of experiments were carried out with larvæ reared for three months on a diet of a known content of chitin, at 28° C. and 50 per cent relative humidity. One control experiment consisted of exposing the same food in the same incubator without larvæ.

In one experiment, chitin was estimated by purification of the material, using the method of Black and Schwartz[7], the residue being weighed as pure chitin. The loss of chitin in the food seemed rather important (28 per cent with dried *Musca* and *Palomena* as diet, 8·5 per cent with *Doryphora*). But this method was found afterwards to be quite unsatisfactory in this particular case owing to the fact that purification is not completed (some proteins remain unhydrolysed) and the excreta, being of a very finely powdered material, are not easily retained during manipulations.

In a second experiment, chitin was estimated by purification of the material with 6 per cent potassium hydroxide at 100° C. for 2 hr.; $N$ hydrochloric acid at 20° C. for 2 hr.; again 6 per cent potassium hydroxide at 100° C. for 2 hr.; 1 : 1,000 potassium permanganate at 60° C. for 20 min.; sodium metabisulphite; hot water, alcohol, ether. These different chemical treatments and the washings were performed in centrifuge tubes, the residue being centrifuged after each treatment for a long time, to prevent any loss of small particles. Estimation of chitin in the final residue was by nitrogen determination (Kjeldahl method).

In these conditions, the loss of powdered material was considerably reduced. The difference in chitin-nitrogen between controls and a diet consisting of dried *Palomena prasina* on which fifty larvæ were reared for three months reached 4 per cent only, this value being within the normal limits of error of the method. Thus chitin is not digested and can be nearly completely recovered in a controlled diet, although the cuticles of the dried insects are partially destroyed and reduced to powder by the larvæ.

Hence we conclude that, using an adequate method for the estimation of chitin balance in dried insects eaten by *Anthrenus verbasci* larvæ, no significant loss of chitin could be observed. The digestive tracts of these larvæ are devoid of chitinase and of chitinolytic micro-organisms. Such larvæ are unable to digest chitin, although there is a high content of chitin their usual diet.

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## Supra-Sternal Ossicles in Primates other than Man

DR. G. T. ASHLEY's communication[1] prompts me record a further example of supra-sternal ossicles primates, this time in *Perodictious potto*. The spe men, which was the prepared skeleton of a you animal, showed a supra-sternal ossicle on the rig side only, contributing to the articular surfa for the clavicle (Fig. 1). The ossicle on the left si was presumably lost during preparation. From comparison with the adult sternum, it would appe that in *Perodictious* the supra-sternal ossicles a responsible for the prominent antero-lateral angl of the manubrium sterni and thus for the dee supra-sternal notch. It is possible that they are regular feature in the development of the sternu in this animal. It must not be forgotten, howeve that the supra-sternal notch in man is considerabl shallower in the newborn than in the adult, thoug supra-sternal ossicles do not seem to be a consta feature here.

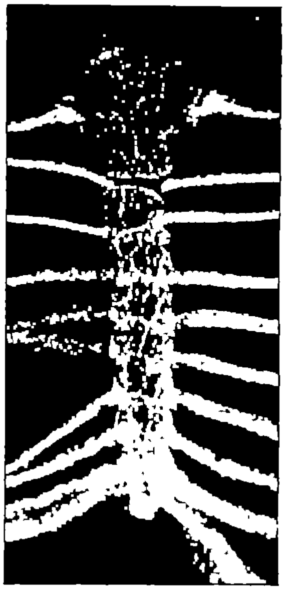

Fig. 1. Radiograph of the sternum of an immature *Perodictious potto* showing the presence of a supra-sternal ossicle on the right side

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London, S.E.1. Sept. 27.

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[1] *Nature*, 176, 608 (1955).

# FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

## Monday, December 12

British Society for the History of Science, Philosophy of ience Group (in the Joint Staff Common Room, University College, ower Street, London, W.C.1), at 5 30 p.m.—Dr. A. W. Phillips. ontrol Systems in Economics".

Society of Engineers (at 17 Victoria Street, London, S.W.1), 5.30 p.m.—Annual General Meeting.

Manchester Literary and Philosophical Society (in the eynolds Hall, College of Technology, Manchester), at 5.45 p.m.—r. V. E. Yarsley: "The Role of Plastics in Shaping the Pattern for e Future" (Ramsden Memorial Lecture).

Pharmaceutical Society of Great Britain (at 17 Bloomsbury uare, London, W.C.1), at 7.30 p.m.—Mr. H. A. R. Binney: "The ork of the British Standards Institution".

Royal Geographical Society (at 1 Kensington Gore, London, W.7), at 8 30 p.m.—Major-General J. C. T. Willis: "Ordnance urvey and the Public".

## Tuesday, December 13

Zoological Society of London (in the Mappin Refreshment avilion, Mappin Terrace, Zoological Gardens, Regent's Park, London, .W.1), at 5 p.m.—Scientific Papers.

Institution of Civil Engineers (at Great George Street, Westinster, London, S.W.1), at 5.30 p.m.—Sir Harold Roxbee Cox: The Development of the Gas Turbine" (Parsons Memorial Lecture).

Illuminating Engineering Society (joint meeting with the Royal stitute of British Architects, at the Lighting Service Bureau, 2 voy Hill, London, W.C.2), at 6 p.m.—Mr. Derek Phillips: "Lighting Buildings—Training and Practice".

Institution of Electrical Engineers, London Graduates and udents Section (at Savoy Place, London, W.C.2), at 6.30 p.m.—r. L. A. Harris: "Colour Television".

## Wednesday, December 14

Physical Society, Colour Group (at the Lighting Service Bureau, Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. W. R. Stevens and r. H. M. Ferguson: "Apparent Brightness of Coloured Light ources".

Geological Society of London (at Burlington House, Piccadilly, ondon, W.1), at 5 p.m.—Scientific Papers and Exhibits.

British Nuclear Energy Conference (in the Great Hall, Institun of Civil Engineers, Great George Street, London, S.W.1), at 5.30 m.—Mr. J. M. Kay and Mr. F. J. Hutchinson: "The Pressurized ater Reactor as a Source of Heat for Steam Power Plants".

Institute of Petroleum (at 26 Portland Place, London, W.1), 5.30 p.m.—Mr. G. W. Sears: "Statistics as an Aid to Specification".

British Institution of Radio Engineers, London Section (at e London School of Hygiene and Tropical Medicine, Keppel Street, ower Street, London, W.C 1), at 6.30 p.m.—Mr. G. J. Dixon and r. H. H. Thomas: "The Remote Presentation of Radar Information".

Institute of Metal Finishing, Organic Finishing Group (joint eeting with the Corrosion Group of the Society of Chemical dustry, at the Chemical Society, Burlington House, Piccadilly, ondon, W.1), at 6.30 p.m.—Mr. H. G. Cole. "Chromate Pigments r Metal Protection".

Society of Chemical Industry, Corrosion Group (joint meeting ith the Organic Finishing Group of the Institute of Metalnishing, at the Chemical Society, Burlington House, Piccadilly, ondon, W.1), at 6.30 p.m.—Mr. H. G. Cole: "Chromate Pigments r Metal Protection".

Society of Chemical Industry, Food Group—Nutrition Panel t the Linnean Society of London, Burlington House, Piccadilly, ondon, W.1), at 6.30 p.m.—Second meeting in the new series Nutrition Requirements and Food Fortification".

British Psychological Society, Medical Section (at the Royal ociety of Medicine, 1 Wimpole Street, London, W.1), at 8.30 p.m.—r. James Laver: "The Psychology of Fashion".

## Thursday, December 15

Society of Chemical Industry, Road and Building Materials roup (in the Lecture Hall of the Junior Institution of Engineers, epys House, 14 Rochester Row, London, S.W.1), at 2.30 p.m. and p.m.—Special meeting on "New and Revised Test Methods".

Institution of Mining and Metallurgy (at the Geological ociety of London, Burlington House, Piccadilly, London, W.1), at p.m.—Scientific Papers.

London Mathematical Society (at the Royal Astronomical ociety, Burlington House, Piccadilly, London, W.1), at 5 p.m.—r. J. C. Shepherdson: "The Factorisation of Polynomials in a inite Number of Steps".

Institution of Civil Engineers (at Great George Street, Westinster, London, S.W.1), at 5.30 p.m.—Sir Richard Southwell, F.R.S.: MacQuorn Rankine and his Work".

Institution of Electrical Engineers, Utilization Section t Savoy Place, London, W.C.2), at 5 30 p.m.—Dr. A. Nemet and r. W. F. Cox: "Intensification of the X-Ray Image in Industrial adiology".

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. R. E. Davies: "Biochemical Aspects of Gastric Secretion". (Last of fifteen lectures on "The Scientific Basis of Medicine".)*

Institution of Mechanical Engineers, Hydraulics Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m—Discussion on "Filtration of Liquids".

Oil and Colour Chemists' Association (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p m.—Mr. R. R. Coupe and Mr. A. H. Smith: "Penetration of Ink into Paper and its Relevance to Print Quality".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

## Friday, December 16

Biochemical Society (at St. Thomas's Hospital Medical School, London, S.E.1), at 2 p.m.—Scientific Papers.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4 15 p.m.—Geophysical Discussion—"World-wide Circulation and Exchange of Water". Chairman: Dr. G. E. R. Deacon, F.R.S. Speakers Dr. W. H. Munk, Dr. D. W. Privett, Dr. R. C. Sutcliffe and Mrs. M. Morgan.

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. H. A. Watson: "Fuel Control and Burning in Aero-gas-turbine Engines" (James Clayton Lecture).

Royal Aeronautical Society (at 4 Hamilton Place London, W.1), at 7 p.m.—Lord Ventry: "Airships of To-day".

## Friday, December 16—Saturday, December 17

Universities of Great Britain and Northern Ireland (in the William Beveridge Hall, University of London Senate House, London, W.C.1)—Home Universities Conference, 1955.

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Demonstrators in the Department of Physics—The Registrar, King's College, Newcastle-upon-Tyne (December 15).

Chemist or Physicist (with a good honours degree in chemistry or physics, and with industrial or commercial experience), to lead a team involved in overseas sales of special atomic energy materials and equipment (Ref. 1,191); Industrial Chemist (with a good honours degree in chemistry or chemical engineering or equivalent qualifications, and several years industrial experience on chemical production, and capable of making critical assessments of essential items of process technology) in the Commercial Section (Ref. 1,192); and a Chemist Engineer (with a good honours degree in chemistry or chemical engineering, and with industrial or research experience), to assist in negotiating for the production and sale of atomic energy materials and equipment (Ref. 1,193)—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting appropriate Ref. No. (December 16).

Physicists (with a university degree or equivalent qualification in physics) in the Central Electricity Authorities' Research Laboratories, Leatherhead, for duties which include research on problems associated with the generation and transmission of electricity—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting NAT/702 (December 16).

Chemist (with a good honours degree or equivalent qualification) for analytical investigational work at the National Coal Board's Coal Survey Laboratory in Chester—Staff Department (Personnel), National Coal Board, Hobart House, Grosvenor Place, London, S.W.1, quoting SS/121 (December 17).

Research Assistant (medically qualified) in Clinical Medicine—The Registrar, The University, Leeds 2 (December 17).

Senior Assistant Physicist (with an honours degree in physics and previous experience in hospital physics)—The Personnel Officer, St. Thomas's Hospital, London, S.E.1 (December 17).

Lecturer (with specialist qualifications in hydraulics) in the Department of Fluid Mechanics—The Registrar, The University, Liverpool (December 19).

Assistant Zoologist (with an honours degree in zoology or specialized in entomology or plant nematology) for work in connexion with the beet eelworm and related species of cyst-forming nematodes—The Secretary, School of Agriculture, The University, Cambridge (December 20).

Lecturer in the Department of Bacteriology—The Secretary, The University, Edinburgh (December 21).

Professor (with high academic qualifications in the field of mathematics and teaching experience of pure and applied mathematics) of Mathematics, at the Royal Naval College, Greenwich, London, S.E.10—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 4527/55 (December 22).

Electrical or Mechanical Engineer (with a first- or second-class honours degree or equivalent qualification in engineering) at a Ministry of Supply Armament Research and Development Establishment, near Sevenoaks Kent, to conduct a basic development programme in mechanical and electromechanical devices for projectiles and rockets—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.548/5A/CA (December 23).

LECTURER IN PSYCHOLOGY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 30).

GEOLOGISTS or SENIOR GEOLOGISTS (4) (with a first- or second-class honours degree in geology or equivalent qualification, or high professional attainments) IN THE ATOMIC ENERGY DIVISION of the Geological Survey and Museum, London, S.W.7—Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.168/169/56 (January 4).

LECTURER in either CIVIL ENGINEERING or MECHANICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (January 4).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (with a university honours degree in engineering, physics, textile science or equivalent qualifications, with additional research experience, not necessarily in textiles) IN THE PHYSICS AND ENGINEERING UNIT, Wool Textile Research Laboratory, Commonwealth Scientific and Industrial Research Organization, Sydney, N.S.W., Australia, to undertake research into the mechanical properties of assemblies of fibres with particular reference to the physical basis of chemical treatments to improve crease retention, dimensional stability and shrink resistance of wool products—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (January 6).

ASSISTANT EDUCATIONAL PSYCHOLOGIST—The Director of Education, Shire Hall, Durham (January 7).

CHAIR OF ORGANIC CHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 14).

LECTURER IN PHYSICS at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (January 16).

READER IN BOTANY at Bedford College, Regent's Park, London, N.W.1—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 25).

READER IN ORGANIC CHEMISTRY, and a READER IN PHYSICAL CHEMISTRY, at King's College, Strand, London, W.C.2—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 30).

SENIOR LECTURER and a LECTURER IN VETERINARY PATHOLOGY—The Secretary of University Court, The University, Glasgow (January 31).

LECTURER (honours graduate in physics or chemistry) IN TEXTILE CHEMISTRY—The Registrar, College of Technology, Manchester 1 (February 6).

ASSISTANT CONSERVATORS OF FORESTS (with a university degree in forestry) in Trinidad—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.61/38/01.

BIOCHEMIST (preferably with not less than two years post-graduate research experience either in carbohydrate or protein biochemistry or in endocrinology) to work in the Physiology Department on mammary gland metabolism—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 55/22.

CHEMIST (with at least a second-class honours degree in chemistry, or the A.R.I.C.), in H.M. Overseas Civil Service, Antigua, Leeward Islands, to provide chemical control and advice for the industrial and agricultural development of Antigua—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/34/03.

CHEMISTRY MASTER (with an honours degree in chemistry and experience of teaching at G.C.E. or equivalent level), for G.C.E. courses, under the Iraqi Ministry of Education, Baghdad, Iraq—Dr A. H. Hilli, Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

GEOLOGISTS (with a university degree in geology), in the Department of Mines, Tasmania, to undertake geological work throughout the State, including investigating and reporting on mines and prospects, general geological work and mapping of areas, advice on water supply, selection of bore sites, and other engineering problems—Agent General for Tasmania, 457 Strand, London, W.C.2.

LECTURER (with an honours degree in metallurgy and preferably with industrial and research experience) IN METALLURGY—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3.

MICROANALYST (Chief)—Prof. H. A. Brande, Organic Chemistry Laboratories, Imperial College, London, S.W.7.

OPERATIONAL RESEARCH OFFICER (with a good university degree in mathematics, science, engineering or economics, and previous operational research experience), to join a team engaged in the study and development of factors affecting productive efficiency throughout the Corporation—Head Office Personnel Officer, British European Airways, Keyline House, Ruislip, Middx.

PHYSICIST or ELECTRICAL ENGINEER (with at least H.S.C. (science) or equivalent, and experience of electronic equipment) at a Ministry of Supply Armament Research and Development Establishment near Sevenoaks, Kent, for experimental design and development of electronic parts of fuses for projectiles and rockets and associated test and trials equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.538/5A/CH.

RESEARCH ASSISTANT (with H.N.C. or equivalent qualification, and previous experience of chemical analysis) IN THE CHEMISTRY DEPARTMENT, to carry out laboratory experiments connected with the physical chemistry of solid steel—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting O.P.2.

SENIOR EXPERIMENTAL OFFICER (with H.S.C. with mathematics or a science subject as principal subject or equivalent qualifications, and an aptitude for analysis of technical information and in particular numerical data), to supervise a technical office concerned with collection, correlation and presentation of works' performance data; presentation of Group programmes; preparation of Group stock accounts for special materials, and building up of basic operational data—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting 1,196.

# REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

## Great Britain and Ireland

British Electrical and Allied Industries Research Associatio Technical Report L/T 287: Electrode Processes in Spark Discharge By R. Craig. Pp. 12+11 figures. 12*s*. 6*d*. Technical Report L/T Plasma Oscillations and Energy Loss of Charged Particles in Solid By H. Frohlich and H. Pelzer. Pp. 5. 3*s*. (Leatherhead: Briti Electrical and Allied Industries Research Association, 1953 a 1955.) [3

Thermodynamic Properties of Fluids and Other Data (Brit Thermal Units). Arranged by Y. R. Mayhew and G. F. C. Roge Pp. 16. (Oxford: Basil Blackwell.) 2*s*. 6*d*. [3

Proceedings of the University of Durham Philosophical Societ Vol. 12, No. 6: The Venation of the Homopterous Tegmen. By Heslop-Harrison. Pp. 43–62. Vol. 12, No. 7: Notes on Morphologic Changes Associated With Sexual Maturity in the Male Starry Ra *Raja Radiata*, Donovan. By Dr. John Phillipson. Pp. 63–72. Vol. 1 No. 8: The Evolution of Mitosis. By Jack L. Crosby. Pp. 73–8 (Durham: University of Durham Philosophical Society, 1955.) [3

Ministry of Agriculture, Fisheries and Food. Domestic Food Co sumption and Expenditure, 1953: Annual Report of the National Fo Survey Committee. Pp. 104. (London: H.M. Stationery Offic 1955.) 4*s*. net. [3

Avonmouth Works of Imperial Smelting Corporation Limite Pp. 7+5 plates. (London: Imperial Smelting Corporation, 1955.) [3

North of Scotland College of Agriculture. Calendar, 1955–5 Pp. 252. (Aberdeen: North of Scotland College of Agriculture, 1955

Sheffield Metallurgical Association. Report for 1954 and List Members. Pp. 33. (Sheffield: Sheffield Metallurgical Associatio 1955.) [3

Institution of Metallurgists. The Inspection and Testing of Metals Lectures delivered at the Institution's Refresher Course, 1954. Pp. 12 (London: Institution of Metallurgists, 1955.) 15*s*. 6*d*. [31

Building Research Station Digest. No. 80. (August, 1955): T Prediction of Levels of Daylighting in Buildings. Pp. 8. (London H.M. Stationery Office, 1955.) 3*d*. net. [3

## Other Countries

Bulletin of the American Museum of Natural History. Vol. 10 Article 5: Fishes of Western Arctic America and Eastern Arct Siberia: Taxonomy and Zoogeography. By Vladimir Walters. P 255–368. (New York: American Museum of Natural History, 1955 1.50 dollars. [3

Museum at Work: Bernice P. Bishop Museum Annual Report f 1954. Pp. 55. (Honolulu: Bernice P. Bishop Museum, 1955.) [3

Commonwealth of Australia: Department of External Affair Australian National Antarctic Research Expeditions. Report Series B, Vol. 2—Botany. The Flora, Vegetation and Soils of Macquar Island. By B. W. Taylor. Pp. ii+192. (Melbourne: Department External Affairs (Antarctic Division), 1955.) [31

National Academy of Sciences. National Research Council. Eight Annual Report, Pacific Science Board, 1954. Pp. 61. (Washingto D.C.: National Academy of Sciences—National Research Counc 1955.) [3

State of Illinois: Department of Registration and Educatio Natural History Survey Division. Bulletin Vol. 26, Article 3: Natur Availability of Oak Wilt Inocula. By H. A. Curl. Pp. iv+277+32 Vol. 26. Article 4: Efficiency and Selectivity of Commercial Fishin Devices used on the Mississippi River. By William C. Starrett an Paul G. Barnickol. Pp. iv+325–366. (Urbana, Ill.: Department Registration and Education, Natural History Survey Divisio 1955.) [31

Bulletins de la Société Royale de Zoologie d' Anvers. No. 1: L Infections a Plasmodium chez les Pingouins. Par Dr. J. Rodhai Pp. 24. No. 2: Les Poissons d'Aquarium du Congo Belge. Par D Max Poll. Pp. 46. No. 3: Les Facteurs Physio-Pathologiques Influe cant l'Acclimatation de l'Okapi. Par Dr. L. M. G. Geurden. Aper Succint de nos Connaissances Actuelles au Sujet de l'Okapi. P Dr. Vandermander. l'Acclimatation des Okapis a Londres et Cope hague. Extraits de Rapports de MM. C. S. Webb (Curator of Mamma and Birds, Zoological Society of London) et Axel Reventlow (Adm Director Zool., Have, Kobenhavn). Pp. 54. Nr. 4: Pathology of Bir in Zoological Gardens, with special reference to Salmonellosis. By Pro L. M. G. Geurden. Pp. 11. No. 5: Quelques Nématodes de la Colle tion d' Helminthes Récoltés à la Société Royale de Zoologie d'Anver Par. Ch. Vuylsteke. Pp. 27. (Anvers: Société Royale de Zoolog d'Anvers, 1953 and 1954.) [31

Ministerio da Educacao e Saudi. Boletim do Museu Nacional, R de Janeiro (Nova Serie). No. 119 (Zoologia). Chinesische *Arachnoide* aus dem Museum Hoangho-Peiho in Tientsin. Von E. Schenkel. P 108. No. 122 (Zoologia): Neotropical Miridae, 61—Genus *N* Reuter with descriptions of Seven New Species (Hemiptera). By Pro José C. M. Carvalho. Pp. 10. No. 123 (Zoologia): Neotropical Dor laidae Studies, Part 3. Brazilian Species and a Key to the Know Species of *Dorilas Sens. Lat.* By D. Elmo Hardy. Pp. 60. No 12 (Zoologia): Fauna do Distrito Federal. 14: Sobre uma Espec do Genero *Oressa* Schaus, 1894 (Lepidoptera-Heterocera). By Alfred Rei do Rego Barros. Pp. 17. No. 127 (Zoologia): Sobre Algu *Nyctiborinae* Brasileiros com Descricao di uma Especie Nova (*Blattida* By Isolda Rocha e Silva. Pp. 39. (Rio de Janeiro: Museu Naciona 1953 and 1954.) [31

Mitteilungen des Deutschen Wetterdienstes. No 13 (Band 2) Bestimmung des Verdunstungsanspruchs der Luft mit Hilfe vo Piche-Evaporimetern. Von Siegfried Uhlig. Pp 24. (Bad Kissinge Deutschen Wetterdienstes, 1955.) [31

Conseil Permanent International pour l'Exploration de la Me Rapports et Procès-Verbaux des Réunions. Vol. 139: Report o Echo-Sounding and Asdic for Fishing Purposes. Edited by W. Hodgson and A. Fridriksson. Pp. 50. (Copenhague: Andr. Fre Høst, 1955.) [31

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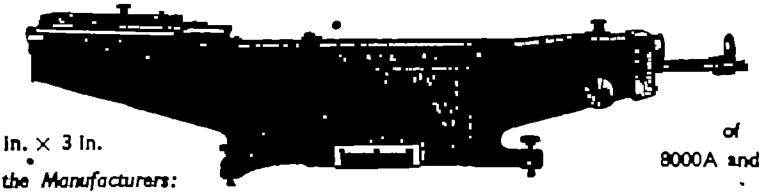

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# THE WATER PROBLEM IN GREAT BRITAIN

WITH many reservoirs in Britain half empty as a result of the summer drought and its prongation into the autumn, concern is once again eing expressed about the water resources of the untry. It is not easy for the general public to concile restrictions and appeals for constraint with eriods of apparently normal rainfall, and yet this equently occurs. Even to the layman, there is learly something amiss when water conservation rces an interruption of supplies in normally wet ocalities such as Durham. These are but the first ortents of a problem which shows every sign of ecoming more acute with the passage of time.

The total amount of water supplied by water underkings in England and Wales at present is estimated be in the region of 1,750 million gallons a day, or an verage of some 40 gallons per head of the population. his amount has been steadily rising during the past wo decades, and it has been estimated that the water ndertakings will be called upon to supply in fifteen ears time at least twice the amount consumed in 938. This rapidly rising rate of consumption is artly connected with the increased population and s rising standard of living ; but water requirements re increasing much faster than the growth of opulation. Improved sanitation and hygiene and the ift from rural or urban areas account for much ; ut it is the spectacular consumption in the industrial eld which calls for most comment. Increasingly rmidable demands are being made by industry.

For example, it is estimated that the refining of ne barrel of crude oil requires eighteen barrels of ater, the production of a ton of steel needs 65,000 allons of water, a ton of sulphite paper similarly eeds 64,000 gallons, the processing of a gallon of lcohol requires 100 gallons of water ; while the emands of thermal generating stations and atomic ower stations begin to look astronomical—some 80 allons are needed for each kWh. produced. At the me time, numerous industrial establishments disarge waste of many kinds such as acids, oils, chemals, etc., which pollute the streams because of their oisonous, harmful or offensive effect. Cooling water turned to streams at high temperature further omplicates the supply for cities and industries ownstream. The problem is, of course, by no means nfined to Great Britain. Even in the United States e industrial use of water has exceeded the agriultural use, and the Paley Commission has estimated at by 1975 industry will be consuming two-thirds all available sweet water, and that availability of ater will be the main factor in determining the cation of industry.

Agricultural demands in Great Britain may shortly ggravate the problem still further. The possibility controlled growth of crops and grass by summer rigation (already demonstrated by successful experients at Rothamsted Experimental Station) involves cceptional demands for water. In south-east Engnd in a dry summer, up to 250,000 gallons per acre uld be usefully applied.

While Nature is fairly bountiful in her supply of water to the British Isles—it is estimated that in a year of average rainfall some 2,000 gallons of water per head per day descends upon us—the greater part is 'lost' in sustaining river-flows to the sea, and this water returns fairly rapidly to its source. As the river-volume is often irregular and intermittent, or locally insufficient, water must be stored or conserved. Britain has no glacial ice-cap to store winter precipitation against summer demands and drought, and we must depend on reservoir storage overground and natural storage underground. The water storage capacity of England and Wales overground is now of the order of 200,000 million gallons, which provides these areas with about three months supply of water. But although this is regarded as sufficient insurance at present against there occurring not more than once in ten years a drought as long as the longest known drought, the insurance is not evenly spread throughout the country ; and, in fact, most parts of Britain need to restrict supplies of water if no measurable rain falls for periods in excess of about thirty days. Moreover, this reserve does not take into account the steadily increasing demands.

The natural storage underground of water is largely confined to certain receptive geological formations, notably the chalk. This has a surface outcrop in Britain of some 5,000 square miles which, catching an average of some 20 inches of rain a year, gives an annual yield potential of some 750,000 million gallons. Other important aquifiers are the Midland Oolites, covering 2,000 square miles, with a yield potential of 315,000 million gallons yearly ; and the Triassic sandstones, covering 1,750 square miles, with a yield potential of 300,000 million gallons yearly. With 15 per cent of our present consumption derived from underground sources, these figures appear reassuring, until we realize that widespread boring and pumping would be necessary to tap all the available resources, which again are not always in the right places. Furthermore, the utilization of these supplies needs careful management. Reports of falling water-tables from nearly all areas using ground-water are commonplace and indicate a rate of extraction in excess of replenishment. Present withdrawals for the 10 million inhabitants of the London Basin take some 260 million gallons daily from the chalk : records show a steady fall in the water-table here for the past hundred years. In the Thames Estuary the hydrostatic level is now several hundred feet below sea-level, and the seepage of brackish water is causing concern. The Water Act of 1945 now forbids the boring of further wells in the City of London without a licence from the Ministry of Housing and Local Government.

The total water supply in Great Britain is clearly adequate ; but it is of little use unless it is available in the right place at the right time. Nature unfortunately distributes it very unevenly in both time and space. How are we to escape from this dilemma ? Clearly more water could be impounded in reservoirs ; but there is an obvious economic limit to this process, for it consumes much-needed land and disturbs many interests. There is the possibility of a much higher standard of watershed management to hold back the run-off and so conserve supplies. Artificial recharge of underground sources now suffering depletion could also be practised, as in the United States and the Netherlands. In the London Basin, some 150,000 million gallons of the Thames flow might be preserved in this way. The use of sea water is also possible where salinity is no objection, although this produces problems of corrosion in pipes. The desalting of ocean water as well as cloud seeding to induce rainfall are probably as yet uneconomic.

The idea of a national water grid for Britain has occasionally been mooted, and indeed found a place in the Labour Party's election manifesto of 1950. But water, although an equally important public utility, is not like gas or electricity: it largely depends on gravity for natural movement, and many doubts have been cast upon the economic and engineering feasibility of a national water grid. At the present time, there are some 1,100 water undertakings in England and Wales responsible for providing public supplies. More than 900 are local authority organizations, some 115 are statutory water companies, 54 joint water boards and 47 smaller non-statutory water companies. There has been a tendency for smaller water authorities to be absorbed by the larger and for joint boards to be formed; but there is still a great number of separate undertakings. In addition to these public supply authorities, there are innumerable private water developers: for example, in the City of London more than a hundred 'wells' supply office and industrial buildings. There is thus a great multiplicity of water undertakers all working independently and very often against each other; and the problem which is looming ahead is being nibbled at piecemeal all over the country.

There thus seems strong grounds for an over-all national water policy, and this was, in fact, envisaged in the Water Act of 1945, which imposed upon the Minister of Health the duty, since transferred to the Minister of Housing and Local Government, "to promote the conservation and proper use of water resources and the provision of water supplies in England and Wales, and to secure the effective execution by water undertakers, under his control and direction, of a national policy relating to water". The necessary administrative organization to achieve this has, however, been slow to emerge, and many complaints have been voiced. The Minister did not set up the regional advisory committees which the Water Act empowered him to appoint. The River Boards Act of 1948 set up boards responsible to the Minister of Agriculture. The Central Advisory Water Committee lapsed in 1952, and the Inland Water Survey was suspended as an economy measure in the same year (see *Nature*, November 7, p. 823, 1953; and *The Times*, March 24, 1954); and the industry has complained that it has been allowed too little capital investment in comparison with other national utilities. (Manchester's Haweswater Reservoir, which was completed in 1941, had not been tapped by 1949 because of restrictions.)

The water industry has proposed the formation a 'Water Commission' separate from, but appointe by and answerable to, the Minister of Housing an Local Government. This idea has been formally submitted to the Ministry by the British Waterwor Association, but appears to have found little favou Since this action the United Nations Economic an Social Council, in a report on Development an Utilization of Water Resources (London: U.N Information Centre, 1954), has recommended "tha each country would be well advised to set up a wate board or water commission at cabinet level". It envisaged that such a water board would hav representatives of all interested government departments and local government bodies concerned wit the numerous aspects of water conservation an utilization. The problem of supply could be looke at as a whole and suitable policies formulated. Th need clearly exists in Great Britain, as elsewhere, an the recent decision of the Minister of Housing an Local Government to revive and reconstitute th Central Advisory Water Committee is a welcome ste in the right direction (*Nature*, October 22, p. 76 and November 12, p. 908). This Committee is now t consider the extent to which the demand for wate is likely to increase and also the ways and means o collecting hydrological data, and will then mak recommendations. Its report will be awaited wit interest, for this problem is closely related to that o flood control, which, as has already been emphasize in these columns (*Nature*, 172, 263 and 823; 1953) also merits more detailed attention. Without muc careful thought and more vigorous action, we mus inevitably move in the future into the paradoxica situation of increasing water shortages amid plentifu precipitation and recurrent flooding.

# THE THREAT TO SCIENCE

A STRIKING picture of the dangers whic confront men of science has been prepare recently by Gerard Piel, publisher of *Scientifi American*, one of America's leading magazines (*Bull Atomic Scientists*, 11, No. 7; September 1955). At th outbreak of the Second World War, he writes, scienc was a kind of ideal world republic. The scientifi community was an international community. It wa the only truly international community at an epoc that was to see nationalism and the narrower concern of national power rise again to ascendancy in worl politics.

Statesmen discovered early in the War that scienc is an essential element of national strength. To-day they rank it as equal in importance to their industria and military establishments. Accordingly, eac major power has sought to monopolize the talents o its scientists and to put them to work in the nam of national security. This suppression of internationa motives in favour of national ends has now ha serious consequences upon the life of science. Th situation in the United States provides an extrem case of what, to a greater or lesser degree, has bee happening in other nations.

Scientists are agreed, in the first place, that there as been a dangerous diversion of resources and alent from the really significant long-range concerns f science to the narrower short-range objectives of ractical results. Nearly half America's expenditure ach year goes to armaments. Economic and social ressures have moved a disproportionate percentage f the inadequate supply of scientists from univerities to government and industrial laboratories. Even in American universities, the work of science as become dependent upon income from outside ontracts and subject to the outside motivations which such contracts imply. As a result, the careers f an alarming number of the younger generation of cientists are now permanently lost to science. The ducation of the next generation is jeopardized by he breakdown of science teaching in American high chools and colleges. The future of science has been mortgaged in the eagerness to exploit its past.

Science has come under another kind of duress hrough preoccupation with national security in the arrow and negative technical sense of the term. Military secrecy seriously hampers publication and ommunication in a number of major fields of work. Direct contact between scientists has been disrupted by restriction on the travel of American scientists abroad and the admission of foreign scientists to America. Scientists have been among the most notable victims of the invasion and abuse of personal privacy and dignity which characterize the loyalty and security programme of the Federal Government. Outside any conceivable connexion to national ecurity, the attendant obsession with loyalty has reated an atmosphere of fear and conformity which s as obnoxious and stifling to science as to any other branch of free inquiry.

It is impossible to calculate the damage that has been done to the integrity and vitality of the American cientific establishment. "Without doubt we shall pay for it in the future. It will show up in the loss f the advances in technology which should have ome from the progress in science we have set aside oday."

There is a lesson in this recital. The scientific nterprise cannot be successfully subordinated to merely national ends. Without the long view—the world view—the advance of science must falter and ome at last to a halt.

The international tradition runs too deep in the fe of science, however, to have been throttled in fteen years. Among scientists in every field, their ersonal and professional associations with colleagues broad, their mutual respect for one another, and the sharing of achievement in significant work estabsh bonds which outreach the dividing movements f this period. The international community of cience still provides us with our most hopeful xample of a world polity, in which statesmen and itizens as well as scientists may some day participate.

In the rest of his article Piel points to activities ke the International Geophysical Year and the work f the United Nations Technical Agencies as examples f those forces which should serve as hope and ncouragement to men of science everywhere.

# MODERN CYTOLOGY

International Review of Cytology
Edited by G. H. Bourne and J. F. Danielli. Vol. 4. Pp. xii+419. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 9 dollars.

As usual, Dr. G. H. Bourne and Prof. J. F. Danielli have selected widely different topics for Vol. 4 of the "International Review of Cytology". While many readers might well ask for more unity, I thoroughly enjoy this non-conformist lack of uniformity. The articles in which I am directly interested are extremely useful and valuable for my research work; the others are no less important for a teacher in general biology.

The first paper, by M. J. Kopac, deals with cytochemical surgery: the list of the methods and the instruments available for quantitative cytochemical investigations on isolated cells or their parts is very complete; but the descriptions are somewhat too short to enable one to utilize them without going back to the original papers. A new "volumetric submicromanipulator" and a modified microdilatometric method are described; they should prove useful, but it is perhaps unfortunate that the results obtained so far with them—if there are any—are not mentioned.

After an interesting article on amœbocytes, especially in molluscs, by L. E. Wagge, M. Wolman discusses cytological and cytochemical fixations: the expected conclusion is that even freeze-drying is far from ideal and that there are no good universal fixing-agents. The next two papers, by A. Marshak and by R. Vendrely, deal respectively with bacterial cytology and histochemistry (the latter a rather ill-chosen title, since bacteria scarcely constitute a tissue in the usual sense). They are well documented, but their very carefulness leaves the reader with a slight feeling of frustration; he will often have to draw his own conclusions.

Next come reviews on plant mitochondria (D. P. Hackett) and the structure of chloroplasts (K. Mühlethaler); we are here on safer ground, and there seems to be little reason to doubt that plant mitochondria strongly resemble animal mitochondria, and that the structurally complex chloroplasts originate from proplastids distinct from the mitochondria. N. B. Kurnick's review on the histochemistry of nucleic acids is very thorough and critical; although it only deals with the techniques, it should prove very useful.

The article on structure and chemistry of nucleoli, by W. S. Vincent, is clear and contains much new information; the author reaches the conclusion that the nucleolus might be the site of a limiting rate-reaction necessary for the maintenance of cytoplasmic syntheses. With H. Moe and R. Couteaux the reader comes back to more orthodox cytology: the former writes about goblet cells, the latter about the localization of cholinesterase at neuromuscular junctions. Both papers are very well illustrated. Finally, E. J. Conway surveys the evidence in favour of a redox pump in the active transport of cations, and shows that this hypothesis adequately explains many facts in yeast cells as well as frog skin, gastric mucosa or plants.

The book is very well produced; the unfortunate consequence is its rather high price. There are extremely few misprints—usually names of authors quoted in the text or in the bibliography; but why is it that the only two words quoted in French are wrongly spelt?

J. Brachet

## STRATIGRAPHICAL PALÆONTOLOGY

**Stratigraphical Palæontology**

A Study of Ancient Life-Provinces. By Dr. E. Neaverson. Second edition, revised and enlarged. Pp. xii+806+18 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 105s. net.

THIS second edition of Dr. E. Neaverson's text-book has been awaited with much interest. The earlier filled a gap of which teachers of palæontology were well aware. It was the first attempt at producing, in Britain, a book dealing with the application of palæontology to stratigraphy, and giving a general account of the succession of faunas and floras throughout the Earth's history. The remaining stocks of this book were destroyed towards the end of the Second World War as a result of enemy action, and the author, in preparing a second edition to make good this loss, has taken the opportunity of revising and augmenting the original. The chapter dealing with the morphology of fossils, more appropriate to a text-book of general palæontology, has been omitted. On the other hand, the account of the marine faunas has been usefully augmented to include details of their occurrences outside Britain. Three more chapters have been added to deal with the vertebrate land faunas of the several continents, and in a final chapter the relationships of the continents as revealed by their past faunas are discussed.

Dr. Neaverson has gathered together a vast amount of information from numerous and scattered sources to make a book which should be invaluable to teachers, no less than students, of stratigraphy. Unfortunately, it is now in size and cost more of a book of reference than a text-book that every student could be expected to buy. The emphasis is on the zoo-geographical aspect in that the faunas are discussed *seriatim* under the various systems so that evolutionary changes are difficult to follow. Since stratigraphical subdivisions are largely based on such changes, a clearer picture of the dependence of stratigraphy on palæontology might have been given if the history of each phylum in turn had been traced throughout the geological record. This treatment has, in fact, been partly accorded to the fossil plants, the account of which is oddly placed in the middle of the book between "Carboniferous Faunas" and "Tetrapod Faunas of the Late Palæozoic System".

The accounts of the faunas of each system are comprehensive and well documented. They assume in the reader a fairly high standard of stratigraphical and palæontological knowledge, but could have been made much easier to digest by the provision of good palæogeographical maps in place of the numerous peculiar and not very informative maps on which the distribution of rocks is shown by crosses, circles and black disks.

In these days, when the economic aspect of geology is more important than ever before, it is to be regretted that Dr. Neaverson, in common with many other teachers of palæontology, has paid so little regard to the microfossils. Less than a page is devoted to the Ostracoda. The larger Foraminifera are paid a little more attention, but no indication is given that there are large and varied microfaunas in almost every formation since the Cambrian, some of which are used daily as guides to stratigraphy. The last chapter, on the relationships of continents and oceans, is interesting in its treatment of a complex and difficul subject but would, nevertheless, have been bette omitted. The subject is perforce dealt with to superficially, and the evidence is not discusse entirely without bias.

The book is well indexed and includes eightee excellent plates figuring a number of fossil specie though the selection is a little unbalanced: one plat is devoted to nummulites, three to brachiopods, n less than eleven to the cephalopods, one to lamellibranchs and two to echinoids. F. W. ANDERSON

## MATHEMATICS FOR BIOLOGISTS

**Biomathematics**

The Principles of Mathematics for Students of Biological Science. By Dr. Cedric A. B. Smith. (Bein the Third Edition and a rewritten version of th work by the late W. M. Feldman, M.D.) Pp. xv+712 (London: Charles Griffin and Co., Ltd., 1954.) 80s. net

NEARLY eighty years ago Charles Darwi described in his autobiography how the stud of mathematics had been repugnant to him in hi early days, and then went on to deplore his consequent lack of understanding of mathematica principles, adding in explanation, "for men thu endowed seem to have an extra sense". How ofte must Darwin's words have been echoed by biologists especially with the tremendous increase of quantitative treatment in biology during the past thirt years or so. This great trend towards the quantitativ has been most striking in the laying out of experiments and the interpretation of results; but it is t be seen also, and no less characteristically, in th growing use of mathematics for the development o biological theory. Biologists are in fact being face with an increasingly insistent demand for capacity as well as willingness, to utilize the tools whic mathematics offers. Willy-nilly they will have to b prepared, in growing numbers, to acquire and use a least some mathematical skill; and they will nee books to help them to do so.

There is now no shortage of books dealing at variety of levels with mathematical aspects of th acquisition, analysis and interpretation of biologica data; but Dr. C. A. B. Smith has set out to meet different need. In rewriting "Biomathematics" h has followed the late W. M. Feldman, to whom th two earlier editions were due, in aiming at a presentation of the fundamentals of mathematics as such, s that the biologist should be able to see for himsel how his problem can be handled mathematically. Starting with an account of arithmetic procedures, including those appropriate to calculating machine and punched cards, the book goes on to cover a great deal of ground including not only the more familia principles of algebra and geometry but also inequalities, series, integral as well as differential calculus, vectors, matrices and statistical theory.

By mathematical standards the treatment is doubtless very largely introductory; but the biologist will find here a wealth of notions and methods such as can scarcely have been available to him before within the covers of a single volume. He must not expect to find the going always easy, as Dr. Smith indeed warns his readers on p. 1, and probably few biologists will take the full course of seven hundred pages without some skipping. Some parts, such as, for xample, those dealing with the solution to equations, nomograms and probability, will inevitably be more widely read because they deal with requirements which arise more widely in practice. In fact, although his may not bring out its full value, "Biomathematics" is likely to be used chiefly as a reference book to be dipped into as the need arises, and its use n this way will be all the easier for the glossary of ymbols provided at the beginning. The need for such a source of mathematical reference is more widespread than even biologists themselves probably eel.

So long a mathematical book can scarcely fail to be expensive, and it is perhaps an inevitable misfortune that at 80*s*. the price of "Biomathematics" will limit its sale. It is to be hoped, nevertheless, hat younger biologists will at least have ready access to Dr. Smith's book in their laboratories, and will be encouraged to use it. For, given the opporunity, it can offer much-needed help. K. Mather

## PRINCIPLES OF ANALYTICAL INORGANIC CHEMISTRY

Grundlagen der analytischen Chemie und der Chemie in wässerigen Systemen

Von Prof. F. Seel. Pp. 348. (Weinheim/Bergstr.: Verlag Chemie, 1955.) 29 D. marks.

THIS book deals in five chapters with the separation of metal ions by precipitation techniques, eactions in molten salts, various volumetric titrations and electrolytic separation methods. In twenty hapters problems of more general interest are set out: namely, definitions and fundamental theories, mass action law, solubilities, theories of precipitation, olloid chemical effects, formation of complexes, proton transfer reactions, acid-base equilibria, ion xchangers and oxidation–reduction processes.

Students who read this book are liable to get an nbalanced view, because the usefulness of the mass ction law in dealing with heterogeneous systems is ver-emphasized and because many important topics re omitted; for example, the relative contributions f $\Delta S$ and $\Delta H$ to $\Delta F$ of a chemical equilibrium, or n appropriate treatment of reaction kinetics and mechanism. Furthermore, there is no coherent story, he presentation being confusing and not consistent. Thus, the mass action law is derived, *ab initio*, in Chapter 2, while the derivation of Nernst's formula, onnecting electromotive force with ionic activities, is only very briefly indicated in an appendix, lthough it is extensively used in the last ten chapters. There are statements such as "reactions with ositive $pK$ values use up energy and reactions with egative $pK$ values yield energy" ($pK$ is the negative ogarithm of the equilibrium coefficient), or "the nergy of dissociation of certain complexes must be erived from a precipitation reaction". In other ections reactions are classed as "inhibited", although t is not suggested that an inhibitor influences the inetics, the failure to reach equilibrium within a hort time being merely due to the energy or entropy f activation. Again, the term "physical" solubility s introduced, implying that this is different from ther solubilities, but there is no definition; and many numerical values of $pK$ are listed, in the text nd in four tables of the appendix, without specifying he temperature.

Advanced research workers and university teachers, on the other hand, should not be unduly disturbed by these and similar shortcomings; but this class of readers, if interested in analytical chemistry, will miss a discussion of colorimetric, flame photometric, chromatographic and polarographic methods, and representative literature references.

It must be pointed out, however, that five out of the twenty-five chapters are rather enjoyable to read, provided they are considered as separate short monographs. These chapters contain instructive numerical calculations and some useful information not given in conventional text-books of analytical chemistry. Albert Wassermann

## LENS THEORY

Theory of Lenses

By E. W. H. Selwyn. (Monographs for Students.) Pp. 62. (London: Institute of Physics, 1955.) 5*s*.

BY the theory of lenses, Mr. E. W. H. Selwyn means a discussion, in terms of physical optics, of the behaviour of real lenses. This book is intended for students preparing for the Higher National Certificate in Applied Physics, and is one of a series bridging the gap between the elementary text-books and the academic and technical treatises. Its outlook is original and refreshing, and the author's long experience of both lenses and learners has enabled him to deal handsomely by both. His aim, he says, is that the reader shall not be too much surprised by some of the things he may notice when using optical devices or trying to make them in the laboratory. One feels that the student who has fully mastered the contents of these few pages will really understand what he is doing in such circumstances, for this is an excellent introduction with a very practical approach.

After an initial discussion of the wave theory of light, in which the beginner's difficulties with Huygens's construction are admirably resolved, the author traces the effect of a refracting surface on a wave-front diverging from a point, considering in turn the image formed by a spherical refracted wave-front corresponding to paraxial conditions, and the distortion of this wave-front due to aberrations. A fair knowledge of co-ordinate geometry is here assumed; but the mathematical treatment is clear and straightforward. Next, the terms in the expression for the distorted wave-front corresponding to the second-order Seidel aberrations are identified, and their effects on the image and their correction are explained. The last chapter deals with correction for colour, high-order aberrations, and the balancing procedure of the lens designer in achieving some cancellation of one aberration by a higher-order aberration of the same kind.

The book ends with a selection of problems, some simple exercises on the book-work and some particularly searching ones. None, says Mr. Selwyn, can be solved merely by substituting numerical values in a correctly remembered formula,—a comment which the late Prof. John Perry might have expanded into many vehement paragraphs, and which conveys all too delicately a warning against the student's greatest temptation. But the reader who has followed Mr. Selwyn's treatment will naturally be thinking in terms of physics rather than of formulæ, so that perhaps even so gentle a reminder may prove superfluous. G. R. Noakes

## Higher Transcendental Functions

Vol. 3. Based, in part, on notes left by the late Prof. Harry Bateman, and compiled by the Staff of the Bateman Manuscript Project. Edited by A. Erdélyi. (Sponsored by the California Institute of Technology.) Pp. xvii+292. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 49s.

THE third and final volume of this work, consisting of Chapters 14–19, deals mainly with problems much less tractable than those discussed in the previous volumes. Chapter 14 contains an interesting account of automorphic functions, a subject more akin to algebra than to analysis. It includes a summary of the theory, with references to text-books and research papers for those desiring to pursue the subject.

Chapters 15 and 16, on Lamé and Mathieu functions respectively, are concerned with differential equations the solutions of which are not expressible in hypergeometric form. As there is no general agreement about standard types of solutions, and as the formulæ are long and complicated, the editors have been forced to make a selection. In the case of the Lamé functions they have, wisely I think, employed the Jacobian elliptic functions; while in the chapter on the Mathieu functions they have followed McLachlan's well-known text-book. Abelian functions and multiply-periodic functions, for the discussion of which at one time large tomes were required, are only briefly referred to. Does a like fate await the Lamé and Mathieu functions? In addition to the Mathieu functions, Chapter 16 has sections devoted to spheroidal wave-functions and ellipsoidal wave-functions.

Chapter 17 contains an account of the functions of number theory. It is scarcely full enough for beginners in the subject, but may be useful to them as a guide; to the research worker the references will, of course, be useful. There follows a chapter on miscellaneous functions, such as Mittag-Leffler's and Wright's generalizations of the exponential and Bessel functions. In the final chapter is to be found a simple and interesting account of generating functions. The editors are to be congratulated on the completion of a most helpful aid to research in this field of mathematics. T. M. MacRobert

## Progress in Cosmic Ray Physics

Edited by Dr. J. G. Wilson. Vol. 2. Pp. xi+322. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1954.) 45 florins.

THIS book continues worthily the work of the previous volume in presenting reviews of interesting topics in cosmic-ray research, primarily for the benefit of specialists in this subject and those closely adjacent. Many such people will already have used the book. Since this book was mainly written in 1952, and since this review appears late, it is necessary to indicate which portions have been seriously outdated. Unfortunately, Dr. J. G. Wilson's discussion of the unstable particles was written before the 1953 Bagnères conference at which the position about these particles was notably cleared. This conference now forms the best starting-point for the study of these particles. For the future, data from high-energy accelerating machines will probably lead to a rapid increase in the amount of information.

Prof. R. D. Sard's article on the nuclear interactions of $\mu$-mesons at rest remains topical, but might need to be more closely tied to the investigation of mesonic atoms. Prof. H. Messel's article on th development of a nucleon cascade is the most con venient presentation of his theoretical work on subject which is under actual experimental investi gation at a number of centres. The article b Dr. L. Voyvodic is a valuable introduction to th technique of interpreting particle tracks in nuclea emulsion.

## An Introduction to Deductive Logic

By Prof. Hughes Leblanc. Pp. xii+424. (Nev York: John Wiley and Sons, Inc.; London Chapman and Hall, Ltd., 1955.) 38s. net.

THE study of logic in its various forms is makin rapid progress; and in some American univer sities it is accepted as an undergraduate course. Thi much is clear from the number of college texts whic appear regularly, many of them valuable in par ticular fields. This one is distinguished for th delicate balance it maintains between philosoph and mathematics. In this way it provides—give the requisite degree of direction from a competen teacher—a very good guide to deductive logic.

In Great Britain, where the emphasis betwee theory and practice is a little different, a course o this kind might well help forward the training o physicists (including theoretical physicists), who migh later become theoretical biologists, capable of copin with the structure of systems of immense complexity The future, both national and academic, seems t need able thinkers orientated towards deductiv logic. Training in some parts of the subject migh also be expected to help in communication theory.

This book by Prof. H. Leblanc contains a coupl of chapters devoted to two-valued and many-value logics (including modal logic), coupled with 'classical and intuitionist quantifiers. Then he discusses, among other topics, identity, classes and relations. Finally, comes a study of syntax. While there i nothing strikingly new in all this, the author ha contributed something of value to the education o non-specialists which should assuredly yield worth-while results. F. I. G. Rawlins

## Science News, No. 37

Edited by A. W. Haslett. Pp. 128+16 plates. (Harmondsworth, Mddx.: Penguin Books, Ltd., 1955.) 2s. 6d.

WITH 'automation' the catchword of the moment in industry and elsewhere, it is not surprising that the enterprising editors of "Science News" have included an article on the automatic factory in their latest issue (37). This has been written by Dr. H. D. Turner, and in it he reviews the development of automatic machines, the growth of the automatic factory, and the need for functional thinking about technology to ensure that the second industrial revolution may avoid some of the harmful effects on society which accompanied the first. Another interesting article is one by J. B. Collins, who describes the inadequacies of existing artificial illumination and gives some pointers for research. The revolution in physics and philosophy brought about since Einstein published his first work on relativity fifty years ago are discussed by W. B. Bonnor. Other articles are by Prof. Kathleen Lonsdale, who writes about neutrons and atom patterns in crystals, and by Prof. J. B. Cragg, who examines the ecologist's role in Nature conservation. The general editor, A. W. Haslett, contributes his usual research report on a wide range of topics.

# THE CHROMOSOME AS A PHYSICO-CHEMICAL ENTITY[*]

By Prof. C. D. DARLINGTON, F.R.S.
Botany Department, University of Oxford

## 1. Deoxyribonucleic Acid and Protein

SOON after the description of mitosis in 1878 its uniform mechanical character led German biologists to point out that uniform physiological properties were to be inferred in the chromosomes taking part. From this beginning the way has led inevitably to the recognition that chromosome behaviour had two aspects, physical and biological, that the second was the expression of the first and that, ultimately, the two must be seen together as a whole. Twenty years ago it was possible, following this view, to set out certain principles of chromosome mechanics and take note of a family of problems arising from them[1]; possible, that is, by the severe neglect of secondary details. Since that time, advances in the physics and chemistry of the chromosomes have brought the two sides within speaking distance.

These advances include two revolutions in our knowledge. The first depended on Caspersson's discovery that the chromosomes consisted characteristically of a combination of protein and deoxyribonucleic acid (DNA), which are jointly concerned in their reproduction and in their other activities[2]. Reproduction is, of course, a property equally of DNA-protein in the chromosomes and ribonucleic acid (RNA)-protein in viruses and other particles of the cytoplasm. Equally for both, Astbury showed that the peptide and nucleotide chains fit one another so that a template principle might apply[3]. This suggestion still seems fundamental, although the mode of fitting is debatable. On Caspersson's view, however, the DNA was accessory to the protein chain; their attachment was reversible in the nuclear cycle and discontinuous along the length of the chromosome, being interrupted in the stretched fibres between the staining units.

The second revolution disturbs this part of the account. The content of DNA does not, it seems, fall in the resting nucleus but remains constant until it increases in the course of reproduction. Thus DNA may well be at least as constant and continuous a structural component of the chromosome as any protein that it may contain.

Several kinds of evidence contribute to this view and carry it even further. Isolated sperm heads[4] and isolated chromosomes[5] have been shown to consist of DNA and protein and a small and variable quantity of RNA. Now the protein varies in character. It is supposed to be largely histone in body-cell nuclei of animals. But, in fish sperm (which carry, in a sense, an India paper edition of the nucleus) it is largely protamine, a smaller molecule than histone, with a different amino-acid content[6]. Other 'residual proteins' in nuclei, moreover, vary in quantity[7].

For the DNA, on the other hand, several kinds of evidence have been obtained in favour of constancy. In regard to quantity, Boivin[8] and Mirsky[9] and their collaborators have shown that a nucleus with a standard chromosome complement (and I shall return later to define what this means) contains a constant amount of DNA. In regard to quality, Chargaff[10] and others have shown that DNA (unlike RNA, which varies from tissue to tissue) has nucleotide proportions in terms of purine and pyrimidine bases. characteristic of the chromosome complement, or the sum of the genes, or the genotype. The analogy here is with the letters in a book the proportions of which differ in different works but are constant in one work or at least one edition. The infinite diversity of words, or of genes, is not, of course, revealed by quantitative analysis of whole books or whole nuclei in terms of these smaller units.

A second property of DNA revealed by these determinations has been the equality in number of the large purine and the small pyrimidine bases. This, together with the crystallographic picture and the template principle, has suggested a new model of DNA[11]. According to Watson and Crick, the DNA normally exists in the chromosome as a double and coiled nucleotide column, each side of which, if separated from its partner, can act as a template for the assembling of the other. On this basis DNA would appear as a self-sufficient genetic structure with the protein at least mechanically subordinate. But, of course, we do not need to take such an extreme view: equality and reciprocity are also conceivable.

This new knowledge leaves some uncertainties and a few apparent contradictions. But it allows us to reconsider the rules governing a part of chromosome behaviour, those concerned with changes of shape within the nucleus, which I have called the internal mechanics of chromosomes. It allows us to find out how far the micron point of view agrees with the angstrom point of view.

## 2. Spiralization

The reproductive or mitotic cycle of the nucleus depends on the alternation of two states, the nucleus and the chromosomes, each of which is stable in its internal mechanics. In the metaphase or most contracted state of the chromosomes the gene-strings are packed for transit in a small, if not the smallest, bulk; and the genes themselves are inactive. In the resting nucleus the chromosomes have absorbed water and have swollen to tens or hundreds of times their metaphase bulk. The genes are, or at least may be, engaged in reproducing themselves and in producing also RNA (ribonucleic acid) and proteins. Both these, partly by way of a special globular structure, the nucleolus[12], are believed to pass into the cytoplasm; but their relative importance is debatable, like that of the DNA and protein in the reproduction of the chromosome.

The physiological activity of the chromosomes is shown very easily. Nuclei which differ in content of

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[*] Substance of a paper to Section B (Chemistry) of the British Association meeting at Bristol read on September 1.

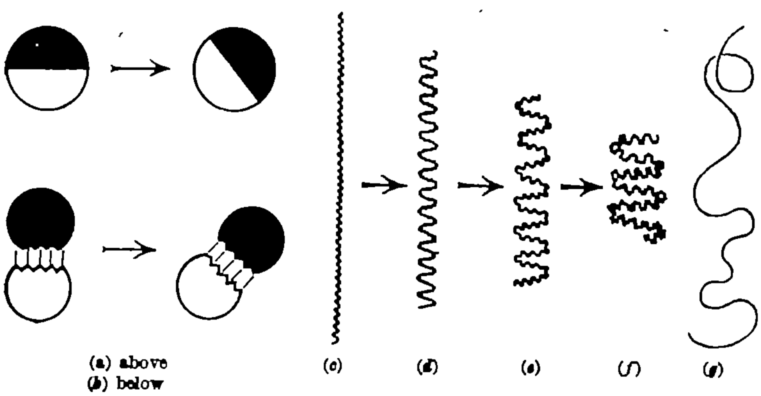

Fig. 1. The three levels of spiral formation. (a) twisting, an internal-molecular change; (b) rolling, a relational change demonstrating the pairing face; (c, d, e, f) coiling stages in the successive development of major, minor and perhaps third-order coils during prophase; (g) relic coiling formed by relaxation in the resting nucleus

genes are regularly produced in the spores which arise at meiosis in most plants: and when they differ the spores diverge in the rate of their growth, a divergence which is the basis of fertility and sterility in plants. The reproductive activity of the chromosomes, on the other hand, shows itself in their double structure: when they appear at the beginning of the next mitosis they have divided into pairs of chromatids. This change is reflected in the doubled DNA content of the nucleus[13].

Side by side with the physiological cycle of mitosis there is also a mechanical cycle which has been called a spiralization cycle. In the first stage or prophase of mitosis each chromosome consists of paired chromatids arising from reproduction. These separately assume a helical or coiled structure which reduces their length to about one-tenth at the metaphase stage[14]. When the chromatids reconstitute daughter nuclei at the end of mitosis by absorbing water, they stretch these coils; but movement is limited by space and the coils fail to straighten. By a kind of hysteresis they are retained right through to the next mitosis, where they reappear as relic coils. The minute incipient internal coils[1] arise quite independently of the large decaying relic coils (Fig. 1).

Three questions now arise. (1) How is the coiling set up? (2) What determines its direction, whether left- or right-handed? (3) Is the visible coiling sufficient to account for all changes in length?

(1) The coiling might be set up by rotation of the ends, just as we coil a piece of wire; if, that is, any outside force were conceivable that could twist ends of fibres in a cell against the resistance of the fibres themselves. This idea, however, is quite excluded by the fact that chromosomes, which have no ends at all, can take a spiral form. In various plants where ring chromosomes have been produced experimentally, they meet with frequent accidents. But they can take a spiral form and they can reproduce. Moreover, in *Drosophila* they propagate themselves well enough to keep the fly alive and, what is more remarkable, allow it to pass them on to its progeny after a due amount of crossing-over[15].

Scarcely less decisive is the evidence of complexes in which all rotation has been stopped by an experimental breakage and reunion of chromatids, which can unite in one body the whole chromosome complement[16]. On such grounds the force setting up coiling must be supposed to b
internal. There must be a mol
cular twist which determines an
at the same time compensat
for the internal coiling (Fig. 1
Now the daughter rings which
ring chromosome produces fa
apart, usually without interlock
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ring chromosome. In other word
each chromosome must be sup
posed to have a reproductive o
splitting or cleavage face which i
continuous throughout its lengt
and continuous also throughout th
mitotic cycle.

(2) The direction of coiling o
chromosomes is another matte
Left and right systems are foun
together in the same nucleus and, in diploid nucle
in the same pair of chromosomes. The direction is
however, probably constant for each arm of
chromosome at each mitosis. Now, if the directio
of twisting as well as the capacity for twisting wer
inherent in each piece of chromosome, the exchang
of pieces which is continually going on in the cours
of evolution would have led to utter disorder lon
ago. The direction, therefore, must be under unitar
control. Probably the agent is the centromere, th
non-spiralizing group of genes which, in each chromo
some, influences or directs all movements, includin
chemical movements, in which the chromosome ha
to behave as a unit (Figs. 2, 3 and 4).

(3) The answer to the third question is given b
certain resting nuclei of glandular cells in flies. I
the salivary glands, for example, the chromosome
are visible in the resting nuclei and are probabl
stretched to as much as three hundred times thei

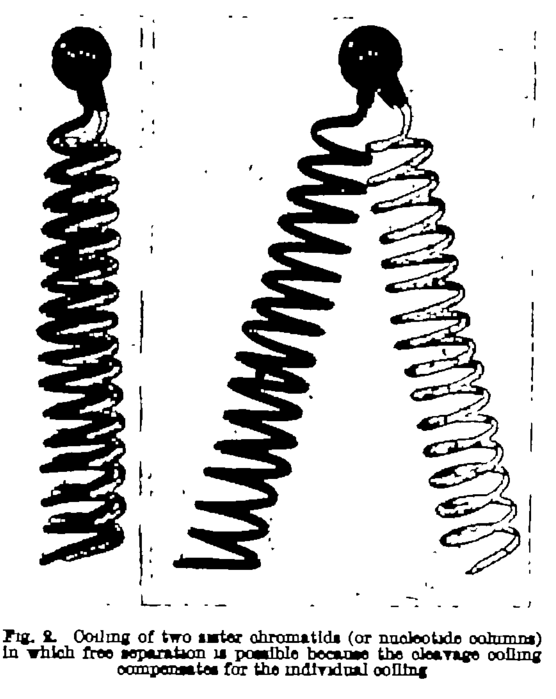

Fig. 2. Coiling of two sister chromatids (or nucleotide columns) in which free separation is possible because the cleavage coiling compensates for the individual coiling

minimum length[14]. Clearly, the single visible coil of mitosis is not enough to account for this degree of change. Part of the explanation is revealed at meiosis.

Meiosis is a distinct type of mitosis in which corresponding chromosomes pair, a process I shall return o later. So far as coiling is concerned, however, the metaphase chromosomes at meiosis show two special features. The first is that the paired chromatids may coil, not separately to form two rods as at mitosis, but jointly to form a single rod. When they do so, however, they are still capable of falling apart instantaneously when the chromosomes move to opposite poles (Fig. 2). In other words, we again have a strictly compensating coil and a strict cleavage face as in ring chromosomes.

The second feature of meiotic coiling is that a minor spiral (first described by Fujii in 1926) can be seen beneath or within the major spiral (Fig. 3). This two-order system of coiling goes with a greater shortening of the chromosomes. But since all degrees of shortening occur, we may suppose that there are two orders of coiling equally at mitosis and meiosis. Indeed, in view of the stretching of salivary-gland chromosomes, we may expect yet a third and lowest order of coiling or folding beyond the resolution of visible light.

How do these systems of coiling develop ? All visible coiling gets larger in amplitude as its develops, a principle which even extends to the last stage of relic coiling. Might there not be, therefore, an indefinite succession of coilings following one another ? The answer to these questions depends on another unknown which we may now consider.

## 3. Polynemy

The characteristic structure of a polypeptide chain or a nucleic acid or a chromosome depends on the lengthwise repetition or polymerization of a unit to give a fibre. The reproduction of a chromosome depends on a cross-wise repetition, a lateral polymerization, of the fibre. But is the chromosome itself a single ultimate unit ? Until recently, this was assumed. But the double nucleotide column at once doubles the minimum element. The biological evidence goes further than this.

Natural protein fibres are usually in bundles. Under certain special treatment, genes and chromosomes can behave as though they were composed of such bundles the constituents of which are capable of mutating or breaking independently[16]. The appearance or emergence of a mutation is then delayed several cell generations[17]: in *Amoeba* five generations suggest thirty-two fibres[18]. The effect of a break followed by reunion is to cause the appearance in the cell of exchanges looking like chiasmata. But they are exchanges between fractions of chromatids.

What does this mean ? An analogy is helpful. The chromosome in genetics has a validity like that of the atom in chemistry, unconditional for ordinary purposes but conditional for extraordinary purposes. Under ordinary conditions, in normal mitosis and normal reproduction, the chromosome acts as a unit. But under extraordinary treatments the unit is decomposed and forces us to admit that it is, after all, a bundle of fibres.

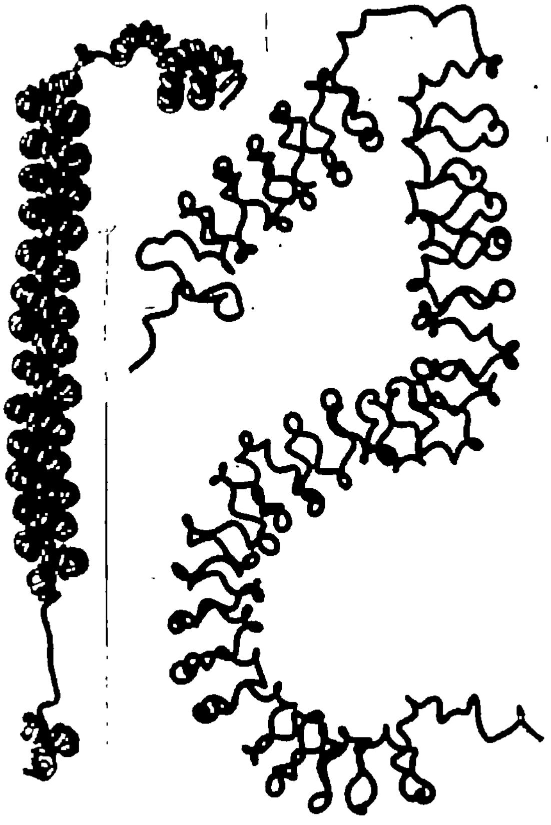

Fig. 3. Double system of coiling in a chromatid as seen at first anaphase of meiosis, and relaxed as relic coils in the ensuing resting nucleus

How many fibres ? We can make only comparative estimates. Closely related plants and animals with similar numbers and shapes of chromosomes often show wide differences in size. A range of the order of 128 : 1 seems indisputable, and it may be much higher[19]. Within the same organism a reduction of size to one-eighth has been found[20]. This happens only in blind-alley tissues of plants. In animals, however, of many groups, repeated chromosome halving is characteristic of the cleavage divisions of the egg[21,22]. In DNA economy, for which cleavage is a crisis, this seems to be the counterpart of 'diminution' in *Ascaris*. But it is a reversible diminution, for in the germ line the size must later be restored completely. In the body cells, on the other hand, we do not know that restoration is always complete: chromosome size, like chromosome number, may sometimes vary from tissue to tissue. Again, following X-raying of roots, chromosomes have been found to come into mitosis at about half their standard size[23]. Conversely, in haploid newts, the chromosomes are said to keep double their normal size, compensating, as it were, for the deficiency in numbers[11].

Can different degrees of multiplication, of polynemy as we may call it, occur in the same nucleus or the same chromosome ? Only once, as a result of hybridization, can this be supposed to have been seen. Species within many genera of plants and animals often have corresponding chromosome complements differing in size. These sometimes retain their differences in first crosses. Wanner and Bruhin[24] have succeeded by heat treatment of a species cross in breaking and recombining segments of the thick and thin chromosomes and so producing mosaic chromosomes. Such mosaics have never been found in Nature. It may be that the same general control which keeps all the chromosomes in step in a uniform nucleus can also usually put them right when they have fallen out of step.

Now if we consider the whole range of animals[9] and plants[14] known for their chromosome sizes and their DNA values, we notice that both vary over a range of 1,000 : 1. Where both are known, they vary in proportion : newts and lilies are large, mammals are medium, and fungi small. Again, we have evidence of a uniform nucleo-protein structure in the chromosomes. As a corollary, where we find related species the chromosomes of which are of similar shape but differ in size, we must assume that a difference in cross-wise multiplication, in polynemy, is responsible ; and the more so where the chromosomes vary in size within an individual.

Only the species test has so far been made. Hughes-Schrader has compared the DNA values of two species of the mantid *Liturgousa* which differ in size of chromosomes. One with smaller chromosomes has twice the number of its relative. It is apparently a tetraploid, one of the half-dozen cases known in animal species with sex chromosomes, But the DNA nuclear contents of the two species are the same[9]. Thus the chromosome, by lowering its polynemy, has compensated for raising its polyploidy ; the opposite to the haploid newt. In many plant genera these size and number relations hold[19]. In such genera DNA value may be expected to change with chromosome size.

In this argument, it will be seen, we are inverting the Boivin–Mirsky rule and using it to correct itself. We are using the quantity of DNA to define the complement of chromosomes and hence to reveal where the character of the complement has broken down or may be expected to break down.

A question of analytical practice is also worth noting here. Hitherto it has been convenient to take genotypic, structural and numerical change as the three dimensions of all variation in chromosome behaviour. Here, however, they cease to be sufficient. Polynemy falls in a class by itself, and is best considered as a fourth dimension of variation.

## 4. Reproduction

With the assumption of polynemy there are two levels at which the processes of gene and chromosome reproduction have to be considered : the ultimate unit of nucleo-protein fibre and the whole chromosome bundle, whether of thirty-two units, as has been assumed in *Amoeba*, or 128, as I would suppose in the large-chromosome lilies and amphibians. The unit fibre of the Watson–Crick model requires the separation of the paired and rolled or coiled columns of nucleotides so that each may act as the template in the building up of a new double column. Further, the mutual template relation of nucleotide columns still leaves us in need of a nucleotide template for protein manufacture. This has its ordinary stereochemical problem with the far-reaching implications discussed by Dounce and others[17] ; and it shares the common uncoiling problem of the nucleotides.

A separation, such as would be required for reproduction of the nucleotide and protein columns, would be possible if their coiling itself represented the molecular spiral the existence of which we have long predicted from the evidence of microscopy. Can i be taken by its amplitude to represent the molecula spiral ? The answer depends on two conditions tha are still uncertain : the degree of polynemy that ca be assumed in chromosomes of particular sizes ; an the position that is to be assigned to the protei components, the histones and residual proteins o Mirsky and his collaborators[7].

The reproduction of individual fibres will be th necessary antecedent of the splitting of the whol bundle, unless the chromosome is to step down t half its former size. The evidence of X-ray breakag indicates that this event coincides with the beginnin of mitosis at the moment when the chromosome begin to become spiral and cease to be breakable[18] We may suppose that bundles beyond a certain siz are unstable, the limit being characteristic of par ticular types of cell. A shift in stability will give change in chromosome size up or down. If the shif is in the germ track, the result may even have th character of an evolutionary change and it has bee described as a 'mutation'[19].

## 5. Meiosis

When the splitting of the chromosomes does no coincide with the beginning of mitosis but, on th contrary, follows it and consequently takes plac visibly and publicly, we have the other type o nuclear division : we have meiosis. We then discove several crucial tests of the mode of chromosom reproduction.

At meiosis the chromosomes become visible o 'enter prophase' when still single ; that is, befor they have reproduced and also before they hav completely untwisted. In this state chromosomes o a kind pair, piece by piece, zipwise. There are tw probably universal mechanical properties of thi pairing. First, the association or attraction is limite at any one point to twos, even when, as in polyploids there are three or more of a kind. Secondly, th chromosomes complete their untwisting and in s doing they set up a fourth kind of spiral system, tha of relational coiling. For once they rotate their ends If the pairing and coiling get out of step (as they d in hybrids) the chromosomes snarl like string unde torsion and this upsets their later development Whether the chromosomes roll right or wrong, the must roll around one another until their relationa torsion reaches equilibrium with their interna torsion, the common textile-spinning equilibrium They do not slip. Evidently the chromosome ha a pairing face just as it has a cleavage [fac (Fig. 1,*b*).

Now, it is difficult to see how columns of nucleotide could have such a pairing face when they are alread paired : they are saturated. But columns separated an prepared to attract the components of daughte columns could have a pairing face and might well b limited to attracting one partner. The face of th pairing chromosome appears to do just what the fac of the reproducing chromosome does : it attracts t itself similar particles in similar positions and in equa quantities. But the result is only momentarily th same. Equilibrium is not reached ; or if it is reached it is soon disturbed again. The preparations fo reproduction are continued or resumed. This happen in the following way. Successive units of activit along the chromosome thread, the chromomere (Fig. 4), are continuing to produce the protein which, according to Caspersson, are pushing the

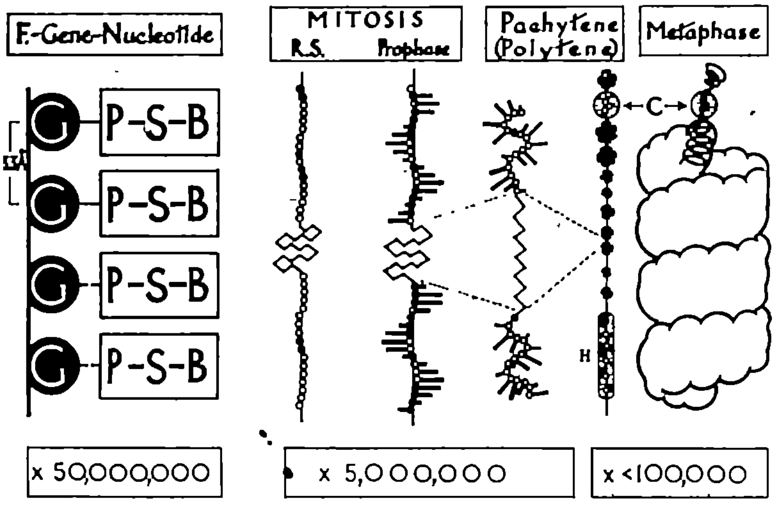

**Fig. 4.** The chromosome considered on the earlier assumption of a single protein thread with a single spiral detachable DNA column and represented at three magnifications

*F*, protein fibre; *R.S.*, resting stage; *C*, centromere; *H*, heterochromatin (reduced from Darlington and Mather, ref. 30)

tion of the parts of genes (Fig. 4). For both vary in different parts of the same chromosome[30] and the same part varies in different tissues of the same organism[31]. These variations must have a molecular basis and that is a problem we have to keep in mind.

## 6. Free Deoxyribonucleic Acid

It is important to see how far we can go with the assumption that DNA is the structural basis of the gene and the chromosome. But we know that DNA can exist in a free state. The occurrence of bacterial transformation shows how important this free state can be. In animal eggs and in the pollen mother cells and pollen grains of plants, reserves of DNA in excess of the nuclear constant have been determined[32], and in the cytoplasm granules containing DNA have been identified[33]. Moreover, there have been found in the Feulgen-staining of chromosomes variations which are related to the capacity for spindle production in the cell at mitosis. This is particularly striking in the differentiation of the mammalian bone marrow, where the red and white blood corpuscle precursors, as described by La Cour, are respectively glutted and starved of DNA; the starved chromosomes are thinner and also longer than the glutted ones[34].

apart and making them visible. The protein and DNA content of the nucleus rises, and when it is doubled[29] the chromosomes split and at the same moment they fall apart.

Thus, although pairing is a substitute for reproduction and may well delay reproduction, it does not prevent it. Why? The rolling or relational coiling of the partners is a sign that the partners are not themselves completely uncoiled at the molecular level and are not therefore attached along one continuous face: the pairing face and the splitting face do not agree. This disagreement may be the reason why pairing is not a substitute for reproduction. The torsion which underlies it is certainly the reason why reproduction is usually followed by a sequence of mechanical changes. For the torsion is released when the chromosomes split into weaker half-threads, the chromatids. It is released by the breakage at corresponding points of pairs of chromatids, their unrolling and reunion in new combinations; all of which together the breeder calls crossing over and the cytologist calls the formation of a chiasma. Both these vary in frequency, as does the torsion which precedes and apparently determines them.

Two points now concern us about these processes. First, the universality and potential uniformity in their time, place and action demonstrate the uniformity in molecular structure of all chromosomes and of their properties of pairing and cleavage. The great range of size and, as we suppose, of polynemy, does not upset the system.

Secondly, a conditionally particulate structure of the chromosome is suggested by chromomeres which can sometimes be seen, and by genes which can correspondingly be inferred. Such a structure, in turn, suggests that only in the intervals between the particles will crossing over usually occur. The chromomeres are condensed regions of coiling or folding joined by stretched fibres which must be weaker. The fewer the number of weak points at which breakage of the two chromatids can occur, the more exactly opposite will the breakage be. It also seems likely that the clustering and folding within chromomeres are related to the physiological integra-

These general variations are to be contrasted with a second type of variations which are cyclical and localized. In many plants and animals there are particular segments of particular chromosomes which seem to accumulate DNA in an unpolymerized or fluid state during the resting stage of the nucleus. These segments are probably groups of smaller and less specific genes[35]. They are known as heterochromatin. Quantitative observations on the cyclical behaviour of heterochromatin are much needed. For the time being we can only say that it appears to differ from the rest of the chromosomes in the rate at which it undergoes mitotic changes, and the difference can be exaggerated at low temperatures. At metaphase, the heterochromatic segments may then appear to be deficient in DNA; they show nucleic acid starvation. They differ from the rest of the chromosomes somewhat as the chromosomes in the white cells differ from those in the red; they are thinner and more weakly staining than the unstarved parts. They remain, however, the same length as when unstarved[35].

In extreme circumstances where there is little heterochromatin in the nucleus, its starvation can also, it seems, be extreme. In certain polyploid plants and in the *X*-chromosome of the hamster[36] and other mammals[37], formation of spirals fails with extreme starvation. This was the first indication we had that DNA was an essential agent in spiral formation, the nucleotides being supposed to be arranged like the steps in a spiral staircase (Fig. 4).

The recent experiments of Mirsky and Ris[7] on isolated chromosomes have carried us a great deal further. They have shown that it is the combination of the polymerized DNA and residual protein (not histone or protamine) which maintains the fibrous structure and thus must determine the forming of spirals of the chromosome. Similarly, the observation that DNA-starved segments show errors of reproduction, sticking of chromatids, was taken to mean that DNA was essential for reproduction of the protein thread. But, of course, we merely notice the DNA because we use it as a marker for staining in routine observation. It would be better, therefore, to say that the protein and DNA are necessary to one another in the right combination.

Are we justified, then, in reconsidering the whole assumption of nucleic acid starvation ? Could we suppose that the starved chromosomes or segments in all these cases are indeed chromosomes which have divided without reproduction of their individual fibres—chromosomes reduced in protein as well as in DNA to half-strength ? On this view, a chromosome with a thin starved segment would be like one in the *Crepis* hybrid between two species with two levels of polynemy.

A number of properties of starvation put this view out of court. First, with local starvation, minute segments of ordinary chromosome can be intercalated in a length of heterochromatin. They are then visible as minute darkly staining points in the starved segment[37]. Secondly, with general starvation and, conversely, with general plethora, there is always a correlation with spindle development and probably general protein production in the cell[38]. Such differences have no parallel in the group of cases where chromosome size is spontaneously or experimentally stepped down.

The two bodies of evidence of DNA as a solely genetic structure on one hand, and as a partly physiological fluid on the other hand, are now in plain contradiction. Before we can resolve this contradiction, however, we shall need to solve problems in the wider field of cell-nucleus relations.

## 7. Cell and Nucleus

The nucleus is the most highly organized part of the cell, and it has hitherto been accessible to more varied modes of experiment and analysis than the cytoplasm around it. It was necessary to establish the nuclear framework of heredity before we filled in the cytoplasmic details. We had to understand nuclear genes before we could invent plasmagenes[40]. So it must be, to some extent, with the chemistry underlying heredity. But we must all the time use the relations of the two, and the relations of chemistry and genetics to keep our bearings.

The predominance of the cytoplasm for the short-term effects which we call physiological and the predominance of the nucleus for the long-term effects which we call genetic, has led to a continual conflict of opinion. On a basis of chemistry and also of microbiology the conflict is being resolved. Nucleus and cytoplasm propagate their enzymatically significant proteins by means of genetic particles, which depend, one on DNA, the other on RNA. The nucleus exerts its long-term control over the cytoplasm by permanently changing its composition ; by passing out into it RNA, perhaps also protein, and exceptionally, also DNA. But, like a good administrator, it delegates as much of its work as possible to the cytoplasm. It delegates the business of respiration to the mitochondria, and as Brachet showed, from the growth of *Acetabularia* cells without nuclei[41], it delegates the routine work of protein production, so far as it is routine work, to the cytoplasm where the RNA-rich microsomes can, no doubt, undertake an unlimited amount of repetitive activity.

The cytoplasm exerts its short-term control over the nucleus not as a rule by changing the composition of the chromosomes, for such changes are irreversible, but by feeding them with materials which either stimulate the activity of certain genes, or provide for the reproduction of all of them. In regard to these alternatives, the cytoplasm differs at the two ends of any cell the products of which are going to follow a different course of development[39]. Similarly, the initiation of meiosis in the nucleus, so often synchronized for large groups of cells, must arise from a sudden change in the cytoplasm, probably the diversion of energy from protein production to processes of nuclear transformation[42].

Our knowledge of the chromosome as a physicochemical entity will continue to be gained in part from these physiological reactions which we can so readily control in our experiments. We have to continue trying, as in the present discussion, to combine ideas expressed in the three languages of the angstrom, the micron, and the naked eye. We may fumble in our efforts to translate ; but in the end we shall learn the same language.

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# CHEMISTRY OF THE GRAM-STAINING PROCESS*

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RIBONUCLEIC ACID (RNA) and deoxyribonucleic acid (DNA) form a high proportion of the organic matter of all bacteria and other micro-organisms. In some yeasts the nucleic acid components may amount to 20 per cent of the dry weight of the cells. While it is quite evident that deoxyribonucleic acid plays a vital part in cell division, constituting, with combined protein, the major part of cell genes and chromosomes, it is by no means clear what are the major functions of ribonucleic acid. Evidence is growing that it plays an important part in protein synthesis, and it also seems to be closely associated with polysaccharide synthesis. Ribonucleic acid forms a high proportion of plant viruses, while deoxyribonucleic acid is present in animal viruses and bacteriophages.

We have tried to discover the significance of both types of nucleic acid on or near the surface of some bacteria, and what connexion they have with the complex surface polysaccharides or 'capsular' components of the bacterial cell.

It is well to remember that there are enormous differences between individual bacteria, and each eventually will have to be treated from the chemical point of view as an individual. Our bacteriological colleagues have built up a vast store of knowledge regarding the activities of all these individuals. By microscopic, staining, fermentation and immunological techniques, it is possible to identify them all rapidly and with great precision. The chemical reasons for the characteristics of morphology and of staining reactions are but little understood. One in particular is the Gram stain, the most commonly used of all bacteriological staining techniques. It consists, as discovered by Christian Gram, a Dane, in 1883, in staining fixed smears with an aqueous solution of a dye of the *p*-rosaniline series and mordanting with aqueous iodine. Subsequent washing with alcohol or acetone removes the dye from so-called 'Gram-negatives' and leaves the 'Gram-positives' stained deeply blue-black. Animal and vegetable cells are not affected by the Gram stain. There are many important microbiological differences between Gram-positives and Gram-negatives. Thus Gram-positives such as the pneumococci usually can be knocked out by chemotherapeutics and antibiotics but give, on injection or after infection, a poor immunity. Gram-negatives, such as the dysentery bacillus, are much less susceptible to chemotherapeutic agents and antibiotics but can give rise to a high degree of immunity.

It seemed apparent that there must be considerable differences between the surface components of Gram-negatives and Gram-positives. Many theories had been put forward in the past to explain the Gram reaction, and most of the early ones were based on studies of the diffusion of the dye through the cell membrane and its subsequent failure to pass out again. Many organisms can readily lose their Gram-positive character under a variety of conditions such as 'old age', treatment with alkalis and acids, and during the process known as autolysis. The resultant Gram-negative cells usually appear smaller and shrunken, and there is an apparent loss of surface material which gives in some cases a reaction for nucleic acids.

With the late Dr. H. Henry we showed that suitable Gram-positive bacteria could be 'stripped' of an essential component of their Gram-positive material by extraction with 2 per cent sodium cholate at 60° C. and thereby rendered Gram-negative. A fraction obtained from material in the extract, itself Gram-negative, could be 'replated' on to the Gram-negative 'cytoskeletons' under reducing conditions to restore in a large measure the Gram-positive characteristics.

This essential part of the extract was identified as the magnesium salt of ribonucleic acid, and we expressed the view that the dye-retaining material, that is, the 'Gram complex', was a magnesium ribonucleoprotein. This was eventually isolated from a number of Gram-positives by a short autolytic procedure and dissociated into Gram-negative magnesium ribonucleic acid and a Gram-negative basic protein which, if the —S—S— groups in the latter were kept intact, would re-combine to give a Gram-positive mass.

Further support came from various workers who showed that ribonucleases would destroy the Gram complex. Striking effects on Gram-positive cells can be obtained with reagents which have a strong affinity for ribonucleic acid. Lithium salts, for example, will cause the nucleic acids to aggregate into masses at the sides and ends of rod-shaped bacteria. Surface-active agents also cause the ribonucleic acid to clump initially and then to disappear. The significance of both magnesium and ribonucleic acid can be demonstrated with one organism, *Clostridium sporogenes*, a Gram-positive, which will grow in Gram-negative form under adverse cultural conditions such as magnesium starvation. Addition of magnesium salts will slowly restore the Gram-positive state, while addition of magnesium–ribonucleic acid will rapidly restore both living and dead organisms to the Gram-positive state.

In removing the surface layers of Gram-positives, many other macromolecules are removed, for example, polysaccharides, fats, phosphatides, etc.; but only ribonucleic acid will 'replate' in any measure. The replating can be seen in a striking manner by photographs in the ultra-violet, where the nucleic acids absorb. Dr. P. Mitchell, of Cambridge, has claimed that the essential part of the Gram complex is a '*P*' factor which is a phosphatide. In our hands, however, extraction, for example, of *Cl. welchii* cells, with boiling methanol and ether for several hours which would remove all Mitchell's factor, leaves 80 per cent of the cells Gram-positive. Phosphatides may help to absorb more of the dyestuff in the intact cell.

In true Gram-negatives, which have a significant ribonucleic acid content, and in Gram-negative cytoskeletons, the magnesium is all in ionic form; whereas in Gram-positives the major proportion of it is in co-ordinated form.

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* Abridged from a paper entitled "Taking the Nucleic Acid Jackets off Bacteria" to Section B (Chemistry) of the British Association meeting at Bristol read on September 1.

Magnesium plays an important part in bacterial cell division and is an essential element for most Gram-positives, which require a higher proportion than do Gram-negatives. Since we have not been able to 'plate' magnesium ribonucleic acid on to true Gram-negatives, we consider that they possess proteins located near the surface which are in quite a different class from those in Gram-positives.

It has been possible, on the other hand, to use ribonucleic acid from Gram-negatives and from many other sources to 'replate' Gram-negative cytoskeletons, so that ribonucleic acid does not show any specificity in this type of interaction with protein. In no case could deoxyribonucleic acid be plated on to cytoskeletons. Recently we have made many efforts to obtain nucleic acids from yeast by means of mechanical disintegration of cells, and we have noted in such cases that the cytoskeletons cannot be restored to the Gram-positive state, neither can cytoskeletons be rendered Gram-negative by autolysis methods. The latter may be due to the very powerful and persistent action of ribonuclease, and only quite recently have we been able to isolate nucleoproteins from yeast free of this enzyme.

We have been able to discover that the useful antiseptic detergent, cetyltrimethyl ammonium bromide ('Cetavlon'), exerts its powerful action on micro-organisms by combining strongly with the surface ribonucleic acid. We have shown that there is a close association between the ribonucleic acid–protein surface components of the Gram complex and polysaccharide synthesis in some micro-organisms. This can be shown very well with those *Streptococci* which produce dextrans and lævans. It is possible that the ribonucleic acid of the Gram complex is part of the enzyme system, for while purifying dextrans and lævans and many other polysaccharides, ribonucleic acid can be shown invariably to be present as an impurity which is difficult to remove by fractionation methods.

The close association of nucleic acid with polysaccharide synthesis can be shown in a much more striking manner in the *Pneumococcus* group of bacteria, in which case deoxyribonucleic acid takes the vital role. Deoxyribonucleic acid 'jackets' in this group can be changed in a dramatic way, and when the jackets are changed we get a change of polysaccharide 'overcoat' also, for the deoxyribonucleic acid jackets and overcoats apparently have to match. The seventy types of pneumococci are detected by means of their serological reactions. Each type of *Pneumococcus* possesses a structurally different polysaccharide of high complexity, and running through the whole group is one common 'somatic' or group polysaccharide. Some of the structural differences between the specific polysaccharides are very profound, for example, as between types 1 and 3, while others have closely similar structures, for example, types 3 and 8.

In 1928 an Englishman, Griffiths, discovered the transformation of types whereby one type of *Pneumococcus* could be transformed into another thus :

Rough Type 1 live cells + Heat-killed encapsulated cells of smooth Type 2 → Type 2 live cells

also

Rough Type 2 live cells + Heat-killed smooth Type 1 → Type 1 live cells

also

Rough Type 2 live cells + Heat-killed smooth Type 3 → Type 3 live cells

Dawson and colleagues in the United States later confirmed these discoveries, and showed that any type could be transformed through its unencapsulated live form ; while Alloway, also in the United States, dissolved the heat-killed cells in sodium cholate and showed that extracts would still achieve the transformation of types. Then came the dramatic work of Avery and his colleagues in the Rockefeller Institute, showing that the factor achieving the transformation was deoxyribonucleic acid—a kind of type-specific deoxyribonucleic acid in each case.

A number of types have now been transformed with the appropriate highly purified deoxyribonucleic acid. The transformed cell takes on all the properties of the new type, including the property to reproduce the transforming deoxyribonucleic acid. Other bacterial types have also been transformed, and, in addition, other properties such as drug resistance have been transferred.

If we consider the mechanism of the biosynthesis of polysaccharides, we know that three components are required, namely, enzyme, substrate (a specific glucoside) and a primer. The latter must possess appropriate receptor groups and must be of the same pattern as the polymer to be synthesized, and it must possess a minimum number of sugar units in its chain.

According to these requirements, then, the transforming deoxyribonucleic acid could possess, and carry with it, its polysaccharide primer. Possibly a simple mono-layer would be sufficient, and it need be no larger than an oligosaccharide. In my view, it would mean that the so-called 'memory' of the transforming deoxyribonucleic acid is not solely due to its own structure, but is due in part to the specific carbohydrate structure holding it rigidly in shape until it meets, in the Rough form of an unencapsulated *Pneumococcus* cell, a receptive protein with which it can combine to re-form the complete enzyme system for polysaccharide synthesis. It is of interest to note what remarkable differences there are between the chemical structures of the *Pneumococcus*-specific polysaccharides, which are probably built up as 'block polymers'.

One of the great fields of investigation awaiting the attention of chemists is that involving the isolation and the chemistry of nucleoproteins. Determination of the mode of linkage between these two groups of natural molecule and their isolation in a form whereby biological function is retained will help in solving problems connected with the chemistry of living matter—especially with chromosomes, enzymes and viruses.

Our work has shown that their dissociation and recombination to retain 'living' attributes may not be too difficult a problem.

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# RADIATION DAMAGE TO METALS AND ASSOCIATED PROBLEMS

N the course of the annual autumn meeting of the Institute of Metals, held this year in Buxton, a discussion was held on September 22 on the subject f "Radiation Damage in Metals". The Metal Physics Committee of the Institute had arranged this disussion under the chairmanship of Prof. R. W. K. Honeycombe, professor of physical metallurgy in the University of Sheffield, and speakers were drawn from the Metallurgy Division of the Atomic Energy Research Establishment.

Dr. M. J. Makin spoke about the effect of radiation on the mechanical properties of metals and the mportance of knowledge of this phenomenon when undertaking the building of nuclear reactors, much of the structure of which is inevitably exposed to a heavy flux of neutrons. An experiment in which the mechanical properties of nickel were tested before nd after irradiation showed, in respect of the rradiated sample, a considerable increase in yield stress, some reduction of ductility and a general ifting of the stress–strain curve. The rate of work-hardening was less in irradiated material than in the original. The mechanical properties of irradiated pecimens recorded at different testing temperatures showed that the results obtained were very dependent upon temperature, while a further variation in these properties was related to the temperature at which he irradiation took place. Some of the irradiation ffects can be annealed out. Experiments with copper show that 300–400° C. is a suitable range, orresponding to an activation energy of approximately 2 eV. With nickel, the range is 350–400° C., uggesting that the activation energy is about the ame as that of self-diffusion. The temperature indicated for nickel is rather lower than that at which cold work anneals out and, further, the eduction of ductility by irradiation is much less than hat brought about by cold work.

The effect produced by irradiation on mechanical properties appears to resemble more closely the change produced by the addition of an alloying element than, as had been suggested originally, that oduced by cold work. Irradiation of material with a ductile-brittle transformation raised the transition emperature. Work on single crystals of ductile metals shows that the rate of increase of yield stress s not linear; the effect appears to be proportional to the ½ power of the neutron dose, and there is no vidence of a saturation point. Efforts have been made to picture a mechanism involving the displacement of atoms by fast neutrons. Thus, Brinkman, discussing copper, has suggested that the knocked-on atom actually melts a very small region of the crystal and that solidification is so rapid that the atom will not return to its original position. Another uggestion is that the copper atoms knocked out of he lattice migrate in clusters, forming a pseudo-precipitate which is attached to dislocations.

Discussing techniques used in studying radiation damage, Mr. O. Plail said that the main divisions of his study—irradiation and subsequent examination—both call for special experimental techniques and cientific apparatus of novel types. It is necessary in he first place to avoid damage to the pile and, in he second, to carry out delicate tests by remote control on specimens which are strongly radioactive. Mr. Plail's contribution clearly demonstrated the demands now made on technicians and apparatus constructors and how well these demands have been met.

Dr. P. C. L. Pfeil dealt particularly with the preparation and microscopic examination of irradiated specimens. The microscope used is of the usual inverted type, but the optical system following the objective is replaced by a high-definition television camera. The camera is connected to a large monitor-tube mounted in a conventional cabinet, and the image of the specimen is displayed on this monitor. A very high standard of resolution has been attained, photographs of the screen image (magnification, × 1,000) being remarkably clear. Dr. Pfeil discussed the microstructures revealed by such examination and mentioned that a Russian delegate at the Geneva Conference reported that a sample of alloy containing alpha-uranium and gamma-uranium became 100 per cent gamma-phase when irradiated at a temperature at which it would otherwise have remained two-phase. There is a difference of opinion as to the mechanism involved in this change, but Dr. Pfeil favours the view that the presence of a body-centred-cubic nucleating agent will initiate the growth of a small region of body-centred-cubic structure among atoms which are cooling after the intense local heating in the track of a particle.

Dr. H. M. Finniston, head of the Metallurgy Division of the Atomic Energy Research Establishment, spoke about radiation damage in uranium and the marked dimensional changes observed in irradiated specimens. It has been found possible to study the dimensional changes by using a thermal analogy, and, although the phenomena are entirely different, the analogue method has given valuable information. It centres around the alpha–beta change which occurs at 650° C. and consists of repeated thermal cycling between 600 and 650° C. When this method was applied to rod specimens prepared in different ways, some specimens bent, and others grew lengthwise or suffered severe surface wrinkling. These effects can be explained by considering how the different fabrication processes or treatments have affected crystal orientation in the rods, since uranium shows pronounced crystal anisotropy. The closeness of the analogy is demonstrated by the effect of pile irradiation on single-crystal specimens of uranium which grow in the direction of the preferred axis. Dr. Finniston discussed the possible forms in which nuclear fuel might be prepared in future. He also referred to the difficulties of studying the properties of plutonium, which has six phase changes against the three in uranium.

Dr. J. H. O. Varley discussed radiation damage in ionic solids with particular reference to the alkali halides and methods of evaluating σ, the ionization cross-section. The investigating tool used is the colouring of the halide crystals on irradiation[1,2]. The colouring can be partly bleached out by light and more thoroughly by heat. The 'temporary' colouring (bleached by light) corresponds to displacements of electrons in the lattice, and the 'permanent' colouring (fast to light) is associated with displacement of atoms. The measured cross-section determined from the number of permanent colour centres per c.c.

produced by a given bombardment is of the order $3 \times 10^{-21}$ cm.$^2$. The cross-section calculated on the assumption that displacements are produced by direct collision with atomic nuclei lies between $5 \times 10^{-23}$ and $10^{-22}$ cm.$^2$. The measured cross-section gives a lower limit to the value pertaining to the principal displacement mechanism because there is not necessarily a one–one correspondence between the number of displacements and the number of colour centres produced. Dr. Varley used the relation between the cross-section $\sigma_p$ for a $p$-fold ionization of a given atom or ion and the cross-section $\sigma_1$ for a single ionization in the approximate formula

$$\sigma_p \sim \sigma_1 \left(\frac{\sigma_1}{A}\right)^{p-1}$$

where $A$ is the 'area' of the atom. From the range–energy relation obtained experimentally, it appears that $\sigma_1$ is of the order $10^{-17}$ cm.$^2$; $A$ can be taken as $\sim 10^{-15}$ cm.$^2$. By the substitution

$$\sigma_p \sim 10^{-17}(10^{-2})^{p-1}$$

since $\sigma_p \sim 10^{-21}$ cm.$^2$, the approximation gives $p = 3$ as the number of electrons stripped from one ion. It is thus indicated that the removal of three electrons from a given negative ion is a sufficiently probable process to account for the number of colour centres and, consequently, for displacements produced, if it be assumed that each one of these three-fold ionized ions is ejected from its lattice site and trapped at some other site in the crystal. The end-state can thus be halogen atoms in interstitial positions, trapped in positive-ion vacancies or at dislocations, and electrons trapped in the sites vacated by the halogen ions, these electrons giving rise to the colour centres. Dr. Varley concluded by remarking that vacancy pairs can lead to fast bleaching by acting as scavengers, but there is still much to be elucidated.

J. F. HINSLEY

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[2] Varley, J. H. O., *Nature*, 174, 886 (1954).

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# THE NATIONAL GEOGRAPHIC SOCIETY—PALOMAR OBSERVATORY SKY ATLAS

THE first section of the Palomar Sky Atlas has recently been distributed to subscribers. This Atlas is being prepared from a survey of the sky north of declination −27°, made with the 48-inch Schmidt telescope on Mount Palomar. This area of the sky has been photographed on 879 pairs of plates; each plate of size 14 in. × 14 in. covers an area of 7 × 7 degrees. The plate centres are separated by 6°, so that adjacent plates overlap by ½ degree.

Each field is photographed in two colours in immediate succession. The blue exposures are obtained on the Eastman 103*a*0 emulsion, with a wave-length range of from 3500 A. (the short-wave transmission limit of the correcting plate) to 5000 A., the maximum sensitivity being at about 4100 A. The red exposures are obtained on the Eastman 103*aE* emulsion, combined with a red 'Plexiglass' filter, with a wave-length range of from 6200 A. (the short-wave cut-off limit of the filter) to 6700 A., the maximum sensitivity being at about 6500 A.

The exposure times for each series were chosen to reach the faintest stars which can be recorded by the telescope under average observing conditions. These times were separately determined for each shipment of plates and range from 10 to 15 min. for the blue exposures and from 40 to 60 min. for the red. The photographic magnitude limit is 21·1 for the blue plates and 20·0 for the red. The magnitudes of stellar images on the blue plates are approximately on the same system as that of the international photographic magnitudes, and those of the images on the red plates are approximately on the same system as the red magnitudes of Kron and Smith. The differences between blue and red magnitudes of stars on the survey plates are approximately 1·6 times their international colour indices. Stars having an international colour index of 0·7 appear about equally bright on the blue and red plates. The scale of the plates is 67·1 seconds of arc per millimetre.

Each pair of photographs of a field was inspected for quality before being accepted for reproduction in the atlas. If one member of a pair was rejected, the area was re-photographed in both colours. Many fields had to be photographed several times before both plates were passed as acceptable.

The photographs were first reproduced as positive transparencies. The photographic prints are in the form of negative reproductions, because they alone permit of satisfactory preservation of the plate limit. The prints were made by the Graphic Arts Facilities of the California Institute of Technology. Care has been taken to ensure that the faintest details at the limits of the plates are reproduced even at the price of inadequate reproduction of bright objects, so that the images of faint stars, galaxies and nebulosities, which are beyond the reach of smaller instruments, are preserved.

After extensive tests and trials, Eastman Kodak Finegrain Positive glass plates were selected for the positive transparencies and Eastman Kodak Unicontrast double-weight paper for the negative prints. The contrast of the paper is gamma 2·0, practically independent of development. The original plates show considerable variation in background density, which depends upon the sky brightness. Original plates with background densities less than 0·3 and greater than 0·9 were found to give inferior results and were rejected. The most satisfactory reproduction was found to be obtained by printing all positives to a density of 1·4. The paper prints were found to be most satisfactory with a density of 0·2 or slightly higher.

On the back of each print is stamped the nominal position of the plate centre for epoch 1855. In the north-east corner of each photograph is a label giving the serial number of the plate, the date of the exposure and the 1950 co-ordinates of the field centre.

The survey was made financially possible by generous grants from the National Geographic Society, which provided the photographic materials and equipment, the salaries of the personnel employed on the survey, and the cost of producing two contact positives on glass of each survey photograph. The bserving time with the 48-inch Schmidt telescope required to obtain the survey photographs was made available by the Palomar Observatory of the California Institute of Technology. Approximately ight years of observing time (1949–56) will be equired to obtain the negatives. The copyright for the Atlas is held by the National Geographic Society.

The Atlas has been made available at a price that overs only the cost of production and handling of he prints. The estimated cost was 2,000 dollars per set of 1,758 prints (879 blue exposures and 879 red exposures) if fifty copies were ordered and ,600 dollars per set if a hundred copies were ordered. The actual price can only be established after the printing is completed. Cancellation of orders will be accepted if the estimated price is higher than ,000 dollars. Only one printing of the Atlas is planned, and no orders could be accepted after October 1, 1954, when the reproduction was commenced.

The Atlas will provide an invaluable working tool for observatories that possess copies. The Franklin Adams Charts, which covered the whole sky but which were made from originals on blue-sensitive emulsions only and which did not reach nearly to such a faint magnitude as the Palomar survey, have for many years proved of great value for many purposes. The photographs in two colours of the present survey and the faint-magnitude limit reached are of special importance: it is readily possible, for example, to recognize red stars and blue stars by the comparison of the sizes of their images on the blue and red photographs, while for such studies as those of interstellar absorption and the distribution of faint galaxies the reproductions will prove most useful.

It is recommended that, in order to prevent damaging the prints when in use, they should be covered with glass plates. The most satisfactory illumination is with the light source low and to the rear.

In making this Atlas available and at a reasonable price, astronomy will owe a great debt to the National Geographic Society and to the Mount Palomar Observatory.

H. SPENCER JONES

# OBITUARIES

## Prof. A. R. Radcliffe-Brown

WITH the death on October 24 at the age of seventy-four of Prof. Alfred Reginald Radcliffe-Brown, emeritus professor in the University of Oxford, comparative social anthropology has lost its leader and foremost exponent. An intellectual heir of Montesquieu, Comte and Spencer, he represented the theoretical tradition which culminated in Durkheim, flourished with the French sociological school and was submitted to the test of empirical field-observations by British anthropology.

Radcliffe-Brown read mental and moral science as a scholar of Trinity College, Cambridge, and he worked with both Rivers and Haddon. At the age of twenty-six, after his election to the Antony Wilkin studentship in ethnology, he carried out research among the Andaman Islanders. His book under that title, completed in 1913 and published in 1922, is a brilliant analysis of ritual and of social organization. Together with the account of the Cambridge expedition to the Torres Straits and with Malinowski's "Argonauts of the Western Pacific", it inaugurated a new departure and pointed the way to the intensive field-work characteristic of modern anthropology. Apart from a number of important articles, this pioneering work marked Radcliffe-Brown's principal contribution to the field-study of primitive peoples. This was due mainly to his conception of social anthropology as a natural science of society and, within this discipline, to his personal attraction to inquiries aiming at the establishment of general principles.

Radcliffe-Brown propagated his views with zeal, and this left him with little time for field-investigations. He was appointed the first professor of social anthropology in the University of Cape Town (1921), head of the newly created Department at Sydney (1926), where he founded and edited *Oceania*, and professor at Chicago in 1931. Between 1937 and 1946 he occupied the newly created chair at Oxford, where he was a Fellow of All Souls, which had taken a leading part in its establishment. He also taught social anthropology at Cambridge, London, Birmingham, Pretoria, Johannesburg, Yenching, São Paulo, Alexandria, Manchester and Grahamstown.

A man of distinctive appearance, he combined a natural charm of manner, kindness to his colleagues and generosity to his juniors with an innate reserve which, at times, bordered on aloofness. He was happiest and most relaxed in the social climate of a 'salon', where he could discuss with equal verve an exotic recipe or his personal conception of Confucian philosophy.

Radcliffe-Brown was by temperament, method and necessity a thinker rather than an observer, a conversationalist, lecturer and essayist rather than the writer of lengthy treatises. He wrote with *litotes* and crystalline clarity, and his essays on kinship, taboo, primitive law and social structure have proved invaluable in helping to lay the anthropological foundations of the subject; and they are indispensable in its present-day teaching.

J. G. PERISTIANY

## Dr. G. Placzek

DR. GEORGE PLACZEK, of the Institute of Advanced Study, Princeton, who died at Zurich on October 16, was born in 1905 in Brunn (now Brno, Czechoslovakia). After studying theoretical physics in Vienna and Prague, he moved around Europe, working in Utrecht, Leipzig, Copenhagen and Paris, among other places. He spent a year at the Hebrew University, Jerusalem. In 1938 he went to Cornell University, and later worked on atomic energy at Cambridge, Montreal and Los Alamos. After two years in the research laboratory of the General Electric Company at Schenectady, he joined the Institute for Advanced Study in Princeton in 1948. He married in 1943.

Placzek's earliest major work was on the theory of the Raman effect, on which his review article became a classic. This led to a study of molecular rotational states, then a fruitful tool for determining nuclear spins. Later he turned to neutron problems. With O. R. Frisch he first proved that resonance-levels for neutron capture have extremely low energies. In collaboration with others, he helped to clarify the dispersion formula for nuclear reactions. Then came a study of the slowing-down of neutrons, which was started for its intrinsic interest, but proved of great importance for work on atomic energy. This led to study of the integral equations of neutron multiplication summed up recently in a book he wrote with K. M. Case and F. de Hoffmann. Since the end of the Second World War, his main interest has been in the scattering of neutrons by solids and liquids, which is important both for its contribution to neutron physics (it made possible the interpretation of experiments on neutron–electron interaction) and for its application to the study of solid state.

In each field his work was characterized by a penetrating thoroughness. He would not leave a problem so long as there was an important difficulty unsolved or a major relation not thought out. He always used simple techniques where possible, and usually used symmetry principles and classical laws for results where others might have tried much more elaborate methods.

His standards were high, and he had no patience with slipshod arguments either in his own work or in that of others. He did not suffer fools gladly, and this is probably why he had no enthusiasm for teaching, and had only a few pupils. But to those, and to others on his own level, discussions with him were always inspiring.

But what will be remembered of Placzek above all was his personal charm, his width of intense interest and his erudition, his understanding of people, and his integrity. He would have no more patience with slackness of moral principles than with sloppy mathematics, and he would not pay attention to the effect his principles would have on his personal convenience.

In his later years he was much troubled with ill-health, and for much of the time he would not have been able to keep his work going but for his iron determination, and for the care, and the vitality, of his wife.

R. E. PEIERLS

# NEWS and VIEWS

## British Cotton Industry Research Association: Dr. F. C. Toy, C.B.E.

The Council of the British Cotton Industry Research Association has announced that Dr. F. C. Toy will be retiring from his position as director of research at the end of this year. He was first appointed in 1944, having previously served for thirteen years as deputy director under the late Sir Robert Pickard. During his directorship, the Shirley Institute has expanded considerably to meet the increasing and changing demands of the industry it serves, and it is due largely to his wise and able direction that, by the quality and value of its work, the Institute is now generally recognized in industrial and scientific circles alike as the leading textile research association in the world. Although the main feature of the advances made under his influence has been the wider appreciation and utilization in the Lancashire textile industry of the practical results of research, he has remained true to his conviction that technological advances must ultimately be based on fundamental research, and he has ensured that a steady flow of such work has been maintained. This is reflected in the fact that the scientific standing of the Institute was never higher than it is to-day. Dr. Toy has the gift of stimulating interest and enlisting the support not only of those working under him, but also of those with whom he comes in contact, and it is not surprising, therefore, that he has won the respect of his staff, and of men at all levels in the Lancashire industry. The national importance of his work was recognized by the award of the C.B.E. in 1947.

The heavy responsibilities of his office have not lessened Dr. Toy's interest in his own subject of physics, and throughout his career he has taken an active part in the affairs of the Institute of Physics, culminating in his appointment as president for the period 1948–50. He has also taken a leading part in the activities of the well-known Manchester Statistical Society, of which he was the president during 1951–53. Although Dr. Toy leaves the Institute to the care of a younger man, he himself is undiminished in vigour of mind and body, and while one sympathizes with his desire to relax a little, one hopes that the great services he is yet able to render both science and industry will not be lost to the country.

## Dr. D. W. Hill

Dr. D. W. Hill, who succeeds Dr. Toy as director of the British Cotton Industry Research Association, joined the staff of the Shirley Institute in 1937 and was appointed deputy director in 1944; and it is a source of pleasure to the industry and to the staff of the Institute that he will be able to continue and extend the work which he has shared with the director for the past twelve years. Dr. Hill was born in Bristol, and is a chemist by training, having graduated from the University of Bristol with first-class honours in chemistry in 1924. After academic work in Liverpool and three years in the research laboratories of Messrs. Boots Pure Drug Co., Nottingham, he spent three years with a Commonwealth Fund Fellowship first at the University of Illinois and then at the Rockefeller Institute. Then came a year in the University of Bonn, followed by two years as special lecturer in chemistry in the Universities of Bristol and Exeter.

With this background of academic and industrial research, Dr. Hill was appointed to an administrative position at the Shirley Institute in 1937; but in 1940 was seconded to the Cotton Control, working in Manchester and London, and also for a time in the United States. He returned to the Shirley Institute in 1944 as deputy director. Dr. Hill's two books, "The Impact and Value of Science" (1944) and "Co-operative Research in Industry" (1946), are well known, and prove his complete faith in the value of co-operative research as it has been developed in Britain. He is fully convinced of the need for the carrying out of fundamental research by a research association serving what is still largely a craft industry, but is also very conscious of the need to apply the results of such research as quickly as possible to the special requirements of that industry. These are difficult times in Lancashire, but it is Dr. Hill's conviction that the greater the difficulties the better the opportunity for proving the value of scientific and technological research.

## Thomas Graham (1805–69)

Thomas Graham, whose discoveries in chemistry and physics had far-reaching effects on modern physiology, was born at Glasgow one hundred and fifty years ago on December 20, 1805. He studied chemistry at the University of Glasgow under Thomas Thomson, graduated M.A. in 1824, and in 1830 became professor of chemistry at the Andersonian College. In 1837 he was appointed to the chair of chemistry at University College, London, and in 1855 he succeeded Sir John Herschel as Master of the Mint. Graham's name is attached to a tube plugged at one end with plaster of paris, which he used in his experiments on the molecular diffusion of gases (1829–31), and to his famous law. Separating animal and other fluids by dialysis, he distinguished between colloids and crystalloids; he also established the polybasic nature of phosphoric acid and noted the formation with alcohol of certain salts, which he called alcoates and which he observed to be analogous to hydrates. Graham possessed a lively mind, though his body was feeble, and he led a full and busy life. He was vice-president of the chemical jury at the Great Exhibition of 1851 and assisted in various inquiries ranging from the ventilation in the House of Commons and London's water supply to methods of gun-casting. At the age of thirty-one he was elected a Fellow of the Royal Society and was awarded Royal Medals in 1838 and 1850. In 1840 he became the first president of the Chemical Society, which he had helped to found, and six years later first president of the Cavendish Society. His "Elements of Chemistry" (1842) was long a classic. Graham died on September 11, 1869, at the age of sixty-four.

## Gregor Johann Mendel

Prof. E. O. Dodson, of the University of Notre Dame, United States, has been fortunate enough to obtain a transcript of material on the life and work of Mendel taken from the archives of Mendel's monastery and of the Augustinian Order in Rome. The material was collected during the 1930's under the direction of the Right Rev. F. W. Howard, Bishop of Covington, Kentucky, and was entrusted by him to Sister M. Julitta, of Villa Madonna College (*Scientific Monthly*, 81, No. 4; October 1955). Using this material, Prof. Dodson has compiled a fascinating account of Mendel's early life and education, his training and monastic work in the monastery of Brunn, his election as abbot, and his unswerving endeavours to discover natural laws. The article also throws new light on the rediscovery of Mendel's work by de Vries, Correns and von Tschermak.

## Noise, Vibration and Health

In the House of Commons on December 2, Sir Lionel Heald introduced a debate on the effect of noise and vibration on the health, well-being and efficiency of the nation, and urged the Government to give careful attention to research and education in this field, and to the need for more effective measures for the protection of the public. Tribute was paid by Sir Lionel, and by other speakers, to the immense amount of work which has been done in this field by the Building Research Station, and, on the medical side, by Dr. Littler and others at King's College Hospital; but it was urged that full advantage is not being taken of available knowledge. Mr. R. Bell, in seconding the motion, besides directing attention to the scope for administrative action and the need for some amendment of the law, suggested that Ministers responsible for departments which are the main offenders should insist on departmental programmes of research and education, and in particular urged that the definition of noise should replace vague terms such as 'reasonable and practicable'. Replying for the Government, the Joint Under-Secretary of State for the Home Department, Sir Hugh Lucas-Tooth, agreed that responsibility must rest with individual departments, and he advised the House to accept the motion. The control of exhaust noise from motor-vehicles is partly in the hands of the police, with whom man-power is a major difficulty, and partly a technical problem between the Ministry and the manufacturers. As regards aircraft, a new principle embodied in the Conway engine is claimed to effect a further reduction in noise, and in the view of the Minister of Supply, technical effort in this field should be directed to the problem in connexion with new types of aircraft. Sir Hugh also referred to the study of vibration caused by passing aircraft, undertaken by the Building Research Station, to the attention being given to the prevention of noise in hospitals and to the investigations of the effect of noise in factories made by the Industrial Health Research Board.

## Thermonuclear Explosions

Following the broadcast from Moscow reported in the press that Soviet Russia is willing to discontinue hydrogen bomb tests by common agreement, the Government has been repeatedly questioned in the House of Commons on the subject. On November 30, in reply to Mr. Attlee, the Prime Minister stated that the Government had had no communication on the subject from the Soviet Government, but was ready to discuss these matters at any time. Sir Anthony commented that the reported statement might have appeared in a better light if it had been made before the recent Soviet explosion, and added that in any such discussions regard would have to be paid to the number and nature of the tests which each country had already made, as well as to those proposed. He also said that it remained the view of the British Government that a comprehensive disarmament agreement is the only final solution to these problems. When pressed by Mr. Attlee on that day, the Prime Minister did not, however, deal with the fundamental reason causing concern over the continuance of such tests, namely, the possible biological effects of the resultant radiation, or with the fact that no system of inspection is necessary to ensure that thermonuclear tests are not made in spite of undertaking to discontinue them, because such explosions can be detected over a wide area. These points were raised on December 1 in a question asking the Prime Minister to propose to President Eisenhower and Marshal Bulganin a cessation of all nuclear explosions pending the report of the United Nations Commission which is considering the effects of radiation. There was also on the notice paper a motion regretting the continuance of such tests, and expressing the belief that the tests in themselves involve a danger to the human race and requesting the Government not to proceed with such tests. On December 6, in reply to further questions, the Prime Minister suggested that we should await the report on nuclear radiation from the Medical Research Council, which is expected within two or three months, and also one from the United States National Academy of Sciences. He also said that the Government has no intention of departing from its decision to manufacture the hydrogen bomb, and it still regards manufacture and possession of the hydrogen bomb as a deterrent to war. While willing to discuss methods of regulating and limiting test explosions which take account of our position as well as that of other countries, the Government is not prepared to accept agreements which would put the United Kingdom in a position of decisive inferiority to other great Powers and one not justified by our scientific knowledge and resources.

## Gift to the University of Leeds for a Research Institute of African Geology

THE Anglo-American Corporation of South Africa, Ltd., has recently given £100,000 to the University of Leeds for the foundation of a Research Institute of African Geology under the direction of Prof. W. Q. Kennedy. The Research Institute will be an integral part of the Department of Geology, of which Prof. Kennedy is head, and will have as its primary objects fundamental research into the origin of mineral deposits generally and the study of African geological structure in particular, and the training of postgraduate research geologists by means of active field-work in connexion with problems of African geology. Both research fellows and post-graduate research students will work on the complex problems of rock constitution, tectonics and mineral distribution in various parts of Africa. The field sessions in Africa will alternate with periods of laboratory work in Leeds, where the Department of Geology is already well equipped to undertake such work and where an additional building now being converted for use by the Department will help to house the Research Institute. By this means it is hoped to gather information both on the interpretation of continental structure and the determination of the factors which control the distribution of minerals of economic value. Prof. Kennedy has been concerned for some years with geological problems in various parts of Africa, and during 1951 and 1952 led expeditions to Mount Ruwenzori (16,794 ft.) on the border of Uganda and the Belgian Congo. These expeditions, which included members of the Colonial Geological Survey, the British Museum (Natural History) and the University of Leeds, have resulted in a new interpretation of the structure of that area.

## Mining, Geological and Metallurgical Institute of India

NEXT January, the Mining, Geological and Metallurgical Institute of India will celebrate its golden jubilee. At the turn of the century, the need for scientific development and utilization of the mineral wealth already discovered in India by geologists was beginning to be realized by the pioneers in the field of mineral industry. At that time, there was no technical association in the country specifically devoted to the promotion of study and research in geology, mining and metallurgy. Conscious of the need for such an organization, and one that would also safeguard the interests of the industries and personnel concerned, a number of leading mining engineers, geologists and industrialists founded the Institute in January 1906. From its inception the Institute has played a part of ever-increasing importance in guiding and developing the technical advances pertaining to geology, mining and metallurgy in India. To celebrate the fiftieth anniversary, the Institute has arranged for an exhibition of modern mining and metallurgical equipment and a programme of visits to coal, manganese-ore, iron-ore, mica, and oil fields, manufacturing and industrial centres, and dam sites. These will be held in January immediately after th Industries Fair at Delhi, and just before the meeting of the Indian Science Congress at Agra. The Institut will welcome members of the mining, geological metallurgical and allied engineering professions, an of learned societies and related technical organizations in other parts of the world. Further informatio can be obtained from the headquarters of th Institute at 27 Chowringhee, Calcutta 13.

## Indian Council of Ecological Research

FOLLOWING a resolution made by the Governmen of India, the Indian Council of Ecological Researc has been founded. Its main objectives will be t study Indian vegetation with the view of collectin basic data on desert and flood control, forestry, soi conservation, agriculture, wild-life management nature conservancy and pasture management. Th founder-chairman of the Council is Shri C. R Ranganathan, inspector-general of forests to th Government of India. The Council has recentl published the first number of its *Bulletin* (1, No. 1 October 1955. Indian Council of Ecological Research New Forest, Dehra Dun). This number contains statement on the vegetation types of India issued a the symposium organized by the Indian Botanica Society held at Baroda during January 1–2, 1955 which led up to the Government's resolution. Th terms of reference of the new Council are also included, together with a personal note on its founder chairman. G. S. Puri, secretary of the Council, contributes a paper on the aims and objectives o ecology, and there are two short papers by Prof W. H. Pearsall (London) and E. H. Graham (Washington).

## Comets and Climatic Changes

IN a paper entitled "Évidences Cométaires de Variations des Climats" (*Bull. Astro. Inst. Czechoslovakia*, 6, No. 1; 1955), F. Link and Z. Linkov deal with statistical research relating to the discover of comets, correlated with solar activity. They hav found that the annual number of comets discovere varies in the course of the solar cycle of eleven years This variation is inversely proportional to rainfall with two maxima during the eleven years, accordin to Helman's investigations, and more recently it ha been found that the number of comets discovere during a cycle is greater in the even than in the od cycles. The numbers of comets discovered betwee 1755 and 1953 are arranged in cycles 1–18, and the the mean number of discoveries per year in th successive cycles is given separately for even and odd cycles. The influence of the meteorological conditions on the observations of comets is shown by means of a graph. Solar activity being greater durin the odd cycles, the circulation in the terrestrial atmosphere is increased, and in consequence observations become more difficult; as a result of this, ther is a decrease in the number of comets observed.

This close connexion between the number of comet discovered and the meteorological conditions (th latter depending on solar activity) led the authors t carry out investigations on climatic variations sinc 1611, and the principle underlying this research i based on the assumption that the number of comet discovered is a function of three factors: the cosmi factor, that is, the actual number of comets tha approached the Earth; the climatic factor, or th atmospheric conditions in civilized countries, whic only need be included, as observations of comets i uncivilized countries would be useless for statistical purposes; the social factor or human activity (in particular, astronomical activity) in civilized countries. While the first factor can be regarded as constant, the second would increase in a more-or-less continuous manner in time, and the third would be revealed in the slope of the curve $N = f(A)$, $N$ being the number of comets discovered from zero year up to the year $A$. Both these quantities have been taken from a catalogue by Baldet ("Ann. Bur. Long", Supp. 1950), and a searching analysis of the results leads to certain conclusions on the meteorological conditions between the years 600 B.C.–A.D. 1740. A comparison is made between these and the data given by C. E. P. Brooks in "Climate through the Ages", covering about a thousand years up to comparatively recent times, and there is a close accordance between them. The Czechoslovak workers hope to carry out further investigations on the subject.

### Imperial Forestry Institute, Oxford: Report for 1953–54

In an introduction to the thirtieth annual report of the Imperial Forestry Institute, Oxford, for 1953–54 (pp. 29; 1955) there is a good résumé of the work of the year. The number of students, particularly in the graduating class and in the research group, naturally varies from year to year; it was below normal during the year under review, but the report states that there would be an increase in the following year. A noteworthy feature of 1953–54 was that practically none of the new graduates sought employment either with the Forestry Commission or in the Colonial Forestry Service. They showed a preference for careers in private enterprises in Britain or Canada. Forestry employment in many of the Colonies is in such an uncertain position that the preference for a safe job is not surprising, though rather sad. Forestry probationers from overseas still go to the Institute; of the ten men who obtained the forestry degree, one was a Colonial forest probationer and returned to his Colony, one was a New Zealand forest scholar and has returned home, and two have gone back to Canada. Sixteen officers of the Colonial Service attended the forest officers' course, coming from Nigeria, Tanganyika, Northern Rhodesia, Sierra Leone, Kenya, Uganda, North Borneo and Fiji. The special Indian course has not yet grown to maturity; but two forest officers attended it, one from India (Bengal) and one from Pakistan (Punjab). The practical courses on the Continent have increased both in number and variety, and are arranged for the varying types of students attending the Institute. The work of the different branches of the Institute is discussed, and the report as a whole furnishes evidence of the value of the Institute to British forestry in its widest sense.

### Crystallographic Symposia in Madrid

The International Union of Crystallography is holding a symposium in Madrid during April 2–7, 1956, on "Structure on a Scale between the Atomic and the Microscopic Dimensions". As well as the symposium, the Union is organizing an open meeting of the Commission on Crystallographic Apparatus and also a series of meetings on crystallographic teaching during April 3–6. Details of the programme will be published in *Acta Crystallographica*; but the main topics are: analysis of material from a world-wide survey; apparatus and books for teaching crystallography; and the teaching of crystal physics, crystal geometry, structure analysis, mathematical techniques and machines. Short papers for circulation prior to the meeting should be submitted by February 1, all communications being sent to the secretary, Dr. H. Judith Grenville-Wells, Chemistry Department, University College, Gower Street, London, W.C.1. Those who wish to submit papers should send the titles and abstracts by January 1 to the chairman of the Programme Committee, Prof. A. Guinier, Conservatoire National des Arts et Métiers, 292 rue Saint-Martin, Paris 3e. Further information on the symposium can be obtained from the Secretario del Comité del Symposium de la Union Internationale de Cristallographie, Instituto de Fisica, Serrano 119, Madrid.

### Animal and Human Diseases in East Africa: Conference in Kampala

The East African Medical Research Scientific Advisory Committee will be holding a "Zoonoses Conference" in Uganda at Makerere College, Kampala, during January 11–13, under the presidency of Mr. H. Binns, director of the East African Veterinary Research Organization, Muguga, Kenya. The first day will be devoted to the general pattern of both human and animal diseases in East Africa and their relation to the fauna, particular attention being paid to kala azar, plague, relapsing fever, rabies and Q fever. During the following two days there will be four symposia at which will be considered brucellosis, helminthiasis, viruses and trypanosomiasis, respectively. The conference secretary is Prof. J. N. P. Davies, Pathology Department, Makerere College Medical School, P.O. Box 2072, Kampala, Uganda, to whom all correspondence should be addressed.

### Announcements

The Chemical Society is offering a Corday–Morgan Medal for 1954 which, together with a prize of 200 guineas, is open to persons of British nationality, less than thirty-six years old, for published work in experimental chemistry. Applications or recommendations for the award should be made before December 31 to the Chemical Society, Burlington House, London, W.1.

The Radio Industrial Council is again offering this year up to six premiums of 25 guineas for articles which are likely to enhance the reputation of Great Britain in radio, television and electronics. Articles published in journals circulating exclusively to members of a trade or in privately published journals of professional institutions or learned societies will not be eligible. In addition, the author must not be engaged full-time in technical writing. Entries, which must include five copies of the article concerned, should be sent before December 31 to the Secretary, Radio Industry Council, 59 Russell Square, London, W.C.1.

A series of natural-history lectures and films for junior audiences, 10–16 years of age, will be given at the British Museum (Natural History), South Kensington, London, S.W.7, during the Christmas holidays, starting on December 27 and continuing each day until January 7, Sundays excepted. The lectures will be free and without booking. Programmes are available on application to the inquiries desk or on written application to the guide lecturer at the Museum.

# LONDON RESEARCH STATION OF THE GAS COUNCIL

## OPENING OF NEW LABORATORIES

On November 18, Sir Robert Robinson formally opened new laboratory buildings at the Fulham works of the North Thames Gas Board which provide additional accommodation for pilot plant and chemical engineering experimental work. Together with the older buildings, these laboratories now constitute the Fulham Laboratories of the Gas Council's London Research Station.

Prior to the nationalization of the gas industry in 1949, there existed two main research establishments in Britain concerned with the production and use of gaseous fuels. These were the research department of the Gas Light and Coke Company started in 1924, and the Gas Research Board, which was set up in association with the Department of Scientific and Industrial Research in 1939. After vesting day, the Gas Council assumed responsibility for research in the industry, and it was decided to keep the former Gas Light and Coke Company's laboratories at Fulham in action as the London Research Station, and to set up a new research station in the Midlands to replace the Gas Research Board.

The London Research Station now consists of two groups of laboratories. Those situated at Fulham gas works are concerned with the manufacture and purification of gas, and with the recovery of by-products. Those at Watson House, on a site adjoining the works, are devoted to the use of gas in appliances of all kinds. The station is operated by the North Thames Gas Board on behalf of the Gas Council.

The laboratories at Fulham were originally opened in 1928 and at the end of the War had expanded into some temporary buildings which were used largely for pilot-plant experiments. The new buildings provide proper accommodation and facilities for this type of work. It is thus possible to carry out a research programme which covers a suitable range of small-scale, analytical and pilot-plant experiments together with design work in the chemical engineering field. Most of the new space is occupied by three large laboratories intended for pilot plants of small and medium size and for work in connexion with full-scale tests on plant in actual operation at any of the works of the North Thames Board. In addition, there are offices, lobbies, workshops and stores.

The older buildings, which were also open to inspection by visitors on November 18, contain four large laboratories which are devoted respectively to physical chemistry, to analytical operations, to by-products chemistry, and to problems arising from the construction and maintenance of gas-making plant. There are also offices, workshops, stores, several small laboratories for special purposes such as X-ray equipment or spectrographs, and a library.

The London Research Station is fortunate in that it can make full use of the extensive engineering, stores and workshop facilities of the Board. It is also customary for large pilot-plants to be installed at one or other of the Board's twenty-one gas-making works.

The overall programme of research authorized by the Gas Council is shared mainly between the London Research Station and the Midlands Research Station at Solihull; but work is also carried out in the laboratories of the South Eastern Gas Board, by the Fuel Department of the University of Leeds, and by other research associations to which the Gas Council subscribes. This programme falls into eleven main sections, concerned respectively with the manufacture of coal gas, the production of water gas and oil gas the cooling and washing of gases, the removal of sulphur compounds, the recovery of by-products, the construction and maintenance of gas-making plant flame and combustion, domestic and industrial heat services, ventilation and flues, refrigeration, and the provision and use of solid smokeless fuels.

Owing to the growing shortage and increased cost of good gas-making coals, some of the most important problems concern the production of gaseous fuels from low-grade coals and oils. Experiments on these problems were not on view at Fulham as they have reached the stage where the pilot plants have to be installed on a works site, or where the work is being done at the Midlands Station.

Among the items which were seen during the tour of the Fulham laboratories, particular interest is attached to four, which are concerned with the biological oxidation of aqueous effluents, the removal of sulphur compounds from gaseous fuels, the search for improved refractory materials, and studies in mass-transfer and heat-transfer processes.

During the purification of gases produced from coal, aqueous condensates are always obtained in association with tar. These liquors contain valuable substances such as ammonia and phenol, which are largely recovered; but small quantities of impurities always remain to make the final effluent harmful to vegetable or animal life in rivers or streams. In order to destroy the traces of phenols and ammonium thiocyanate which are present in these liquors, biological treatment, apart from disposal in sewage treatment plant, is being investigated and a considerable degree of success has already been reached in the search for suitable cultures.

Crude fuel gases always contain sulphur compounds, notably in the form of hydrogen sulphide, and efforts are being made to replace the conventional dry-box purifier which is used for its removal by a process depending on liquid reagents. Any success in this direction might also involve the production of elemental sulphur by a catalytic process, and an investigation into the physical properties of catalysts is associated with this section of the programme. Interest in catalysts is also extended to those used for the decomposition of organic sulphur compounds in gases.

The carbonization of coal in continuous vertical retorts is a process with a high thermal efficiency and several other attractive features; but conditions in the retorts are so severe that the life of the refractory materials used in their construction is relatively short. Much of the damage arises at the time when carbon deposits are burned off the brickwork at intervals, and a search is being made for refractory materials which will resist this disruptive action. As a contribution to this search, the mechanism of the deposition of carbon and of its removal by combustion is being investigated in high-temperature experimental furnaces.

Many processes in the gas industry involve mass and heat transfer. For example, the cooling of gas is a process of heat transfer with simultaneous mass transfer of water vapour from the gas to the condensate film. Much original work on this subject is done by the chemical engineers of the staff of the laboratory. The removal of impurities such as ammonia from gas involves washing processes in which the type of packing in the scrubber is important. Pilot-plant studies of grid and ring packings have led to improvements in the design of full-scale plant.

The gas industry in Britain is at a stage where far-reaching changes in its techniques are needed, and the Gas Council's research stations are fully occupied with the experimental work on which new production methods will be based.

# MYXOMATOSIS

The Mammal Society of the British Isles held a symposium on myxomatosis at the London Zoo on November 5; Dr. L. Harrison Matthews took the chair.

Mr. H. V. Thompson (Ministry of Agriculture, Fisheries and Food) gave a general historical introduction and then described the main aspects of myxomatosis in Britain, pointing his description with evidence derived from other countries affected by the disease. Careful records have been kept of outbreaks of myxomatosis in Britain and, since the first notification of the disease in October 1953, it has spread over most of England, Wales and Scotland, although pockets of rabbits still survive in many places. In Continental Europe, the disease has spread from France to Belgium, Luxembourg, the Netherlands and Germany and, more recently, to Austria, Italy, Spain and Switzerland.

Since the first epizootic of myxomatosis in Australia during 1950–51, there has each summer been a similar epizootic, depending for its effectiveness mainly upon the presence and activity of adequate numbers of mosquito vectors. The natural spread of myxomatosis in Australia has been rapid, and, even when moving slowly, speeds of three miles a day have been recorded. In Britain, however, natural spread has been much slower, averaging three and a half miles a month in one carefully checked area. This slow spread, in an area where woodland mosquitoes were abundant but did not bite either wild rabbits or caged domestic rabbits, indicated that mosquitoes were not important vectors in Britain, and the rabbit flea has, in fact, been found to be the principal vector.

Mrs. G. Lane (Hon. Miriam Rothschild) considered the main vectors in her paper, stating that far too little is known of the natural history of the rabbit flea (*Spilopsyllus cuniculi*) and stressing the need for more research. In Northamptonshire all wild rabbits were infested with this flea, and a dense rabbit population is usually heavily infested. It may be found that in areas sparsely populated with rabbits, fleas are correspondingly few; it is possible that as the rabbit population falls, due to myxomatosis, so will the numbers of fleas on the remaining rabbits, a natural check being thereby offered to the disease. If a rabbit becomes infected with myxomatosis, then the infection spreads rapidly to all the fleas on that rabbit. The fleas are found to concentrate on the head and ears of the rabbit. It is interesting to note that when an infected flea bites a rabbit on the ear, the incubation period of the disease is much longer than after a bite on the head.

The grey squirrel flea (*Orchopeas howardi*), which can also be made to feed on rabbits, can become infected and be a reservoir of the virus for up to twenty days; the same may be true of other fleas.

The rabbit flea in Australia is a different species from that in Britain, and is a poor vector. Much of the work on vectors in Britain had been done by Dr. Muirhead Thomson, who was unfortunately unable to be present. The only mosquito so far implicated in the spread of myxomatosis in Britain is *Anopheles maculipennis atroparvus*. It has been found carrying infection in the same hutches as myxomatous rabbits. Unlike other British mosquitoes, *A. m. atroparvus* may live throughout the winter, feeding at intervals; but Mr. P. G. Shute considered that, since this mosquito rarely bites in the open, it is not likely to be an important vector. Dr. C. H. Andrewes pointed out, however, that the virus survives in the mosquito for as long as six months and, unlike many viruses, the titre of which falls initially and then builds up, the myxoma virus maintains its level in *A. m. atroparvus* with very little change. It is thus difficult to determine whether or not there is a multiplication of the virus in this mosquito.

Mr. J. R. Hudson (Ministry of Agriculture, Fisheries and Food) stated that myxomatosis is not readily transmitted by mechanical contact, such as wiping the nasal secretions from an infected rabbit on to a clean one, or by infected herbage. He also stated that animals of many different species, suspected of infection with myxomatosis, have been examined in his department; but with the exception of two hares there was no evidence of the disease affecting other animals. Five hares have been found in France with clinical myxomatosis, the disease being transmissible to rabbits but not to other hares.

Immune rabbits have been bred; but so far none of the progeny has shown any evidence of immunity. The residual rabbits in most parts of Britain are susceptible to myxomatosis; but in one area, part of Sherwood Forest in Nottingham, many rabbits have survived the disease and developed immunity. The strain of the virus is here much reduced in virulence, producing nodular lesions which contain fully virulent virus during the early stages but attenuated virus during the later stages. Attenuated field strains of myxoma virus have been recovered from several parts of Australia during the past two years, and this year have also been found in France.

The diet of foxes was discussed by Mr. H. V. Thompson in the light of stomach analyses being done in his department. He emphasized that the work is not yet complete; but that comparison with the results obtained by Southern and Watson fifteen years ago showed that there has been an increase of field voles, brown rats and vegetable matter in the diet of the lowland foxes, after myxomatosis. Similar changes in diet were also noted by Mr. H. N. Southern at Oxford. The small-mammal population declined considerably in the summer of 1955 following the arrival of myxomatosis, and the runways of mice and other small mammals were dug up by foxes. There has, however, been some recovery in the small-mammal population during the past autumn. Southern also noted a very low reproductive-rate among the resident population of tawny owls on the Wytham Estate, Oxford, and there was some evidence that foxes, and also stoats, had produced smaller litters than usual this year.

Dr. N. W. Moore (Nature Conservancy) described very striking reductions in the breeding of buzzards, few birds having produced eggs in areas affected by myxomatosis; but in the areas to which the disease had not spread by spring of this year, the reproduction-rate was normal. There is also evidence that buzzards are moving about much more than previously, although spread in the range of buzzards has been taking place for some years.

Hares appear this year to be colonizing areas vacated by rabbits, and to be more frequently found in woods than hitherto; they also appear to be more abundant than in 1954, but it is too early to impute these changes to the effects of myxomatosis. The situation is also complicated by a number of introductions of hares into Cornwall, Pembrokeshire and elsewhere.

There is already good evidence of the recovery of the rabbit population in areas which were considered to be largely cleared by the disease. Southern stated that at Wytham Estate, near Oxford, only three rabbits' tracks were seen during the winter of 1954–55, whereas many thousands of rabbits were present before the onset of myxomatosis; now twenty burrows have been reopened. Similar reports came from several parts of Britain.

Dr. A. S. Thomas (Nature Conservancy) reported striking botanical changes following the great reduction of rabbits. He took photographic records of particular areas before the onset of myxomatosis, and compared these with more recent photographs. Detailed records of the changes have also been made since March 1954 along transects in ten places, mostly on declared or proposed Nature reserves on the chalk; the total length of these transects is more than 23,000 ft., and fifty point quadrats are recorded on every 100 ft. once or twice yearly. The early results of this method are very encouraging. The grasses are higher, there is much better ground cover and a greater range of species, especially of the more palatable grasses and clovers which were grazed by the rabbits. Woody plants, especially ling and gorse, which were closely grazed by rabbits, have made much growth; in the case of gorse the shoots have been up to 18 in. long in twelve months.

There has been not only marked vegetative growth, but also a wonderful show of flowers, both of the common ones like cowslip and rock rose and also of the less common orchids, which have appeared in profusion in places where they were not previously noticed, because rabbit grazing prevented flowering. One interesting result of the disappearance of rabbits has been the great profusion of ragwort in some places during the summer; the plants colonized rabbit-grazed turf, but rabbits also prevented many of them from flowering.

Many plants which have been relatively common in areas of intense rabbit infestation have owed their abundance to the fact that they are unpalatable or poisonous and could flourish when rabbits ate down and killed more palatable species. Such plants include viper's bugloss, hound's tongue, deadly nightshade, stinging nettle and elder, all of which flourished on the disturbed and manured soil around rabbit holes. It is too early to look for marked changes in these plants; but already elder bushes are suffering in some places from the absence of rabbits, because increased stocking with cattle to utilize the increased grass has resulted in the barking and killing of elder. Increased stocking should also control the growth of other woody plants which are appearing in grassland areas now that they are no longer being eaten back by rabbits.

Mention was made by Mr. H. N. Southern (Bureau of Animal Population, Oxford) of the great increase in tree cover on the Wytham Estate, Oxford; ash and particularly oak saplings are appearing where they were scarcely seen before.

Mr. W. Ives, scientific liaison officer in London of the Commonwealth Scientific and Industrial Research Organization, Australia, spoke of the remarkable changes which have occurred in the vegetation in Australia since the rabbit population was reduced, saying that grass is now growing well in places that had been virtually desert and that, in some areas, land capable of carrying one sheep previously now carries two cows.

Kenneth M. Backhouse
Harry V. Thompson

# BIOCHEMICAL AND MICROBIOLOGICAL RESEARCH IN HUNGARY: SOME IMPRESSIONS

A generous invitation to spend three weeks this summer as guest of the Hungarian Federation of Technical and Scientific Societies (METESZ) enabled one of a party of six British and four French scientists to see something at first hand of recent academic research in biochemistry and microbiology in post-war Hungary. Damage and losses suffered during the War, the economic and social revolution and the reorganization of academic research under the ægis of the greatly enlarged and reconstituted Academy of Sciences have resulted in big changes and considerable expansion in research programmes. At the same time, they have inevitably led to many administrative difficulties, and heavier teaching responsibilities (associated with an increase of more than four-fold in the number of university students).

Academic research is also still handicapped in many parts of the country by shortage of specialized equipment. The more complicated laboratory apparatus such as high-speed centrifuges, spectrophotometers, electron microscopes, etc., is not manufactured in Hungary and has to be imported from the U.S.S.R., Germany and Czechoslovakia. This means that such instruments are only rarely available. There have also been delays and difficulties in obtaining radioisotopes, which are now, however, beginning to arrive from the Soviet Union.

Hungarian biochemistry has suffered much from the departure of Prof. A. Szent-Gyorgyi, together with several of his most valued younger colleagues, to the United States in 1947. This gap, however, is gradually being filled by the younger generation of biochemists led by Academician F. B. Straub (a former pupil of Szent-Gyorgyi), director of the Institute of Medical Chemistry in the Medical University of Budapest, and by Prof. E. Szorenyi, head of the Biochemical Institute of the Academy. Straub's department of sixteen workers is devoted primarily to a study of protein synthesis. In spite of old and unsuitable accommodation (the city was terribly damaged during the siege early in 1945 and much rebuilding is still needed), this group has been doing important work and has recently succeeded in demonstrating the production of amylase by a mitochondrial preparation from homogenates of pig and pigeon pancreas and the formation of pepsinogen by homogenates of gastric mucous membrane. Other work includes the study of induced penicillinase synthesis by protoplasts of *Bacillus cereus* (Dr. M. Kramer) and the development of a technique of reversible 'hæmolysis' of red blood cells (Dr. S. Manyay) whereby they are rendered temporarily permeable to adenosine triphosphate and other substances, without actual disruption of the cell membrane.

A group of young and enthusiastic protein chemists at the Biochemical Institute has a wide programme which includes (*a*) the study of scleroproteins, in particular the relationship between procollagen and collagen in mammalian skins and fish swim bladder (Dr. I. Komyat); (*b*) a comparative immunochemical investigation of serum albumens from horse, donkey and mule (Dr. F. Antoni); (*c*) an enzymological comparison of crystalline triosephosphate dehydrogenases from yeast, mammals and crustacea (Dr. P. Elödi); and (*d*) the specificity and speed of action of proteinases (for example, trypsin) on homologous and heterologous proteins (Mrs. G. Szabolcsi).

One of the most distinguished figures in Hungarian microbiological research is Academician G. Iványovics, director of the Microbiological Institute in the Medical University of Szeged, who is well known to many British and American microbiologists. This University was moved from Kolozsvár when Transylvania was handed over to Roumania after the First World War. The buildings are relatively new, well designed and pleasantly situated in one main group in this attractive town of 100,000 inhabitants on the River Tisza. Prof. V. Bruckner, of Budapest, has recently succeeded in synthesizing a D-glutamic acid polypeptide, which Iványovics has found to be chemically and immunologically similar to the polypeptide he originally isolated from the capsule of *Bacillus anthracis*. Iványovics is also studying the properties of a high-molecular weight substance—'megacin'—isolated from *Bacillus megaterium* after ultra-violet irradiation, which appears to be a type of 'bacteriocin', specifically able to lyse cultures of *B. megaterium*. Other work in this Institute includes research on animal viruses, typing of influenza strains, etc., and some interesting studies by Dr. L. Alföldy on a bacteriophage of *Pseudomonas aeruginosa* having properties intermediate between those of a virulent and temperate phage.

Another medical university is in Debrecen—a quiet town of about the same size as Szeged 140 miles due east of Budapest, with important historical traditions (it was declared the capital of the short-lived independent Hungarian Republic during the war of liberation led by Lajos Kossuth against the Hapsburg dynasty a century ago). Its main university was founded in the fourteenth century only a few years after the University of Budapest; but most of the present buildings are comparatively new and the medical university was built during and after the First World War in a pleasantly wooded park on the outskirts of the town. It consists of well-designed separate buildings for each department and related hospital clinics, connected by a system of underground corridors. Here, in the Institute of Pharmacology under the leadership of Prof. T. Vályi-Nagy, a small group of microbiologists is studying antibiotics. An interesting new compound—'primycin'—produced by a species of actinomyces isolated from the intestine of the wax moth, has been crystallized and found to inhibit the growth *in vitro* of both *Mycobacterium tuberculosis* and *Staphylococcus aureus* at a concentration of 0·02 µgm./ml. It is unfortunately too toxic for general use, but some promising preliminary results are reported after local application in superficial infections. Among other work, the inhibitory action of streptomycin on growth of the organism which itself produces this antibiotic (*Streptomyces griseus*) is being studied by Dr. G. Szabó.

Back in Budapest, at the Institute of Microbiology of the Medical University, an opportunity was afforded of seeing a technically very well-produced film, shown by Drs. I. Juhász and J. Vadász, of the remarkable phenomenon of cell regeneration from an apparently acellular degenerated mass of granular protoplasm formed after treatment of a strain of *Salmonella enteritidis* with high concentrations of penicillin.

Finally, specific mention should be made of the Institute of Genetics in Budapest where, apart from other work on higher plant genetics, Prof. B. Györffy has recently established a microbiological section comprising five workers covering a wide range of subjects: (*a*) heterokaryosis in *Penicillium* (Dr. Igali); (*b*) streptomycin resistance in *Serratia marcescens*; (*c*) nucleic acid chemistry (Dr. Thomas); and (*d*) transformation, by deoxyribonucleic acid extracts, of *Rhizobium* species (Mrs. R. Balassa), using streptomycin-resistance and ability to form nodules on the alfalfa plant as genetic characters, which appear to be transmitted independently of each other. After early difficulties, not unconnected with the attitude to genetics prevailing five years ago, when Györffy's department was in danger of becoming a subsidiary section of the Agricultural University, his Institute is now being fully supported, as an independent research centre, by the Academy.

All this, of course, represents nothing more than a glimpse at some of the research work at present being done in Hungary. Although far better supported than before the War, academic research still suffers, perhaps, from the relatively greater emphasis laid on applied research—in industry and in the technical and agricultural universities. This is understandable—perhaps inevitable—in view of the determined efforts at industrialization of what was primarily an agricultural community. It shows itself, especially, in some shortages of specialized equipment and the great difficulties in obtaining technical assistants, who are attracted into industrial establishments by salaries up to twice those which they can earn in institutes of pure research (a problem not exclusive to Hungary).

Although excellent library facilities (which compare favourably in some cases with those provided in similar British research centres) have allowed Hungarian scientists to keep closely in touch with recent advances in the West, this cannot compensate for the rarity of direct personal contact. Unfortunately, during the past few years, opportunities for direct contact have been largely restricted to countries in Eastern Europe. One of the most lasting impressions obtained from this recent visit was the repeatedly expressed desire to re-establish closer contact with Western scientists. The more favourable political climate should make it easier to remove the obstacles still present (on both sides) to a freer exchange of visits, and might perhaps even abolish some of the restrictions to normal trade relations which at present prevent the import of badly needed British scientific research equipment into Hungary. A conversation with Academician Bognár, general secretary to the Hungarian Academy of Sciences, gave grounds for hope that the Academy might actively support projects for a more liberal exchange of visits of individual scientists between Britain and Hungary in the near future.

Meanwhile, it is encouraging to learn that a party of Hungarian scientists has recently visited Britain, under the auspices of the World Federation of Scientific Workers and the British Association of Scientific Workers; and that METESZ is to repeat its group invitations (begun in 1954) to British and French scientists next year. METESZ and its hard-working and imaginative secretary (Dr. E. Valko) and assistant secretary (Mrs. Barbara Striker) are indeed to be congratulated on having taken one of the first steps to break the ice. M. R. POLLOCK

# DEVELOPMENT AND WELFARE IN THE BRITISH COLONIES

THE schemes made under the Colonial Development and Welfare Acts, covering the period April 1, 1954–March 31, 1955, which are detailed in the latest return*, bring the total commitments for development and welfare schemes under the Acts to £123,402,271, and for research schemes to £12,908,139, of which £14,757,289 and £533,548, respectively, are for the year in question. Of this last sum, £133,157 is for agriculture, £83,767 for medicine, £54,413 for locust control, £47,589 for insecticides, £25,553 for social science, £9,042 for economic research, £6,795 for products research, £6,200 for fisheries and £2,250 for tsetse and trypanosomiasis.

Of the actual research schemes, £104,024 was for the establishment and maintenance for two years of the East African Scientific and Industrial Research Organization, a further £42,500 for the East African Medical Survey, £50,000 for the establishment and maintenance of the Colonial Road Research Section at the Road Research Laboratory, Harmondsworth, a further £37,750 for the maintenance of the Anti-Locust Research Centre and extra-mural activities, £31,483 for the purchase of buildings at Kavete for the East African Veterinary Research Organization, £22,329 to establish an Agricultural Research Station at Aden, £17,780 for sylvicultural research in Nyasaland, a further £16,365 to maintain the Ebini Livestock Experimental Station in British Guiana, a further £16,663 for the Desert Locust Survey and £14,390 for the maintenance of the Colonial Insecticides Research Unit at Porton.

In West Africa, £10,955 was provided for the establishment of a Standing Advisory Committee for Agricultural Research and a further £5,306 for the establishment of the West African Building Research Organization, as well as £4,500 for a social and anthropological investigation of the State of Gonja, Gold Coast. In East Africa, a further £8,100 was provided for control of coconut palm pests in Zanzibar; in the Western Pacific, a further £6,832 for investigation of means of controlling *Amblypelta cocophaga* and other coconut pests in the British Solomon Islands; in Sarawak, £4,300 for an investigation into the control of pepper disease; and in the West Indies, a further £4,230 for cytogenetical research on sugar cane and £6,780 for a pilot scheme for establishment of a Nutritional Research Unit in Jamaica.

Among the major development and welfare schemes of particular scientific interest are the following: in East Africa, a further £700,000 for the desert locust control campaign and £785,438 to intensify African agricultural development in Kenya during 1954–55; in Malaya, £408,250 for the construction of a road between Temerloh and Maran, linking the west and east coasts, £204,000 for the establishment of rural health centres, and £410,000 for the construction of a teachers' training college at Penang in British Guiana, and a further £72,750 for geological survey, as well as £35,000 for aerial survey and £20,833 for hydrographic and hydrological surveys. In British Honduras, a further £38,075 was provided for the artificial regeneration of pine, £29,555 for rice investigation and £45,200 for afforestation of pine savannah. Among a series of grants to the University College of the West Indies are £10,000 for the establishment of a Department of Chemical Technology and a further £10,000 for scientific equipment. £11,450 was provided for rice research in the British Solomon Islands Protectorate, and £33,500 for an aerial survey of Fiji. In West Africa, besides £99,314 for senior staff housing for the Nigerian College of Arts, Science and Technology, a further £150,000 for road development in the Cameroons and various contributions to Fourah Bay College (including £27,000 for additional laboratory and library accommodation), a supplementary contribution of £3,763,351 to the Development Plan for Nigeria includes substantial grants, distributed over all the regions, for agriculture (totalling £615,113), general education (£527,828), technical education (£455,478), forestry (£83,315), leprosy control (£217,793), medical and health (£884,909), veterinary (£125,244) and fisheries (£38,437).

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* Colonial Development and Welfare Acts: Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the Concurrence of the Treasury, in the Period from 1st April, 1954, to 31st March, 1955. Pp. 32. (London: H.M.S.O., 1955.) 1s. 3d. net

# ECONOMIC DEVELOPMENT OF BASUTOLAND, BECHUANALAND AND SWAZILAND

A WHITE Paper on the High Commission Territories of Basutoland, Bechuanaland and Swaziland* gives a concise picture of the economic development and social services in these three territories, to which since 1945 nearly £14,144,000 has been granted or earmarked. Of this, nearly £3¾ million was from Colonial Development and Welfare Funds available for 1945–56, and a further £3 million has been allocated under the 1955 Act for the period to 1960. The Colonial Development Corporation has embarked on projects in the Bechuanaland Protectorate and in Swaziland, for which capital sanction of £7,299,000 has been given; of this amount, £4,424,000 had been spent by the end of 1954, and, according to present plans, full development of these projects may involve expenditure of another £10 million, not necessarily all from public funds.

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* High Commission Territories: Economic Development and Social Services. Pp. 20. (Cmd. 9580.) (London: H.M.S.O., 1955.) 9d. net.

Reviewing the more important results of this investment, the White Paper emphasizes that, as a result of a campaign against soil erosion, the whole of Basutoland will be fully protected against erosion during the next few years ; and it is also hoped that, by reclaiming existing dongas or gullies by damming and planting trees, the water-table throughout the whole of the lowlands will be raised, with much benefit to pasturage and crop yields. The agricultural techniques best suited to Basutoland are being determined at an agricultural experimental station at Maseru and at twelve sub-stations, and a complete catchment area is being developed intensively to demonstrate how better land-utilization can increase productivity as well as prevent soil erosion. Other measures have considerably improved the quality and value of the Basutoland wool clip, and, besides some improvement of the lowland road system, a road to continue sixty-eight miles into the mountainous interior is under construction and is expected to be completed during the next two years.

In the Bechuanaland Protectorate much effort has been given to the improvement of water supplies in the settled areas in the eastern part of the reserves, while attention has also been given to the improvement of the quality of the cattle as well as the control of foot-and-mouth disease. The opening of an abattoir and cold-storage plant in Lobatsi in October last year will enable producers of first-grade animals to sell their beasts in peak condition and help to prevent disruption of marketing arrangements caused in the past by outbreaks of foot-and-mouth disease. On one of two large cattle ranches established in the Protectorate, the Colonial Development Corporation has made available watering facilities and large areas of grazing to a co-operative body of cattle exporters for rearing young animals in better conditions. Better farming methods are also being demonstrated, and a geological survey has confirmed deposits of minerals such as copper, coal, asbestos and kyanite.

In Swaziland, where the territory's revenues have been doubled during the past few years, significant improvements over the whole field of African activity —agriculture, cattle, water supplies, health, hygiene and education—have been obtained by a rural development scheme in which development teams are concentrated on chosen areas. Under a native land settlement scheme, conservation farming, grazing control and efficient crop production are practised in model settlements under government supervision. Some 160,000 acres have been planted with pine trees, and the possibilities of irrigated farming are being explored. About 30,000 acres are already irrigable, and it is intended to irrigate some 30,000 acres in north-east Swaziland. In these projects a variety of crops, including rice, bananas, citrus fruit and vegetables, are already being produced, while an important livestock and dairying industry has done much to reduce the incidence of stock disease.

Although the first essential is to develop the wealth and resources of all three territories so as to increase their revenues and make possible a general improvement in the standard of living of their inhabitants. expenditure on medical services has also greatly increased, and further greatly needed improvements are planned. In Basutoland, where there is now one doctor to every 21,600 persons and one hospital bed to every 1,250, more accommodation is to be provided during the next five years for patients suffering from tuberculosis, and a new mental hospital is to be built, which will be open to patients from all three territories. In Bechuanaland there is now one doctor to every 17,000 persons, and one hospital bed to every 555, and efforts are being made to provide adequate facilities in rural districts. In Swaziland the objectives, for which more than £200,000 has been granted during the past ten years from Colonial Development and Welfare Funds, have included the eradication of malaria (incidence of which has been reduced from 5,750 cases in 1948 to 765 in 1953) and the expansion of medical services in the low veld to meet a redistribution of population.

Special interest is attached at the moment to the development of African education. In Basutoland, where most schools are run by missions with financial assistance from the Government, a ten-year educational development plan was formulated in 1946 ; by the end of 1954 more than three hundred schools had been erected, altered or repaired, and the Lerotholi Technical School, with accommodation for boarders, had been built. A further five-year plan is proposed for building an agricultural training school and six new junior secondary schools and to separate secondary education from teacher-training at the Morija training school. In Bechuanaland, two junior secondary day schools and two secondary boarding schools have been built, the percentage of qualified teachers raised from 40 per cent to 52 per cent and the average size of classes reduced from 56 pupils to 33. Under a further programme a new teacher-training college, a trade school and four new junior secondary schools are to be built and the Bamangwato College enlarged and run as a secondary school for the whole Protectorate. In Swaziland, where enrolment in schools has increased by 80 per cent during the past ten years, further developments are also contemplated beyond those for which grants exceeding £175,000 have been made since 1945 from Colonial Development and Welfare Funds.

# PENTAGONAL SYMMETRY IN NATURE

In the various papers and books on the nature of organic symmetry, there is surprisingly little comment on pentagonal or pentamerous forms. This is not because of a rarity of occurrence of objects displaying such characteristics, for, although not ubiquitous, five-part units are common in both animal and plant design. One of the reasons for such a situation is that the pentagon does not lend itself to readily understood physical and mathematical notions of utility and function as do the hexagon and equilateral triangle. None the less, several groups, including both animals and plants, have developed either a five-part symmetry as a whole or special structures with a five-part symmetry, and their significance has recently been discussed by C. M. Breeder, jun. (*Bull. Amer. Mus. Nat. Hist.*, 106, Art. 3 ; 1955. Pp. 48 ; 1.50 dollars).

The number five and pentagonal designs have figured prominently in ancient mythology, magic and theology, and still exist in numerous present-day symbolic designs. Not the least interesting aspects of such considerations are found in some of the dynamic consequences of five-part symmetry. These consequences extend into the behaviour patterns both of those organisms possessing it in some form and of those reacting in some way to designs of this order. Organisms as different as honeybees and men clearly show striking attitudes and responses with respect to this form of symmetry.

Breeder's studies were based on prominent and varied echinoderm fauna as well as a striking number of five-petalled flowers, such as *Hibiscus*. His findings show that pentagonal order is common in some groups and is absent in others; there is little casual or incidental occurrence. It appears as the basic pattern of flowers, of dicotyledons, of echinoderms, of the vertebrate body section, of the distal ends of tetrapod limbs, and of the oral armature of priapulids. Its occurrence elsewhere is not common but includes the following cases: the tarsi of half the super-families of beetles have uniformly five segments, the other half showing various reductions in the number of segments; the ancestrula of certain bryozoans is pentagonal, although all subsequent individuals are hexagonal.

Five-partness, where it appears, is held to with great rigidity, even when extensive evolutionary change has taken place. This does not seem to be the case to such a marked extent with other symmetries, as the coelenterates show; here the group is marked by a considerable symmetrical instability.

# A PROJECTION INSTRUMENT TO AID IN THE DETERMINATION OF MESOMORPHIC AND POLYMORPHIC TRANSITION TEMPERATURES

By Dr. G. W. GRAY and A. IBBOTSON
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THIS instrument consists of a simple optical system to be used in conjunction with the electrically heated microscope block[1] for the measurement of mesomorphic and polymorphic transition temperatures in the range room-temperature to about 380° C. Such transition temperatures are determined[1] on a mounted specimen, which is inserted in the slide slot of the heating block so that, by means of the optical system, its image is projected on to a screen. The detail which can be seen in the image is very much less than when the sample is observed using a microscope; but it has been found that transitions can be observed with equal accuracy and facility. The projection of the image on to the screen has the advantage that the eye strain involved in carrying out large numbers of determinations of transition points is completely eliminated. This is of significance in any investigation into the effects of changes in chemical constitution on the mesomorphic behaviour of organic compounds[2].

Fig. 1 illustrates the constructional and optical details of the projector. The light source (*A*) is a 500-watt projection bulb, which is mounted vertically in a well-ventilated lamp housing. The light beam passes horizontally through an aperture (2 in.) and is reflected vertically downward by the mirror *B*, through a condenser *C*, a sheet of heat-absorbent glass *D*, the mounted specimen (*E*) in the heating block, a projection lens *F*, on to a mirror *G*, and from there to the screen *H*. Two sheets of 'Polaroid' ($P_1$ and $P_2$), 2 in. in diameter, the uppermost capable of rotation about a vertical axis, enable the sample to be viewed in normal or polarized light. Using a 4-in. focal length projection lens, and a distance of 20 in. from the screen to the mirror *G*, the ¼-in. diameter specimen provides an image of diameter 3½ in.

The arrangement of this optical system relative to the instrument as a whole is also shown in Fig. 1. All parts are attached to two vertical steel tubes, 6 ft. long and 2 in. in diameter, carried on a stout wooden base, 18 in. square. The platform which carries the heating block is 8 in. square and is supported, at the two corners away from the main stand, by two pillars 23 in. long. A 6-in. square of ¼-in. thick asbestos is screwed to this platform, and through both is drilled a ¼-in. diameter hole. The heating block is arranged centrally over this hole. The 'Polaroid' ($P_2$), the projection lens, and the mirror *G* (4 in. × 3 in.) lie below this platform, and all three may be moved independently in a vertical plane. The superstructure above the platform, also

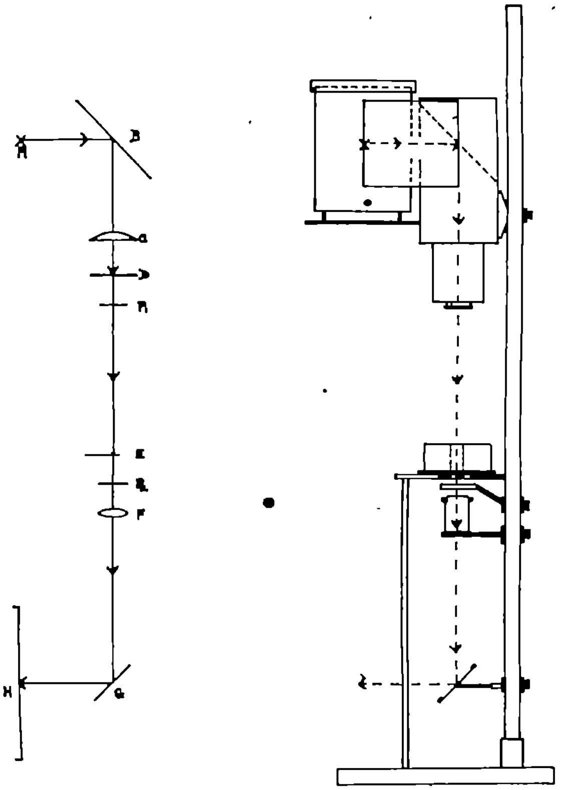

Fig. 1

movable in a vertical plane, consists essentially of two hollow brass cylinders. The first of these (10 in. long and 6 in. in diameter), containing the mirror *B*, is closed at the top and the 4-in. diameter hole at the bottom carries the condenser. A subsidiary cylinder, 4 in. in diameter and 4 in. long, screws in below this cylinder. Mounted in this cylinder is the heat-absorbent glass, and the lower end is closed by the rotatable 'Polaroid' $P_1$. This 'Polaroid' is mounted in a brass ring with a serrated edge which facilitates its adjustment, and carries a 0–360° scale. The other major cylinder (11 in. long and 8 in. in diameter) constitutes the lamp housing and is attached to the first cylinder by two brass sheets riveted to both cylinders. The gaps above and below are covered by brass sheet to eliminate the scattering of light. The base of the lamp housing is a 9-in. diameter disk which carries the lamp, but is held at least one inch clear of the cylinder base. The top of the cylinder is covered by a 9-in. diameter lid which is supported by brass strips about an inch above the cylinder top. These precautions were taken in order to ensure adequate ventilation of the lamp housing. The light beam passes through 2-in. diameter holes in the cylinders and thence to mirror *B*.

As a result of standardization against measurements made on the heating block in conjunction with a microscope, the following procedure was adopted for determination of melting points, mesomorphic and polymorphic transition temperatures. The nematic- or smectic-isotropic transition is taken as the temperature at which the last trace of anisotropic mesophase disappears from the image in polarized light. In the same way, the smectic–nematic transition temperature is that at which smectic characteristics can no longer be seen. In all cases, the above mesomorphic transition temperatures are reproduced when the sample is cooled. Similarly, melting points are given by the temperature at which all crystalline material vanishes from the image, and polymorphic transitions by the disappearance of one solid modification in another. [Aug. 30

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[1] Gray, *Nature*, 172, 1137 (1953).

[2] Gray and Brynmor Jones, *J. Chem. Soc.*, 4179 (1953); 683, 1467, 2556 (1954); 236 (1955). Gray, Hartley, and Brynmor Jones, *J. Chem. Soc.*, 1412 (1955).

# ACCELERATION OF ABSCISSION BY A FACTOR PRODUCED IN SENESCENT LEAVES

By DAPHNE J. OSBORNE

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NEARLY twenty years ago, La Rue[1] demonstrated that removal of the leaf lamina causes a rapid abscission of the petiolar stump; but if a small part of the blade is left attached to the petiole, abscission is retarded. He further showed that if indole-acetic acid mixed with lanolin is applied to the cut end of the petiole following removal of the lamina, then the effect due to the blade tissue is simulated since abscission is delayed. Other workers[2–4] have confirmed and extended these results, and many active plant growth-regulating substances are now known which can, like indole-acetic acid, retard abscission.

More recently, Addicott and his co-workers[5] have shown that if indole-acetic acid and certain other growth substances are applied to the petiole in a position proximal to the abscission zone, abscission may be accelerated. By means of tissue extraction followed by bio-assay[6], they have assessed the auxin content of the leaves and petioles of bean plants in different stages of development, and have shown that there is a gradient of natural auxin from leaf to stem, which falls as the leaf matures. On the basis of their accumulated evidence, these workers have suggested that abscission may be controlled by an auxin gradient across the abscission zone from leaf to stem. As long as this gradient is positive, abscission will not occur; but when the gradient falls to zero, either as a consequence of leaf senescence or removal of the leaf blade, separation will take place. When the gradient becomes reversed, following an increase in the proximal supply of auxin, abscission is accelerated.

Jacobs[7], in his comprehensive investigations with *Coleus*, has demonstrated that leaves, particularly those in the apical bud which produce the maximal amount of auxin, promote the abscission of nearby petioles from which the laminae have been removed. He also showed that abscission of the petiolar stumps is accelerated if the apical bud is removed and replaced by lanolin containing indole-acetic acid, and concludes that the auxin produced in the apex is, in part, transported down the stem and acts as a source of proximal auxin.

Ethylene gas has long been known to accelerate the abscission of intact leaves; the production of ethylene by plant tissues is well established, and Gawadi and Avery[8] have proposed that a balance between auxin production and ethylene production may control abscission in the leaf. Although ethylene and indole-acetic acid may have opposite and antagonistic effects on abscission[9], proof of the existence of such a balance has not, so far, been obtained.

During the course of experiments on leaf abscission, carried out over the past three years at Oxford, it has become apparent that there is a further controlling factor, namely, that as leaves mature and reach senescence they produce a chemical substance or substances which have the property of accelerating the abscission of intact abscission zones.

This chemical factor was first extracted into agar from the distal pulvini of senescent primary leaves of *Phaseolus vulgaris* using the classical methods of diffusion employed by Boysen-Jensen and Went. The bio-assay is a modification of a method originally described by Addicott[10], and the following is a brief description of the procedure.

The distal pulvini are excised from the primary leaves of *Phaseolus vulgaris* var. Canadian Wonder, and are placed, proximal side down, on 0·03-ml. blocks of 2 per cent agar. Each pulvinus is left in contact with its agar block for twenty-four hours at 24° C. under conditions of high humidity. Each agar

Table 1. Average time in hours for abscission of bean explants when (*a*) agar blocks containing diffusates from young or abscinded pulvini are applied to the pulvinar end; or (*b*) whole pulvini are sealed with agar to the pulvinar end

| Time for abscission (hr.) | | | | | |
|---|---|---|---|---|---|
| (*a*) | | | (*b*) | | |
| Control | Diffusate from young pulvini | Diffusate from abscinded pulvini | Control | Pulvini from attached leaves | Pulvini from abscinded leaves |
| Expt. 1<br>107 | 105 | 88 | Expt. 3<br>>120 | 55 (from senescent leaves) | 45 |
| Expt. 2<br>61 | 55 | 53 | Expt. 4<br>57 | 56 (from young leaves) | 37 |

block is then applied to the cut surface of a 1-cm. section cut from the petiole of a primary leaf of a bean plant. The sections, or 'explants', include the distal pulvinus, the abscission zone and part of the petiole. They are aligned on 'Perspex' racks mounted over 3 per cent agar in Petri dishes maintained at 24° C. Every few hours, the pulvinar end of the explant is given a light tap to determine if separation of the abscission zone has taken place. Twenty explants are used per treatment.

As the primary leaves grow older, it is found that explants cut from their petioles take progressively longer to separate. With those from very young expanding leaves, abscission is complete after 25–35 hours; but when plants are growing vigorously in midsummer, explants from fully expanded primary leaves may fail to separate by the end of six days. Explants from leaves of all ages have been used in the present studies, and the results quoted have been selected to include a wide range of test material.

It will be seen from Table 1 (*a*) that when a block of agar containing the diffusate from the pulvinus of an abscinded bean leaf is applied to the pulvinar end of an explant, the average time required for abscission is shorter than for the control. Blocks containing the diffusate from the pulvini of young expanding leaves produce no significant effect. From these and other experiments, it can be concluded that as the leaves become senescent and approach abscission the diffusate is progressively more effective in accelerating abscission. Confirmation of the increase in the power to induce abscission with age of leaf is obtained from further experiments in which sections of the pulvini are excised from leaves of different ages and sealed to the pulvinar end of explants by a 1-mm. disk of 2 per cent agar. The substance or substances present in the pulvini of senescent and abscinded leaves is found to diffuse across the agar seal and to accelerate abscission of the explant, see Table 1 (*b*). No comparable stimulation has been observed with pulvini from very young leaves.

When whole pulvini, or agar blocks containing the diffusate derived from them, are sealed to the petiolar or proximal end of the explants, instead of to the pulvinar end, acceleration of abscission is again obtained, indicating that, unlike indole-acetic acid, the diffusate is effective from whichever side it reaches the abscission zone.

Other experiments have shown that the production of this abscission factor is not confined to the lamina. Diffusates from the pulvini of abscinded explants cut from young leaves, and from petiolar stumps which are becoming senescent as a result of removal of the lamina, are both effective in accelerating abscission.

Experiments with many evergreen an deciduous species have demonstrated tha during the period of autumnal leaf-fall substances inducing abscission are of widesprea occurrence in the petioles of senescen leaves. Comparisons have been made of th diffusate from the petioles of yellow leave which have just completed abscission an that from green leaves which are stil attached to the branches. To do this a section from the leaf base 0·5 cm. long is placed proximal side down upon an agar block in the manner already described, and after twenty-four hours at 24° C. the leaf-base is removed and the block applied to the pulvinar or petiolar end of a bean explant. The results obtained for a selected number of trees and shrubs are listed in Table 2, and it is clear that an acceleration of abscission has resulted from the application of the diffusate from abscinded leaves of each species. The diffusate from the green leaves of the deciduous species, which at this time of year are fast approaching senescence, also accelerates abscission; but generally to a lesser extent. In the evergreen species, privet and *Rhododendron*, leaves in their first year of growth do not normally undergo abscission, and it is noteworthy that the diffusate obtained from the petioles of such green leaves is not found to accelerate abscission. It is only the diffusate from senescent leaves in their second or third year of growth which appears to be active. Diffusates from the first-year leaves of several *Rhododendron* species are, in fact, found to delay rather than hasten abscission.

A preliminary study of the diffusible factor from senescent leaves has revealed that it has the property of counteracting the retardation in abscission which results from treatment with indole-acetic acid. This conclusion is based on the following type of result. A 0·002-ml. drop of distilled water or an aqueous solution of indole-acetic acid (sodium salt) at 20, 50 or 100 p.p.m. is applied to the freshly cut surface of the pulvinar end of an explant. When the drop is completely absorbed, a block of plain agar or agar containing the diffusate is sealed to the pulvinar end. The results of such an experiment using the diffusate from *Pyrus aria* are given in Table 3 (*a*), and it is seen that although indole-acetic acid alone delays abscission the effect is partly or wholly reversed by the addition of the diffusate.

In other experiments, a block of agar or a segment of pulvinus from an abscinded primary leaf is sealed

Table 2. Average time in hours for abscission of bean explants treated at the pulvinar end with agar blocks containing diffusates from the petioles of previously attached or abscinded leaves

| Species | | Control | Diffusate from attached green leaves | Diffusate from abscinded leaves |
|---|---|---|---|---|
| *Ulmus glabra* | Expt. 1 | 102 | 77 | 48 |
| | " 2 | 84 | 72 | 55 |
| *Aesculus hippocastanum* | " 1 | 76 | 62 | 65 |
| | " 2 | 63 | 40 | 40 |
| *Ligustrum ovalifolium* | | > 58* | > 59† | 44 |
| *Rhododendron sutchuense* | | 67 | > 77‡ | 55 |

* Abscission had not occurred in 25 per cent of the explants when the experiment was terminated at 96 hr.

† Abscission had not occurred in 15 per cent of the explants when the experiment was terminated at 96 hr.

‡ Abscission had not occurred in 35 per cent of the explants when the experiment was terminated at 144 hr.

Table 3. The percentage of explants abscinded within 100 hr. after treatment at the pulvinar end with 0·002 ml. drops of water or indole-acetic acid at 20, 50 or 100 p.p.m., followed by: (*a*) blocks of plain agar or blocks containing the diffusate from the petioles of abscinded leaves of *Pyrus aria* sealed to the pulvinar end; (*b*) blocks of plain agar, or a segment of abscinded pulvinus of *Phaseolus vulgaris* sealed to the pulvinar end

| Indole-acetic acid (p.p.m.) | Per cent abscission within 100 hr. | | | |
|---|---|---|---|---|
| | (*a*) Subsequent treatment with | | (*b*) Subsequent treatment with | |
| | Block of plain agar | Block containing diffusate | Block of plain agar | Segment of abscinded pulvinus |
| 0 | 15 | 80 | 100 | Not done |
| 20 | 5 | 100 | 40 | 85 |
| 50 | 0 | 41 | 10 | 45 |
| 100 | 0 | 0 | 0 | 40 |

to the pulvinar end of an explant previously treated with a drop of indole-acetic acid. Typical results are given in Table 3 (*b*), and again this demonstrates that the diffusate from senescent pulvini counteracts the effect of indole-acetic acid.

The possibility that the factor could be ethylene has not been overlooked; but since explants in the process of abscission do not accelerate the abscission of intact explants enclosed with them, it seems unlikely that the active substance or substances can be gaseous.

On the basis of the present results it is proposed that leaf abscission may be controlled not only by endogenous auxins but also by some substance or substances which are produced as the leaf matures, and which reach a maximum at senescence. The question whether this factor is itself active in inducing abscission or whether it functions indirectly by altering the level of the effective auxins in the abscission zone must await the results of further investigations.

I am indebted to Miss Patricia Humphrys for carrying out the experiments with privet and to Prof. G. E. Blackman for his encouragement and for suggesting and supplying the two types of leaves from several species of *Rhododendron*.

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# AN ASSOCIATION BETWEEN THE *P* AND *Jay* SYSTEMS OF BLOOD GROUPS

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THE system of blood groups called *P* was discovered by Landsteiner and Levine[1] in 1927. One antibody, anti-*P*, and one red cell antigen, *P*, define the system. The antigen *P* is inherited as a dominant Mendelian character; no antibody, and therefore no antigen, corresponding to the hypothetical allelomorphic gene *p* has yet been found. The phenotype $P-$, assumed to represent the genotype *pp*, has a frequency of 21·15 per cent in Europeans[2]. Traces of anti-*P*, active only at temperatures around 4° C., can be found in the serum of most $P-$ persons[2]. However, human sera containing anti-*P* strong enough for diagnostic purposes are a rarity. Marked variation in the strength of the *P* antigen in different samples of blood was noted by the discoverers[1]: the variation has been proved to be due, at least in part, to the homozygous or heterozygous state of the donor[3].

The *Jay* system of blood groups was discovered by Levine, Bobbitt, Waller and Kuhmichel[4] in 1951. One antibody, anti-$Tj^a$, and one antigen, $Tj^a$, define the system. The antigen $Tj^a$ is inherited as a dominant Mendelian character; no antibody, and therefore no antigen, corresponding to the hypothetical allelomorphic gene $Tj^b$ has yet been found. The phenotype $Tj(a-)$, assumed to represent the genotype $Tj^bTj^b$, is a great rarity: fourteen $Tj(a-)$ persons, members of eight families, have been found[4-11]. The agglutinin anti-$Tj^a$ is present in the serum of each of these people; most of the examples are also capable of hæmolysing $Tj(a+)$ red cells in the presence of complement. The frequency of the phenotype $Tj(a-)$ is not known: the propositi were brought to notice because of the antibody in their serum, but no random $Tj(a-)$ has been found though more than ten thousand white people have been tested[4-7,11].

Samples of blood from three unrelated $Tj(a-)$ people, Herr K.[11], Mrs. El.[8] and Miss Pa.[7], have recently been tested in this Unit and all three were $P-$. This was startling, for only one white person in five is $P-$. Reference to published work then showed that the *P* groups of three other unrelated $Tj(a-)$ persons and of one sib had been recorded, and all four were $P-$. The probability that six consecutive unrelated $Tj(a-)$ persons should be $P-$ merely by chance is too remote to be entertained. The blood groups of all the known $Tj(a-)$ people are given in Table 1.

The antibody, anti-$Tj^a$, was then investigated, with the attention thus directed to the *P* system. Six anti-$Tj^a$ sera were available (from Mrs. J.[4], Mrs. Mo.[5], Miss Pa.[7], Mrs. El.[8], Herr K.[11] and from a Swedish patient (Broman, B., personal communication)). Each serum after absorption with an equal volume of $P-$ red cells gave the reactions of anti-*P*. Most of the resulting anti-*P* sera were much stronger, and reacted at higher temperatures, than the 'naturally occurring' anti-*P* found in the serum of normal $P-$ donors.

Of one serum (Mrs. El.) there was plenty for more elaborate absorptions and elutions. All antibody

Table 1. THE BLOOD GROUPS OF $Tj(a-)$ PERSONS

| Country | Ref. | Propositi and $Tj(a-)$ sibs | $ABO$ | $MNSs$ | $P$ | $Rh$ | Lutheran $Lu^a$ | Kell $K$ | Kell $k$ | Lewis $Le^a$ | Lewis $Le^b$ | Duffy $Fy^a$ | Duffy $Fy^b$ | Kidd $Jk^a$ | Kidd $Jk^b$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| United States | 4 | Mrs. J. | $O$ | $MNS$ | − | $CDe/CDe$ | − |  | + | − |  | + |  |  |  |
|  |  | Her sister | $O$ |  |  | $CDe/CDe$ |  |  | + |  |  |  |  |  |  |
| South Africa | 5 | Mrs. Mc. | $O$ | $MsNs$ |  | $cDE/cde$ |  | + | + |  |  | + |  | + |  |
| Poland | 6 | Frau Z. | $A$ | $MN$ | − | $CDe/cde$ |  | − |  | − |  |  |  |  |  |
| Australia | 7 | Mrs. Y. | $O$ | $MSNs$ |  | $cdE/cde$ | − | − |  | − |  | − |  |  |  |
|  |  | Her sister (Miss Pa.)* | $O$ | $MSNs$ | − | $cde/cde$ | − | − |  | − | + | + | + | + | + |
| United States | 8 | Mrs. H. B. | $O$ | $MsNS$ | − | $cDE/cde$ |  | + | + | − |  | − |  |  |  |
|  |  | Her brother | $A$ | $MsNS$ | − | $CDe/cde$ |  |  |  | − |  | + |  |  |  |
| Canada | 9 | Mrs. Hl.* | $O$ | $NsNs$ | − | $cde/cde$ | − | − |  | − | + | − | + | + | + |
| Japan | 10 | Rit Ho | $A$ | $MN$ |  | $CDe/CDe$ |  |  |  |  |  |  |  |  |  |
|  |  | Her sister | $A$ | $MsMs$ |  | $CDe/CDe$ |  | − |  | − |  | + |  | − |  |
|  |  | Her brother (Yoi) | $O$ | $MsNs$ |  | $CDe/CDe$ |  | − |  | − |  | + |  | − |  |
|  |  | Her brother (Yas) | $O$ | $MM$ |  | $CDe/CDe$ |  | − |  | − |  | + |  | − |  |
| Germany | 11 | Herr K.* | $A_1$ | $MSNs$ | − | $cde/cde$ | − | − | + | − | − | + | − | − | + |

* The blood of the three people marked with asterisks was tested in this Unit. Miss Pa. is now in England; her $P$ and *Kidd* groups have not previously been published. Mrs. Hl. is now in England; her groups have not previously been published.

Miss Pa. secretes $H$ and $Le^a$ but not $A$ or $B$; Mrs. Hl. secretes $H$ and $Le^a$ but not $A$ or $B$; Herr K. secretes $A$ and $H$ but not $B$ or $Le^a$

could be removed by absorption with $P+$ red cells, and the ease of the removal was proportional to the strength of the $P$ antigen of the absorbing cells. Eluates from the absorbing cells, whether $P+$ or $P-$, reacted more strongly with $P+$ than with $P-$ cells.

But the best evidence of the direct relationship of anti-$Tj^a$ to the $P$ system was provided when the serum of Mrs. Hl. was found, after titration, to give lytic and agglutination reactions which were strongest with strong $P+$ red cells, a little less strong with weak $P+$ cells and a little less strong still with $P-$ cells.

A close relationship between the $P$ and *Jay* systems is therefore established. Though the nature of the relationship is not yet known, it is simplest to suppose that *Jay* is part of the $P$ system. The facts would fit surprisingly well if the $P$ system were constructed on the $A_1A_2O$ pattern. To fit this pattern, the gene $P$ has to become $P_1$, the gene $p$ has to become $P_2$ and the gene $Tj^b$ has to become $p$. Anti-$P$ becomes anti-$P_1$ (like $\alpha_1$ in the serum of an $A_2$ person) and anti-$Tj^a$ becomes anti-$P$ + anti-$P_1$ (like $\alpha + \alpha_1$ in the serum of a group $O$ person). Absorption and elution tests using anti-$Tj^a$ and $P+$ and $P-$ red cells give results directly comparable with the same tests using $\alpha + \alpha_1$ and $A_1$ and $A_2$ cells. There are doubtless other possibilities: $Tj^b$ might, for example, represent suppression of $P$ or $p$, but the $A_1A_2O$ model offers an easy way of understanding the relationship of the *Jay* blood groups to the $P$ system.

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# ENZYMIC SYNTHESIS OF A 'BRANCHED' TRISACCHARIDE

By DR. R. W. BAILEY, DR. S. A. BARKER, DR. E. J. BOURNE and PROF. M. STACEY, F.R.S.

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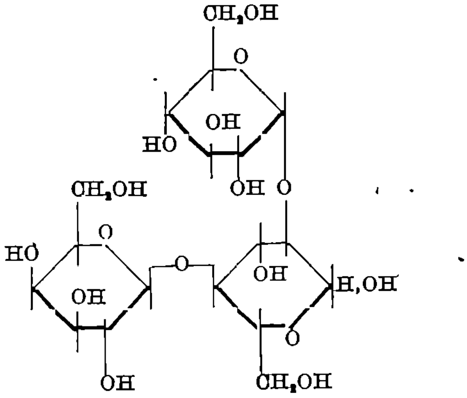
EVIDENCE is now accumulating that oligosaccharides, rather than higher polymeric materials, are formed when dextransucrase acts on sucrose in the presence of relatively large amounts of certain simple sugars, which serve as chain-initiators (cf. refs. 1–3). In large-scale preparations of such oligosaccharides, it is often more convenient not to use a purified enzyme but instead to grow a dextransucrase-producing organism on a culture medium containing a high concentration of the chain-initiator in addition to the sucrose substrate[2]. For example, it was shown recently[3] that oligosaccharides (probably in the tri- and tetra-saccharide range) are produced when cultures of *Betacoccus arabinosaceous* (Birmingham strain) are grown on a medium containing yeast extract, inorganic salts, sucrose (2 per cent) and lactose (10 per cent). We now report the isolation, using the charcoal column technique[4], of a trisaccharide from such a culture, and describe the elucidation of its structure. This trisaccharide was chosen for investigation because it seemed from other studies (unpublished results obtained by us) that the αβ-D-glucose unit of the lactose was more likely to be the acceptor of the enzymically transferred glucose residue than was the β-D-galactose unit, in spite of the fact that the former constituted the reducing moiety. Such a transfer resulting in a novel trisaccharide synthesis was indeed found to occur, for the trisaccharide was shown to be O-β-D-galactopyranosyl-(1→4)-O-[α-D-glucopyranosyl-(1→2)]-D-glucopyranose (I).

Hydrolysis of the trisaccharide with $1 \cdot 5\,N$ sulphuric acid at 100° for 4 hr. gave a 96 per cent conversion (determined by cuprimetric titration) into glucose



(I)

and galactose ; visual comparisons on paper chromatograms indicated that the glucose/galactose ratio was approximately 2/1. Partial hydrolysis with 1·1 $N$ sulphuric acid at 90° for 1 hr. gave products with the $R_F$ values of galactose, glucose and lactose, together with a component ($X$) which was very similar to sophorose (2-O-β-D-glucopyranosyl-D-glucose) in its $R_F$ value and in the characteristic yellow-brown stain which it gave with an aniline hydrogen phthalate spray. Since it is the position, rather than the configuration, of the glycosidic linkage which governs the mobility of a disaccharide[5], this component could equally well have been 2-O-α-D-glucopyranosyl-D-glucose. While the reducing power of the trisaccharide towards alkaline hypoiodite[6] was 104 per cent of the theoretical value, that towards the Shaffer–Hartmann copper reagent[7] was only 0·3 per cent of the reducing power of glucose ; such a discrepancy between the results of the two methods is shown by 2-O-substituted glucoses (for example, the corresponding values for 2 : 3-di-O-methyl-D-glucose were 100 and 14 per cent, respectively) (cf. refs. 6 and 8).

Confirmatory evidence that the trisaccharide had the structure shown was obtained by four routes : (*a*) treatment with a phenylhydrazine acetate solution at 100° for 2 hr. gave glucosazone (melting point and mixed melting point 199–201°) and lactosazone (melting point and mixed melting point 193–195°), each of which had the same mobility as an authentic specimen when submitted to ionophoresis in aqueous formic acid (Whelan, W. J. (private communication), has used a similar method) ; (*b*) reduction of the trisaccharide with sodium borohydride gave the corresponding alcohol, which on partial hydrolysis yielded glucose, galactose and two disaccharide alcohols ($R_{glucose}$ 0·32 and 0·35), and which consumed 5·05 mol. of periodate in 24 hr. with the liberation of 0·85 mol. of formaldehyde and 1·8 mol. of formic acid (theoretical values : 5·0, 1·0 and 2·0, respectively) ; (*c*) the trisaccharide itself consumed 3·9 mol. of periodate and produced 1·85 mol. of formic acid (theoretical values, 4·0 and 2·0, respectively), leaving a residue which gave glucose on hydrolysis ; and (*d*) methylation of the trisaccharide (once with methyl sulphate – sodium hydroxide and thrice with methyl iodide – silver oxide), followed by acidic hydrolysis and paper chromatographic analysis of the products, revealed three main components, with the mobilities of 2 : 3 : 4 : 6-tetra-O-methyl-glucose, 2 : 3 : 4 : 6-tetra-O-methyl-galactose and 3 : 6-di-O-methyl-glucose, and traces of two slower-moving components, but no 2 : 3 : 6-tri-O-methyl-glucose.

The α-configuration of the new glucosidic linkage in the trisaccharide was indicated (*a*) by the high value of its $[\alpha]_D$ (+103° equil., *c*, 1·03 in water), and also that of its alcohol (+66·1°, *c*, 0·97 in water), relative to lactose (+52·6°, equil. in water) ; (*b*) by its infra-red absorption spectrum (930–750 cm.$^{-1}$), which displayed a peak at 843 cm.$^{-1}$ in addition to the peaks shown by lactose (cf. ref. 9) ; and (*c*) by the fact that with almond β-glycosidase it yielded disaccharide $X$, galactose and a trace only of glucose.

The enzymic synthesis of the trisaccharide has also been accomplished using a cell-free culture filtrate from the organism. Its identity with that described above was established by paper chromatography of the two samples, and of the products of partial and complete acidic hydrolysis, by comparison of their infra-red spectra and by determinations of reducing power and optical rotation. It is not possible at present, however, to decide whether the synthesis was effected by dextransucrase itself or by an accompanying enzyme.

Several important points of interest arise from this work, which has revealed a method for the enzymic synthesis of the rare α-1 : 2-glucosidic linkage. (Recently, Peat, Whelan and Hinson[10] detected the α-1 : 2-linked glucose disaccharide in a mixture of ten disaccharides formed from a glucose solution by an extract of *Aspergillus niger NRRL* 330.) We believe this to be the first enzymic synthesis *in vitro* of a 'branched' trisaccharide. The mechanism of its formation could be a general one for branched oligosaccharides ; it involves the use of a carbohydrate primer in which a sugar residue, other than the usual non-reducing end unit, has the correct structure for it to serve as an acceptor of a transferred sugar residue. Moreover, there is an indication of a possible route to the synthesis of branched polysaccharides which does not involve branching of a linear polymer as is the case with glycogen and amylopectin (cf. ref. 11) ; thus, a 'branched' trisaccharide in the form of a glycoside (for example, phosphate, fructosyl derivative) could well serve as a substrate for a transglycosylase which transfers the three sugar units *en bloc* to a growing chain of a branched polysaccharide. This work also raises the possibility that the non-terminal glucose units in an α-1 : 6-linked glucose polymer might serve as primers for the enzyme system studied above, giving rise to dextrans with a few α-1 : 2-branch points in addition to the α-1 : 3- and α-1 : 4-branches commonly found.

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[Sept. 28

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Interference Photography of the Chromospheric Spectrum

The high resolution and dispersion available with interference spectroscopes such as the Fabry–Pérot interferometer has led to the development of standard techniques for their employment in the study of the Fraunhofer absorption spectrum[1]. Until very recently, no such success had attended efforts to observe interferometrically the emission spectrum of the solar corona and the chromospheric flash spectrum. Although the flash spectrum is much stronger than that of the corona, its interferometric observation is complicated by the fact that it is confined to an extremely narrow layer, which extends only some 10″ beyond the much brighter solar limb.

During the total solar eclipse of June 30, 1954, Jarrett and von Klüber succeeded[2] in obtaining measurable fringes in the green coronal line at 5303 A. An attempt by Brück and Jackson to photograph the chromospheric spectrum interferometrically during the total solar eclipse of February 25, 1952, failed to produce fringes, but the authors were able to conclude from their observations that the unblended lines included in their investigation[3] must have widths in excess of $1\cdot2$ cm.$^{-1}$, or $0\cdot24$ A. at 4471 A.

The stronger lines of the chromospheric spectrum can be observed in the uneclipsed sun by setting the slit of the spectroscope across or tangentially to the solar limb, so that it intersects the chromosphere. When observed by this method the chromospheric emission lines have superimposed upon them a Fraunhofer absorption spectrum produced by atmospheric and instrumental scatter from the sun's limb. Satisfactory observations of this kind can therefore only be made when a combination of suitable atmospheric conditions occurs.

During the summer of this year, the problem of photographing the interferometrically observed spectrum of the chromosphere of the uneclipsed sun has been investigated at the University Observatory, Oxford, and a series of satisfactory plates obtained. These show conspicuous fringe systems of the emission lines $H_\alpha$ (6563 A.), $D_3$ (5876 A.), $H_\beta$ (4861 A.), and of the $H$ and $K$ lines (3968, 3934 A.).

The instrument used for this work has been the new Oxford 35-metre solar tower, in which a 20-in. diameter paraboloid of fused quartz provides a solar image about 32 cm. in diameter. The image was formed on a screen containing a slot which selected a small region of the solar limb. The region so selected was re-imaged on the slit of a Hilger medium glass spectrograph, by means of a system comprising a field lens, collimator and camera each of 60 cm. focal length. The spectroscopic dispersion was about 40 A./mm. at 5876 A. The slit width was $0\cdot02$ mm. The solar limb was adjusted to be tangential to the slit, the point of contact coinciding with the base of the slit. Under these conditions, the full height of the slit, about 2 cm., corresponds to a height of 8″ (5,800 km.) above the solar limb. A Fabry–Pérot interferometer with a 1-mm. invar spacer was placed in the parallel beam between the auxiliary collimator and camera, and tilted so that several diametral sections from one side of the ring pattern would fall within the chromospheric region. The measured mean values of the reflectivity and transmission of the newly deposited silver coatings were $95\cdot5$ and $2\cdot5$ per cent at 5500 A., giving a theoretical resolving power of 260,000. Exposure times varied from 1 to 2 min., and during the exposure the solar limb was guided by means of an optical control.

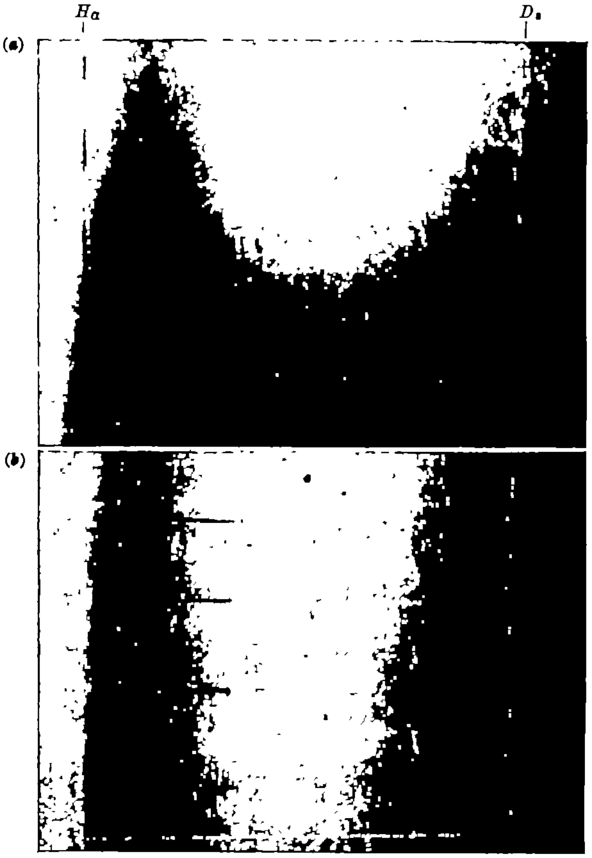

Fig. 1. Interference spectra of the Sun (negative prints) λλ 5700–6600 A. (a) Chromospheric $H_\alpha$ and $D_3$, and limb scatter spectrum from 500 to 5,500 km. above the solar limb. (b) Photospheric spectrum at solar centre with superimposed fringes of cadmium 6438 A

In addition to a pair of chromospheric spectra, the plates have a photometric calibration exposure and an interference spectrum of the solar centre, on which is superimposed a control set of fringes obtained by replacing the solar image by a cadmium discharge lamp and widening the slit. These features can be seen in Fig. 1, which is an enlargement of part of a typical plate. The Fraunhofer scatter spectrum in (a) and the centre spectrum (b) both show the well-known knotted appearance in the absorption lines. On the original plates, the very fine parabolic channels can be traced nearly to $H_\alpha$, where they become submerged in plate grain. In (a), fringes of the chromospheric helium line 5876 A. are seen in emission. The range between successive orders at this wave-length is $1\cdot73$ A., and from this the great width of the line is apparent. The control fringes of cadmium in (b) indicate that the actual resolving power is adequate to provide reliable profiles of this line. The fringe system of $H_\alpha$, which appears prominently on all plates, is more complicated and variable. In general, it appears to be wider than the range of the étalon

·1 A. at 6563 A.) in the lower chromosphere, but igher up it gives fringes which show self-reversal. the corresponding centre spectrum (*b*) the absorpon line of $H_a$ is also too broad to show fringes, and is absent.

A fuller account of this work and of the profiles the $D_3$ line in the latitude range covered will be ommunicated elsewhere.

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# Palæomagnetic Study of Rocks from the Grand Canyon of the Colorado River

DR. S. K. RUNCORN has recently described easurements of remanent magnetization made on diments collected from the Colorado Plateau of rizona[1] and has compared these results with those ade on rocks of similar age from Great Britain. uring the summer of 1954 I also collected from e Grand Canyon of the Colorado River for the urpose of making studies of remanent magnetism n these rocks. I wish here to compare my results ith those obtained by Dr. Runcorn.

Of the many rocks exposed in the Grand Canyon, nly those of the Supai Formation (Permian Age) nd the Hakatai Shale (Algonkian Age) could be nown to have retained, up to the present, the agnetization they obtained on deposition. A comarison of the results obtained by Dr. Runcorn and yself is given in Table 1.

Table 1

| Authority | Formation | Magnetic declination | Magnetic inclination | Rad. of 95% probability | Deduced pole position |
|---|---|---|---|---|---|
| Runcorn | Supai | S. 47·8° E. | + 22·0° | 7·5° | 121° E., 26° N. |
| Doell | Supai | S. 34° E. | + 8° | 7° | 115° E., 30° N. |
| Runcorn | Hakatai* | S. 87·7° W. | + 72·8° | 5·4° | 150° W., 31° N. |
| Doell | Hakatai* | S. 66° W. | + 72° | 17·5° | 144° W., 18° N. |

* The magnetic directions are not corrected for geological dip (about 10°).

The angular difference between the average irections is 19° for the Supai rocks and 7° for the akatai rocks. It is very probable that Runcorn's irection for the Supai should be farther to the south ith a smaller inclination[3], thus bringing the angular ifference between the two sets of measurements ithin the probable error.

It is important to note that these measurements ere made entirely independently. Runcorn restricted is collection to the Kaibab Trail, whereas my ollections were taken equally from the Kaibab and right Angel Trails (separated by about 2½ miles). urther, Dr. Runcorn's measurements were made on n astatic type instrument, whereas mine were made n a 'rock generator' type magnetometer made available by the Stanolind Oil and Gas Co., Tulsa, Oklaoma. The comparison is very encouraging, in that e number of samples measured in each determination is of the order of ten to twenty.

No 'reversals' were found by Dr. Runcorn or me either the Supai rocks or the Hakatai rocks. Thus, if the main geomagnetic field reverses itself, as postulated by Hospers for the Tertiary[4], and by Clegg *et al.* for the Triassic[5], such reversals are not evident in the periods represented by the Supai and Hakatai rocks.

Details of this work will appear elsewhere after further studies of magnetic stability have been made.

I am indebted to the Institute of Geophysics, University of California, for a grant to cover expenses. This work forms a portion of a dissertation submitted to the University of California in partial satisfaction of the requirements of the degree of Ph.D.

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# Anisotropy of Effective Gas Diffusion Coefficients in Extruded Carbon Rods

IT is well known that, in extruded cylindrical samples composed of either particles of amorphous carbon or graphitized carbon, the properties of thermal expansion, thermal conductivity and electrical conductivity are highly anisotropic[1]. The anisotropy in these properties is caused by the orientation of the irregular particles with their long side parallel to the direction of extrusion and by the inherent anisotropic behaviour of the crystallites composing the particles.

The orientation of irregular particles would also be expected to produce anisotropy of effective gas diffusion coefficients in extruded carbon rods. To investigate this phenomenon, effective diffusion coefficients, $D_{eff}$ ($H_2$–$N_2$), were determined on three commercial samples, all using coal-tar pitch as a binder: a lampblack gas baked at about 1,000° C. (*A*), a petroleum coke graphitized at about 2,500° C. (*B*), and a petroleum coke graphitized at about 3,000° C. (*C*). The apparatus and procedure described by Weisz and Prater[2] and us[3] were used. Samples ½ in. long by ½ in. in diameter were used; they were previously cut either parallel or perpendicular to the direction of extrusion from rods 2 in. long by ½ in. in diameter. The results on each sample, shown in Table 1, represent at least three different specimens, with the individual values duplicated within ± 5 per cent.

$D_{eff}$ ($H_2$–$N_2$) was calculated on the basis of the external geometrical length of the cylinder. If the pores in the solid are completely random in direction, the average length of travel of gas is shown by Wheeler[4] to be 1·41 times the external length of sample (tortuosity factor). However, if the particles composing the sample are oriented by extrusion, it is

Table 1. EFFECTIVE DIFFUSION COEFFICIENTS OF HYDROGEN–NITROGEN IN CARBON RODS PARALLEL AND PERPENDICULAR TO DIRECTION OF ROD EXTRUSION

| Sample | $D_{eff}$ (cm.²/sec., S.T.P.) | | Ratio of $D_{eff}$ |
|---|---|---|---|
| *A* | 0·049 | 0·038 | 1·29 |
| *B* | 0·044 | 0·039 | 1·13 |
| *C* | 0·088 | 0·053 | 1·66 |

seen that the assumption of randomness of pore direction is no longer valid. Parallel to the extrusion direction the tortuosity factor would be expected to approach more closely to 1 (perfect channelling)] the higher the degree of orientation. Conversely, the tortuosity factor perpendicular to the direction of extrusion would be expected to become progressively greater than 1·41 with increased orientation of the particles. Therefore, it is felt that the anisotropy of effective gas diffusion coefficients in the extruded carbon rods is primarily a result of differences in the tortuosity factor produced by particle orientation.

We thank Dr. P. B. Weisz and the Socony Mobil Laboratories for determining the effective diffusion coefficients.

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## A Comparative Study of the Mode of Action of X-Rays and Alkylating Agents

PHARMACOLOGICAL and toxicological researches have shown that the effects of nitrogen mustard are strikingly similar to those of ionizing radiation[1]. On account of the great similarity shown by the effects of mustards to irradiation effect, the mustards have been termed 'radiomimetic poisons'[2]. The similarity, furthermore, was found also in the action on the viscosity of deoxyribonucleic acid[3]. On the other hand, Auerbach[4] found that the types of genetic change induced by mustard gas are in some respects different from those caused by X-rays, and suggested that the mode of action of the two agents is also different. Widner *et al.*[5] and Koller *et al.*[6] compared the cytological effects in normal and tumour cells, and found a significant difference which they attributed to the difference in the mode of action of these agents. The mechanism of the effect, however, seems to involve many obscure points and demands further investigation from various points of view.

I have succeeded in establishing resistant variants of the Yoshida ascites tumour to methyl-*bis*-(β-chlorethyl)-amine N-oxide, one of the alkylating agents, by passing tumour cells through animals treated with the agents (MBAO-resistant subline)[7]. These resistant variants were proved to be cross-resistant to the other three alkylating agents, namely, methyl-*bis*-(β-chlorethyl)-amine, tris-(β-chlorethyl)amine and tris-ethylen-imino-s-triazine, but not cros resistant to the unrelated agents, namely, 8-az guanine and colchicine[8]. It seemed, therefore, to l interesting to test whether the MBAO-resistant sul line is cross-resistant to X-rays or not. The suscep ibility to X-rays of tumour cells in the MBA resistant sublines was compared with that in th original sensitive strain of the Yoshida ascit tumour.

Rats of mixed breed and weighing about 100 gn were used, each receiving an intraperitoneal inocul tion of 0·02 c.c. of tumour ascites, containing abou $2 \times 10^6$ tumour cells. Half the animals in eac group (1,000 r. irradiation group, 200 r. irradiatio group and non-irradiated control group) were i oculated with tumour cells of the resistant sublin and the other half were inoculated with those of th sensitive strain. They showed 100 per cent suscept ibility to the tumour. The MBAO-s.c. resist ant subline[7,8] was used as a resistant subline. group of ten rats was exposed to a single dose 1,000 r. whole-body X-radiation, and another grou of sixteen rats to 200 r., on the fifth day after inocul tion with the tumour. The radiation factors were 160 kVp., 3 m.amp., half-value layer 1·02 mm. copper filter, 0·5 mm. copper plus 1·0 mm. aluminium focal skin distance, 30 cm.; and dosage rate 20 r./min Besides these X-radiation groups, another ten rat served as control material without X-radiation. Th sensitivity of the tumour cells to X-rays was judge by changes in the mitotic index (mitoses/2,000 tumou cells), which was calculated with Giemsa-staine smear preparations of the tumour ascites withdraw just before exposure to X-rays, and 1, 3, 6, 9, 12, 2 and 48 hr. after the end of exposure. The mitoti index of non-irradiated control animals was cal culated in the same way as in the irradiated animal The mean values of the mitotic index in each grou are represented in Fig. 1. All results were analyse statistically using the method of analysis of variance On the variation of mitotic index of non-irradiate control group, a significant difference was not foun between the MBAO-resistant subline and the origina sensitive strain ($P > 0.05$). Following exposure t X-radiation, as shown in Fig. 1, the mitotic cells i both resistant and sensitive strain decreased markedl

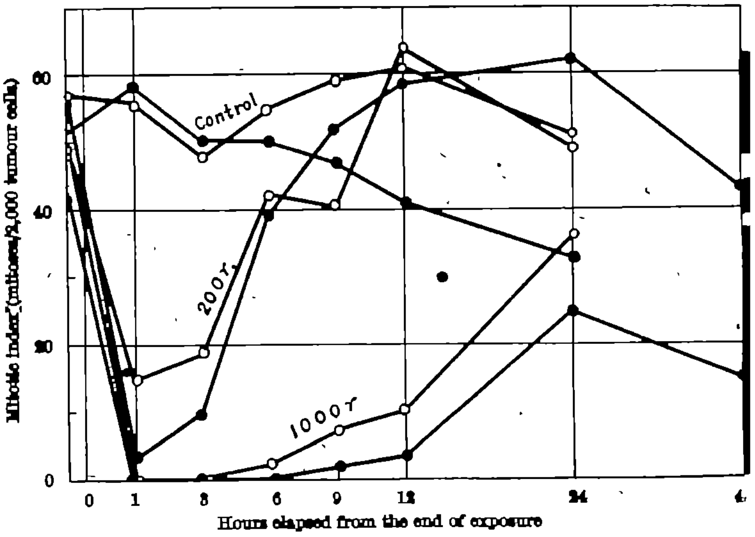

Fig. 1. Changes in the mitotic index following X-radiation
○——○, Original sensitive strain; ●——●, MBAO-resistant subline

number. In the group exposed to 1,000 r. X-diation the mitotic index recovered almost to the te it was before exposure about 24 hr. after the radiation, and after 200 r. irradiation it recovered the same way about 9 hr. after the irradiation. these irradiation experiments, the mitotic index the resistant subline was always markedly less an that of the sensitive strain, which was thus ill under the effect of irradiation. The difference tween these two lines was not significant statistically $> 0·05$) in animals given 1,000 r., but it was significant ($P < 0·01$) in animals given 200 r. In other ords, a significant difference on the sensitivity to -rays was not found after 1,000 r. irradiation, but ter 200 r. irradiation the MBAO-resistant subline as found to be more sensitive to X-rays than the BAO-sensitive strain. The fact that there was no gnificant difference of sensitivity after 1,000 r. radiation between the two lines may be attributed the striking effects of X-rays at that dosage-level.

Hence the tumour cells resistant to methyl-*bis*-(β-lorethyl)-amine N-oxide were not cross-resistant to -rays. Further, from these results it can be inrred that alkylating agents and X-rays are different their mode of action on the cell.

I am indebted to Prof. Fukuzo Oshima, director the Department of Pathology, Nagoya University, r his guidance, and to Prof. S. Takahashi, Department of Radiology, for providing laboratory facilities.

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## Nature of Calcium Sulphate Gels in Ethylene Glycol

GILLE[1] has described the formation of a thick el by saturating ethylene glycol with gypsum, a$SO_4.2H_2O$, at 19° C., filtering carefully, and heatg the solution to 40° C., at which temperature, wing to its decreased solubility, the calcium sulphate recipitates, but in the form of a gel. Gypsum has a ructure[2] in which layers of water molecules alternate ith $CaSO_4$ layers, and Gille suggests that the last-entioned layers are preserved in the gel, but with hylene glycol substituted for the water, and causing n indefinite expansion.

Such an expansion would be similar to that of ontmorillonite, and we might expect it to be ssociated with a phenomenon of the same nature s 'interlamellar sorption' in that mineral[3].

These observations of Gille seemed of interest to s, in connexion with our studies on interlamellar welling and sorption, and we decided to investigate ille's gel by X-ray diffraction. We used the 'flat-ayer' technique[4], which is convenient for this type f study, since a little of the moist gel can be spread on filter paper, which is then mounted directly on the specimen holder. Some ordinary powder photographs (specimen in glass tube) were also made.

Photographs of the gel show haloes, as given by liquids or amorphous substances. If then the filter paper containing the gel is washed with methanol, ethanol or acetone, to remove the excess of ethylene glycol, a line at 17 A. appears, which does not disappear on treating with other organic liquids; but if one drop of water is placed on the filter paper, the 7 A. line characteristic of gypsum appears. The line at 17 A. remains on treatment with a mixture of one part of water and two of methanol; but a mixture two parts of water and one of methanol, or one of water and two of acetone, causes the gypsum line to reappear.

Because of too rapid heating, and possibly of other causes not yet clarified, the calcium sulphate may fail to form a gel, and be precipitated instead as a light sediment of fine particles. These particles give a line at 17 A., similar to that given by the gel washed with organic solvents.

It seems, therefore, that ethylene glycol can be substituted for the water molecules between the gypsum layers, and that the resulting $CaSO_4 - C_2H_4(OH)_2$ complexes are stable in the presence of many organic solvents, but unstable in the presence of water, which readily expels the glycol molecules. So far as our experience goes at present, therefore, the reaction with ethylene glycol is rather specific.

We tried to carry out the same preparation with $CaHPO_4.2H_2O$, which is isomorphous with gypsum[5], but without success. The presence of hydrogen ions perhaps causes more powerful bonding between the layers than in gypsum.

A fuller account of this work will be given elsewhere. Acknowledgment is made to the Consejo Superior de Investigaciones Científicas for a grant.

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## Action of Complexes of the Zinc Group Metals on the Tail Protein of Bacteriophage $T_2r^+$

A SPECIFIC reaction has been found between complexes of the zinc group metals and the bacterial virus, $T_2r^+$. Zinc ions ($M/100$) do not inactivate $T_2r^+$, but if a variety of metal-complexing agents are added to a solution containing zinc nitrate and $T_2r^+$, the virus is rapidly and irreversibly inactivated. Identical reactions occur with cadmium ions. Mercuric mercury inactivates $T_2$ as the free ion as well as when present as a complex ion. Cyanide complexes of all three metals and iodide complexes of cadmium and mercuric mercury inactivate the virus. Inactivation also occurs when a number of amino-acids (such as $M/100$ glycine or glutamic acid) and pure proteins (such as trypsin or chymotrypsin at 2 mgm./ml.) are used as metal-complexing agents. Versene complexes of zinc, cadmium or mercuric mercury do not affect the virus.

The action of complexes of the zinc group metals is highly specific, since cyanide complexes of these metals inactivate only $T_2r+$ and $T_2r$ and do not inactivate $T_1$, $T_4r+$, $T_5$, $T_6r+$ and $T_7$, which invade the same host *E. coli* B. Further, cyanide complexes of other metals such as ferric and ferrous iron, silver, cobalt, nickel, and cuprous and cupric copper do not affect $T_2$.

Bacteriophage $T_2r+$ has been shown by antigenic analysis to contain at least two proteins which are usually designated as head and tail proteins[1]. The viral deoxyribonucleic acid is located largely within the head of the virus particle. Electron micrographs of $T_2r+$ inactivated by zinc or cadmium cyanide complexes show that the distal half of the virus tail is removed in the reaction (Fig. 1). The rate of viral inactivation is almost identical with the rate of appearance of virus particles with short tails (Fig. 2). $T_2r+$ inactivated in this manner loses its ability to attach itself to host cells, to kill host cells or to reproduce. These changes in the biological properties of the virus, together with the results of the electron micrographs, indicate that the metal complex is acting upon the tail protein of the virus particle.

The head of the inactivated virus particles always appears intact, but it may or may not contain deoxyribonucleic acid, depending upon the experimental conditions. From $p$H 6·0 to $p$H 7·5 there is little or no release of viral deoxyribonucleic acid from the inactivated virus particle (measured as the release of phosphorus-32 from labelled virus particles). However, from $p$H 7·75 to $p$H 9·0, up to 95 per cent of the deoxyribonucleic acid is released into the suspending medium within five minutes.

From the known dissociation constants for the four cadmium cyanide complexes, it is possible to compare the rate of inactivation of $T_2r+$ with the concentration of each complex. Using solutions of constant concentration of cadmium ions and varying concentration of cyanide ions, it was found that the inactivation-rate could be correlated only with the concentration of $Cd(CN)_3^-$. It appears that only $Cd(CN)_3^-$ inactivates $T_2$, whereas $Cd(CN)^+$, $Cd(CN)_2$ and $Cd(CN)_4^{=}$ do not affect $T_2r+$. The rate of the viral inactivation, measured conveniently a

$$\frac{1}{\text{time for 60 per cent } T_2 \text{ survival}},$$

increases logarithmically from $p$H 6·0 to $p$H 7·7, and does not increas further when the $p$H is raised to 8·7. When measure between 0° and 25° the $Q_{10}$ for the inactivatio reaction is 3·0. The fraction of $T_2r+$ inactivated i a given time is independent of the initial viru concentration.

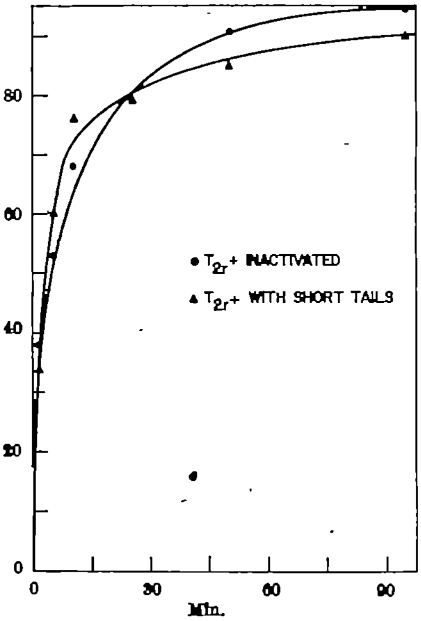

Fig. 2. The relationship between $T_2r+$ inactivation by cyanide complexes of Cd++ and the appearance of viral particles with short tails. Samples were taken at various times from the reaction mixture ($p$H 7·0, 25·0°, 0·01 *M* $Cd(NO_3)_2$, 0·033 *M* NaCN, initial $T_2$ was $10^{11}$/ml.) and assayed, and electron micrographs prepared in the usual manner. The fraction of virus particles with short tails was calculated from the electron micrographs

When *E. coli* B. is invaded by $T_2r+$ bacteriophag the virus attaches itself tail first to the cell and afterwards the viral deoxyribonucleic acid is introduc into the cell. Any uninjected deoxyribonucleic acid as well as the bulk of the vira protein which remains outside th cell, can be removed by stirrin in a Waring blendor[2]. Recen experiments have demonstrate that $T_2r+$ causes the release o nitrogenous materials from th bacterial cell wall, suggesting tha the virus makes a hole in the cel wall[3].

It has been possible to show tha after $T_2$ is adsorbed to the hos cell and presumably has penetrated the cell wall, the release o viral deoxyribonucleic acid from it protein covering and its passag into the cell requires the presenc of a polyvalent metal ion. Whe $T_2r+$ labelled with phosphorus-3 is added to susceptible host cells i nutrient broth + *M*/40 versen (which complexes all polyvalen anions) the virus is adsorbed and th host cells are killed. However, non of the bacteria produces phage, anc

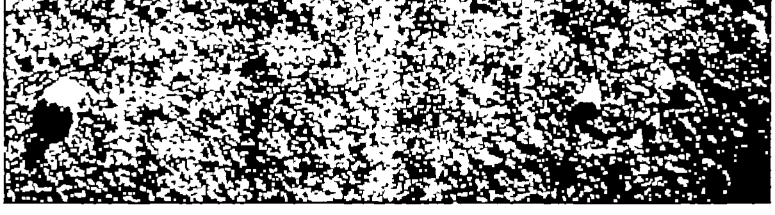

Fig. 1. Effect of 0·01 *M* zinc nitrate plus 0·033 *M* sodium cyanide on $T_2r+$ at $p$H 7·0 and 25°. After 1 hr. a sample was air-dried and shadowed with uranium. For comparison, the electron micrograph (× 8,000) shows a field containing one normal $T_2$ particle and one altered $T_2$ particle. The tail of the altered particle is one-half the normal length and is slightly thicker

y violent stirring of the cell-virus complex in a Varing blendor 90 per cent of the viral phosphorus-32 hat is, deoxyribonucleic acid) can be shaken off the ost cell. In the absence of versene, only 30 per ent of the viral deoxyribonucleic acid can be emoved from the host cell.

The similarity of the *in vitro* reaction between $T_2$ nd metal complexes and the reactions occurring uring invasion suggest that the mechanism by hich the tail of the virus is altered and the deoxyibonucleic acid is liberated from its protein covering uring virus-cell interaction involves the action of a etal complex.

This investigation was aided by grants from the Iational Foundation for Infantile Paralysis, Inc., nd the Dr. Wallace C. and Clara A. Abbott Memorial und of the University of Chicago.

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## Direct Interaction between Copper Ions in the Molecules of Copper Acetate and Propionate

EXAMINATION of the magnetic properties[1] and also X-ray photographs[2] showed that the crystal of copper cetate consists of molecules, $Cu_2(CH_3COO)_4.2H_2O$, n which a direct type of metal-to-metal interaction might be anticipated. A similar metal-to-metal interction was proposed for copper propionate[3]. Recently, re have made a quantitative determination of the dichroism of microcrystals of copper formate, acetate nd propionate, demonstrating the existence of the opper-to-copper linkage in the crystal of the latter wo compounds, and absence of this linkage in the former.

Polarized absorption spectra in the visible and near ltra-violet of copper acetate were determined by suchida–Kobayashi's microscopic method[4]. Using he data of the crystal analysis[2], the components of he molecular absorption coefficients were estimated. The crystal shows in the above regions three absorpion bands, at 43, 80 and 100 × $10^{13}$ c./s. For the band at 43 × $10^{13}$ c./s., which is usually supposed o be due mainly to the copper atom in combination vith the ligands[5], absorption is much stronger with he electric vector along the plane containing four oxygen atoms around the copper atom than with the lectric vector along the direction binding two copper toms in a molecule. This relation agrees with the ule previously derived for the band of a similar kind with planar complexes of various metals[6]. The band t 80 × $10^{13}$ c./s. is of a new kind that has hitherto eldom been found, since most cupric complexes usually exhibit not more than one electronic absorpion band of moderate intensity in the visible and near ultra-violet[5]. Thus the appearance of the new band at 80 × $10^{13}$ c./s. might be taken as an indicaion of the linkage between two copper atoms. The present measurement indicates that for this band the lectric vector along the Cu–Cu axis is about 2·5 times s strongly absorbed as that perpendicular to this axis. This relation is different from the polarization characteristic for the absorption bands of typical planar complexes as well as for the 'copper band' at 43 × $10^{13}$ c./s. The reversal of the polarization property is in agreement with the assumption of the copper-to-copper linkage in $Cu_2(CH_3COO)_4.2H_2O$.

A similar measurement of dichroism was made with a crystal of copper propionate, $Cu(C_2H_5COO)_2.H_2O$. This exhibits a similar band of the new kind at 80 × $10^{13}$ c./s., in addition to a band at 43 × $10^{13}$ c./s., suggesting the existence of the copper-to-copper linkage. The polarization of the band at 80 × $10^{13}$ c./s. is found to be the reverse of that of the band at 43 × $10^{13}$ c./s. This relation, similar to that for copper acetate, also supports the above assumption.

The measurement shows that the crystal of copper formate tetrahydrate involving no copper-to-copper linkage[7] exhibits no band of the above kind at 80 × $10^{13}$ c./s. This also seems to support the metal-to-metal linkage in the crystals of copper acetate and propionate.

Copper acetate and propionate in alcohol or chloroform are found to show the band at 80 × $10^{13}$ c./s. It is concluded, therefore, that in the solution there should be such entities as $Cu_2(CH_3COO)_4X_2$ or $Cu_2(C_2H_5COO)_4X_2$ ($X = H_2O$, $C_2H_5OH$, or $CHCl_3$) in which the copper-to-copper linkage could exist.

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## Chemiluminescence in the Decomposition of the Propyl Nitrates

THE decomposition of the alkyl nitrates is chemically complex, and studies of the spontaneous ignition of methyl and ethyl nitrates have shown that this complexity is associated with a variety of visually distinct modes of inflammation. Thus methyl nitrate[1–3] may undergo three different modes of decomposition: (1) slow decomposition unaccompanied by light; (2) chemiluminescent decomposition; and (3) explosive ignition. Sharp limits of pressure and temperature separate these different modes. Similar behaviour has been found for ethyl nitrate[1,2].

The inflammation of *n*- and *sec*-propyl nitrates has now been examined, and the critical pressure limits above which chemiluminescence and explosion occur have been measured over the temperature-range 240–340° C. These limits in a quartz reaction vessel, volume 350 cm.$^3$, surface to volume ratio 1·0 cm.$^{-1}$, are shown in Fig. 1.

*sec.*-Propyl nitrate shows the same two modes of inflammation as methyl nitrate. For example, at 260° C. when a pressure of 0·4 mm. is admitted to the reaction vessel, reaction is accompanied by an immediate faint bluish-white luminescence lasting about half a second. Above a pressure of 7·5 mm., the luminescence is succeeded after a very short induction period by explosive ignition. At low temperatures the two different modes of reaction are sharply differentiated. As the temperature is raised, so the pressure limits come together and the distinction between luminescence and explosion becomes less marked.

*n*-Propyl nitrate does not show two distinguishable modes of inflammation. At temperatures above 280° C., when the critical pressure limit is exceeded, decomposition is accompanied by an immediate, faint, brief glow of white light. The critical pressure limit resembles the chemiluminescence limit of the other nitrates rather than their explosive limit.

The decompositions of all these alkyl nitrates thus resemble the oxidations of many hydrocarbons, which show cool and blue flames, in addition to slow reaction and explosion. The emitter in these hydrocarbon flames is well known to be excited formaldehyde, and it has been suggested[1] that it is also the source of the luminescence in the decomposition of nitrates. This suggestion is supported by recent spectroscopic work on the decomposition flames of methyl[5] and ethyl[6] nitrates, from which formaldehyde emission has been found.

In the oxidation of hydrocarbons the origin of the excited formaldehyde is not known. An energy of about 75–80 kcal. mole$^{-1}$ is necessary; but it has been estimated[4] that fewer than ten excited formaldehyde molecules are involved for every million fuel molecules which react. It has been suggested[7] that the alkoxy radical $CH_3O\cdot$ is the precursor of $CH_2O^*$:

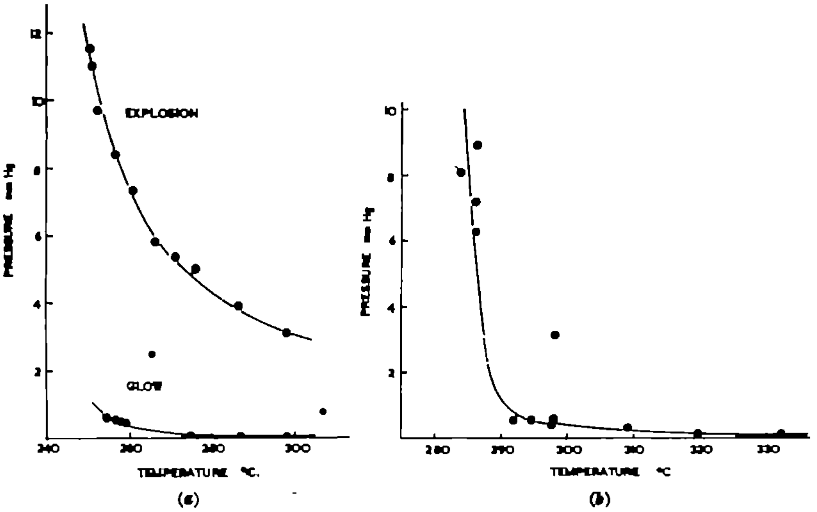
$$HO\cdot + CH_3O\cdot \rightarrow H_2O + CH_2O^* \quad \Delta H = -95 \text{ kcal.}$$

and recent data[8] on alkoxy radical thermochemistry show that this is energetically satisfactory. Other reactions between a methoxy radical and another radical may also be sufficiently exothermic.

In decomposition reactions of the type described here—of nitrates $RONO_2$, nitrites $RONO$, peroxides $ROOR'$ and hydroperoxides $ROOH$—luminescence is always associated[9] with the presence of alkox radicals generated in the initial fission; for exampl

$$C_3H_7ONO_2 \rightarrow C_3H_7O\cdot + NO_2$$

Further study of these alkoxy radicals, which a also known[10] to play an important part in hydr carbon oxidation, may provide the key to the origi of cool flames.



(*a*) (*b*)

Fig. 1. Critical pressure limits of the visible decomposition modes of (*a*) *sec.*-propyl nitrate, and (*b*) *n*-propyl nitrate

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## Separation and Identification of Phenols b Paper Chromatography

THE application of paper chromatography to th qualitative separation of phenols and phenolic derivatives has been reported by a number of workers The methods described employ the one-dimensiona partition technique and they separate, with varyin degrees of efficiency, phenolic derivatives havin fairly pronounced structural differences.

Recent work in this laboratory[2] on the analysis c vitamin E has shown that a mixture of five tocopherols (differing only in methylation in the phenoli ring) can be separated completely by a two-dimensional technique. This technique consists of a first dimensional separation by adsorption chromatograph on zinc carbonate - impregnated paper, followed b second-dimensional reversed-phase partition chromatography on the same paper impregnated wit liquid paraffin. The tocopherols, in this system, separate as would be expecte from theoretical consideratio of the methylation relative t the phenolic hydroxy-group It was therefore of interest t see whether such a chromatographic system would be useful in separating closely related simple monohydri phenols.

A number of modification to the system were made Benzene was used as th developing solvent in th first dimension, since th lower phenols are not solubl enough in *cyclo*hexane. This in turn, required a heavie deposition of zinc carbonate in the paper than ha been used previously. I the second dimension, ethy

Table 1. $R$ AND $R_F$ VALUES OF PHENOLS
$R$ values are measured from leading edge of spot and $R_F$ values to middle of spot

| Substance | $R$ value | $R_F$ value |
|---|---|---|
| Phenol | 0·27 | 0·74 |
| *o*-Cresol | 0·50 | 0·53 |
| *m*-Cresol | 0·30 | 0·60 |
| *p*-Cresol | 0·30 | 0·60 |
| 2-Ethyl-phenol | 0·53 | 0·45 |
| 4-Ethyl-phenol | 0·32 | 0·50 |
| 2-Propyl-phenol | 0·55 | 0·35 |
| 3-Propyl-phenol | 0·35 | 0·40 |
| 2,5-Xylenol | 0·53 | 0·44 |
| 3,4-Xylenol | 0·33 | 0·50 |
| 3,5-Xylenol | 0·33 | 0·50 |
| 2-Methyl-6-propyl-phenol | 0·78 | 0·20 |
| 3-Methyl-6-propyl-phenol | 0·60 | 0·25 |
| 3-Methyl-6-*iso*propyl-phenol | 0·60 | 0·18 |
| 2-Methyl-5-*iso*propyl-phenol | 0·60 | 0·18 |
| 2-Ethyl-6-propyl-phenol | 0·82 | 0·10 |

oleate was used as the stationary phase and the oncentration of aqueous ethanol was changed.

Squares of Whatman No. 1 paper (25 cm. × 25 cm.) are immersed in a solution, prepared by suspending zinc carbonate (B.P.C. 40 gm.) and ammonium carbonate 30 gm.) in water (500 ml.) and adding 0·880 ammonia (200 ml.). The papers are hung in air for an hour, dried at 95° for three hours, and then ruled lightly in pencil, as shown in Fig. 1 (*AB* = *AE* = cm., *BC* = 4 cm.). The phenol or mixture of phenols (5–20 μgm. of each), dissolved in a suitable olvent, is applied to a prepared paper as a thin line along *FG*. The paper is then hung vertically in a ank from edge *HY*, with edge *AD* dipping in the solvent, and developed by the ascending method with dry benzene. The walls of the tank are lined with benzene-saturated filter paper. After three hours, he paper is removed and dried in air. The area *CDXY* is now immersed in a 5 per cent solution of ethyl oleate in light petroleum (40–60°), removed and allowed to dry. The solvent in the chamber s replaced by 40 per cent (v/v) aqueous ethanol and he paper hung in the tank with edge *AH* dipping n the solvent. The chromatogram is developed for sixteen hours, again by the ascending method. After drying, the paper is sprayed with any of the well-known phenol-spotting reagents, after which the ndividual phenols appear as a series of well-defined elliptical spots in the area *CDXY*.

Table 1 gives the $R$ values in the first dimension and $R_F$ values in the second dimension for a number of simple phenols. The results indicate a striking conformation between chromatographic behaviour and molecular structure. $R$ and $R_F$ values are both additive and constitutive functions, each being effected by contributions from carbon side-chains, according to the following rules. For each carbon atom in the side-chains, the $R$ value is increased by 0·03 and the $R_F$ value is decreased by 0·10; each substituent *ortho* to the hydroxy group further increases the $R$ value by 0·20 and decreases the $R_F$ value by 0·05. (Phenol itself has a slightly anomalous $R_F$ value and, in the $R_F$ series, *p*-cresol is better taken as the reference compound.) In the two examples given, simple branching in the side-chain seems to have an additional effect on the $R_F$ value, decreasing it by a further 0·07, but has no effect on the $R$ value.

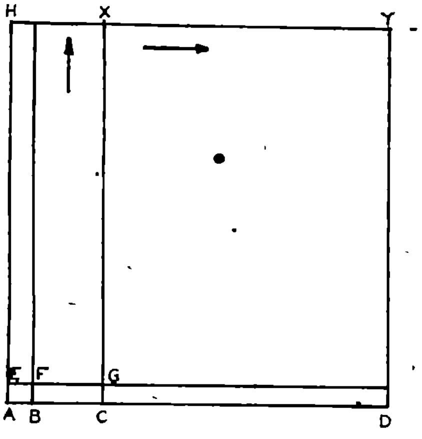

Fig. 1

From Table 1, it will be seen that many closely similar phenols are readily separated on the two-dimensional chromatogram, although others are not. In fact, the possibility of separation can be calculated.

The results are in general agreement with those already found on heavily substituted phenols such as the tocopherols[2], and it appears that the technique may have a more general usefulness in the isolation, separation and identification of phenol derivatives. With suitable modifications of the stationary and mobile phases, the method might be extended to more complex mono- and di-hydroxy derivatives, and it would be interesting to see whether the two-dimensional chromatographic behaviour of a highly complex phenol such as α-tocopherol could be completely correlated, through a series of chromatograms, with a simple substance such as, for example, *ortho*-cresol.

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# Application of Paper Chromatography to Structural Problems in the Veratrum Alkaloid Group

IN a previous communication[1] we have described procedures for the separation, by paper chromatography, of the natural ester alkaloids derived from verabevine, cevagenine and cevine, as well as some partially synthetic esters of these alkamines. The most suitable solvent system proved to be chloroform on formamide-impregnated paper; detection was carried out with Dragendorff's reagent or by reaction with concentrated sulphuric acid.

A study of the effect of structure on the chromatographic behaviour of this group of compounds showed that the mobility is affected by the structure of the alkamine, the nature of the acid moiety, the number of ester groups and—very markedly—by the position of the esterified hydroxyl groups. In the case of the partially synthetic acyl derivatives, where the structure of the alkamine and the acylating agent are known, the remaining structural features to be determined are the number and position of the esterified hydroxyl groups.

As a result of the non-equivalence of the hydroxyl groups of the veratrum alkamines, the $R_M$ value of their derivatives is not a simple linear function of the number of free hydroxyl groups (cf., for example, ref. 2). Hence this relation cannot be used directly to determine the number of ester groupings; on the other hand, it becomes possible for the same reason to derive information as to the position of these esterified hydroxyl groups.

Since the hydroxyl groups in the veratrum alkamines form a number of diol groupings, we have attempted to exploit the reaction of such diol groupings with boric acid to determine the number of free glycol groups and hence in some cases the number and position of esterified hydroxyl groups. The same type of complex formation has previously been used, in the case of sugars[3-5], phenols and aromatic hydroxyacids[6], to decrease the rate of movement of suitably constituted compounds in paper chromatography.

In our procedure, the compound under examination is run in two parallel chromatograms with chloroform as the mobile phase on paper impregnated with formamide containing 5 per cent boric acid in one case, and with formamide alone in the other. Since the glycol–borate complexes are of a highly polar character, the rate of movement of compounds containing suitable glycol systems will be greatly decreased on the boric acid-impregnated paper. The difference in the $R_M$ values for the same compound in the two parallel experiments ($\Delta R_M$) will, moreover, give a direct indication of the number of free α-glycol systems present. Of the veratrum alkamines, veracevine and cevine contain three such systems (3 : 4, 12 : 14, and 16 : 17 or 17 : 20), cevagenine two (12 : 14, and 16 : 17 or 17 : 20). The examples recorded in Table 1 show that the presence of two glycol systems leads to $\Delta R_M$ values between 0·8 and 1·2 units, the presence of a single glycol grouping corresponds to a $\Delta R_M$ of 0·3–0·45, and in the absence of a free α-glycol system, the $R_M$ values are the same in presence and in absence of boric acid.

The change in $\Delta R_M$ upon acylation, upon partial methanolysis of polyester derivatives, etc., gives an indication of the number of glycol systems blocked by esterification of one or both hydroxyl groups involved. Similarly, information as to the presence of an ortho-ester grouping and, in the case of cevagenine, as to its position (ring *C* or ring *D*) may be readily obtained. Further possibilities of application are evident.

Table 1

| | Formamide | | Formamide–boric acid | | $\Delta R_M$ | No. of free glycol systems |
|---|---|---|---|---|---|---|
| | $R_F$ | $R_M$ | $R_F$ | $R_M$ | | |
| 3:4-Diacetylcevine | 0·55 | −0·08 | 0·09 | 1·0 | 1·08 | 2 |
| 3:16-Diacetylcevine | 0·14 | 0·78 | 0·03 | 1·6 | 0·82 | 2 |
| 3:*X*-Diacetylcevine* | 0·55 | −0·08 | 0·30 | 0·37 | 0·45 | 1 |
| 3:4:16-Triacetylcevine | 0·78 | −0·57 | 0·20 | 0·62 | 1·19 | 2 |
| 3:4:*X*-Triacetylcevine* | 0·55 | −0·08 | 0·30 | 0·37 | 0·45 | 1 |
| 3:4:16:*X*-Tetraacetylcevine | 0·78 | −0·57 | 0·64 | −0·25 | 0·32 | 1 |
| 3:4:16-Triacetylcevine-D-orthoacetate† | 0·62 | −0·2 | 0·59 | −0·17 | 0·03 | 0 |

* Chromatography and oxidation studies show that *X* is position 12 or 14.

† Developed with benzene–chloroform (7 : 3).

Table 2

| | Group constant *G* | | Position factor *a* |
|---|---|---|---|
| Acetyl | −0·7 | *C*.3 | 2 |
| α-Methylbutyryl | −1·2 | *C*.16 | 1 |
| Benzoyl | −1·2 | *C*.4 | 2·15* |
| Veratroyl | −1·35 | *C*.*X* | 0* |

* These values have so far only been verified for the acetyl deriv tives.

The results obtained by the above method are c interest with regard to the configuration of the glyc system in position 17 : 20. This configuration ha not yet been securely established[7], though Barto *et al.*[8] suggest that it is *trans*, on the grounds tha 3 : 4 : 16-triacetylcevine is inert toward lead tetr acetate oxidation. On the other hand, however, ou results indicate clearly (Table 1) that this glyc system is capable of complex formation with bor acid; past experience[9] would seem to suggest tha it is therefore more likely to have the *cis* configuratio

On the basis of the experimental material accum lated in this work, we have attempted to calculat the group constants, *G*, for the various acyl grou used to esterify the veratrum alkamines. Martin has shown that the introduction of a new group t a given fundamental molecule leads to a change i the partition coefficient (and hence in the $R_F$ an $R_M$ values) which is dependent on the nature of th group and the solvent system, but not on the natu of the fundamental molecule. As has been show above, in the case under consideration it is furth necessary to introduce factors expressing the effe of the position at which the change is made. Th we may write:

$$\log\left(\frac{1}{R_F} - 1\right) = R_M = Z + a_x G_1 + a_y G_2 + \ldots$$

where *Z* is the fundamental constant (for cevin $Z = 2{\cdot}9$), $G_1$, $G_2$ . . . are the group constants for th various acyl groupings, and $a_x$, $a_y$ . . . are the positio factors for the particular hydroxyl groups esterifie Some values for *G* and *a* are given in Table 2.

The use of this expression and the appropriat constants makes it possible to predict $R_M$ and henc also $R_F$ values for isomeric mono- and poly-esters c the veratrum alkamines. For the chromatographi detection and identification of esters of any furth acid it is, moreover, sufficient to determine exper mentally the $R_F$ value of a single alkamine ester c this acid.

A detailed account of this work will be publish elsewhere[11].

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## Paper Chromatography of Steroid Glucuronosides and Sulphates

We wish to report the separation by paper chromatography of a number of steroid glucuronosides and sulphates. The composition of the three systems eported and the conjugates used are given in Table 1, ogether with the $R_F$ values noted in a representative xperiment. 10–50 gamma amounts of the free acids r their sodium salts in methanol were spotted on 2½-in. lengths of Whatman No. 1 paper and, after quilibration overnight at room temperature in aper-lined glass tanks, the mobile phase was added o the trough and descending chromatography was carried out for periods of 4–8 hr. Following chromatography, the papers were dried in a current of air at oom temperature, and the conjugates were detected y spraying with, or dipping in, 2–4 per cent phoshomolybdic acid in absolute ethanol followed by eating at 90°–100° C. for 5 min. Conjugate 2 was also detected by dipping in 15 per cent aqueous phosphoric acid, followed by heating at 90° C. for 0 min. and examination under ultra-violet light[1], or by dipping in a triphenyltetrazolium chloride reagent repared by combining immediately before use one olume of 2 per cent triphenyltetrazolium chloride in water with four volumes of 10 per cent sodium hydroxide in 60 per cent aqueous methanol.

In these experiments the ambient temperature varied from 23° to 33° C.; but in the course of a single experiment the temperature change usually did not exceed 3 degrees. Although $R_F$ values varied lightly with temperature, it was possible to use these ystems at temperatures as low as 4° C. and as high s 38° C.

System I has been used chiefly to separate conjugates 1 and 2 recovered from urine following the dministration of tetrahydrocortisone (pregnane-3α, 7α, 21-triol-11,20-dione)[2]. Substituting formic acid or acetic acid, as in system II, specifically increases he $R_F$ values of the sulphates and diminishes tailing. This system is the most useful one so far developed or separating the three sulphates. System III separates the several glucuronosides from one another nd from the sulphates, but does not separate completely the three members of the sulphate group. Fig. 1 illustrates the resolution of a mixture of onjugates 1, 2, 3, 4, 5 and 7 using system III. All three systems separate effectively conjugate 3 from onjugate 5 and, presumably, would separate other sulphates and glucuronosides having a common steroid moiety.

Table 1. $R_F$ Values of Steroid Conjugates chromatographed on Paper

Experiment 22A. Equilibration time, 14½ hr. at 29·7°–32·0° C. Running time, 5¼ hr. at 28·5°–29·7° C.

| Conjugate | | Chromatographic system | | |
|---|---|---|---|---|
| No. | Identity | I | II | III |
| 1 | β-Cortolone monoglucuronoside (crude) | 0·14 | 0·16 | 0·08 |
| 2 | Tetrahydrocortisone monoglucuronoside | 0·39 | 0·42 | 0·13 |
| 3 | Dehydroisoandrosterone glucuronoside | 0·78 | 0·78 | 0·21 |
| 4 | Pregnanediol monoglucuronoside | 0·81 | 0·82 | 0·27 |
| 5 | Sodium dehydroisoandrosterone sulphate | 0·25 | 0·34 | 0·42 |
| 6 | Sodium androsterone sulphate | 0·38 | 0·47 | 0·45 |
| 7 | Sodium pregnenolone sulphate | 0·40 | 0·52 | 0·52 |

System I: *n*-Butyl acetate – *n*-butanol – 10 per cent acetic acid 0 : 20 : 100).

System II: *n*-Butyl acetate – *n*-butanol – 10 per cent formic acid 0 : 20 : 100).

System III: *n*-Butyl acetate – methanol – 0·1 *M* sodium barbital buffer in 50 per cent aqueous methanol, *p*H 8·2 (150 : 50 : 50) (monobasic).

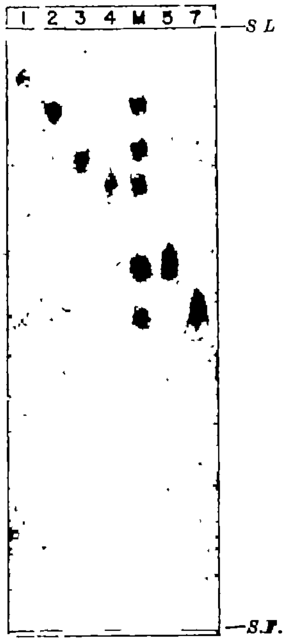

Fig. 1. Resolution of a mixture (*M*, above) of conjugates 1, 2, 3, 4, 5 and 7 using system III. Running time, 5¼ hr. at 30·5°–32·5° C. *S.L.* designates starting line and *S.F.* solvent front

We wish to thank Dr. Constance deCourcy for her advice and suggestions, and Dr. Seymour Lieberman for supplying the dehydroisoandrosterone glucuronoside used in these experiments.

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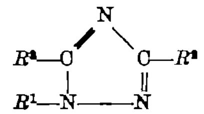
## Inhibition of Cholinesterases by 1 : 2 : 4-Triazoles

It has been repeatedly observed in my laboratory that workers, including non-smokers, manipulating 1 : 2 : 4-triazoles develop symptoms of light nicotine or physostigmine poisoning from time to time. Subsequent experiments have shown that some simple water-soluble 1 : 2 : 4-triazoles may act as inhibitors of cholinesterase activity.

Fresh brains of sheep or rabbit homogenized in 0·025 *M* sodium bicarbonate were used as sources of cholinesterase. Sheep brains were satisfactory, but experiments with rabbit brains could not be satisfactorily duplicated. The inhibitors tested were 3 : 5-dimethyl (I)-, 1 : 3 : 5-trimethyl (II)-, 3 : 5-dimethyl-1-phenyl (III)-, 3-ethyl-5-methyl-1-phenyl (IV)- and 5-ethyl-3-methyl-1-phenyl (V)-1 : 2 : 4-triazoles.



|  | $R^1$ | $R^2$ | $R^3$ |
|---|---|---|---|
| I : | H | Me | Me |
| II : | Me | Me | Me |
| III : | Ph | Me | Me |
| IV : | Ph | Et | Me |
| V : | Ph | Me | Et |

The cholinesterase activity was determined by the manometric method[1], using acetylcholine, acetyl-β-methylcholine and benzoylcholine chlorides as substrates. In all experiments a time-effect was noted: after an initial rise, the pressure decreased to a minimum after 10–20 min., after which the usual rise was observed, occasionally with slight fluctuation. A second 'wave' (usually after 60 min. or more) was observed when using rabbit brain with or without inhibiting triazoles, or sheep brain with (I) or (II) as inhibitors. Fluctuation of temperature, lack of saturation of the tested mixtures with carbon dioxide or insufficient equilibration were excluded as the causes of this phenomenon.

Triazoles (III), (IV) and (V) had the same effects; most experiments were carried out with (III), which was readily available[2]. The nature of the inhibition was ascertained by plotting inverse rates of carbon dioxide evolution against inverse substrate concentrations. Specific cholinesterase is competitively inhibited by (III) for substrate concentrations of 1–30 mgm. acetyl-β-methylcholine / 100 ml. and triazole/substrate ratios in the range of 0·01–0·05. At lower concentrations of triazole there is no significant effect; at higher concentrations the enzyme is slightly activated. In a similar range of concentrations of benzoylcholine and triazole/substrate ratios, (III) activates the unspecific cholinesterase; inactivation occurs at higher triazole concentrations. With acetylcholine as substrate the results were not consistent. In general, lower concentrations of triazole appear to activate, and higher concentrations inactivate, the enzyme system. As the cholinesterase activity of sheep brain is largely due to the specific cholinesterase, it is evident that a factor other than the specific and unspecific cholinesterases is involved in this case. The nature of this factor and the reason for the waves of cholinesterase activity in the stated cases are subjects of further studies.

I wish to thank students of my Department, particularly Mr. R. Naylor and Mr. P. W. Smith, for their assistance in checking some of the results.

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## Double Reduction at the Rosy, or Pink, Locus in *Lythrum salicaria*

It is one of the peculiarities of tetrasomic inheritance, such as we have been investigating for some years past[1] in the purple loosestrife, *Lythrum salicaria*, that, for any two loci in homologous chromosomes, there are a large number of possible genotypes heterogenic at both loci, and therefore capable of throwing light on the process of genetic recombination. With only two alleles available at each locus, there are indeed nineteen such genotypes, and with the linked loci for short style and for pink, or rosy, flower colour, most of these have been obtained; although the six genotypes triplex for the domina Short gene have been inaccessible, owing to th illegitimacy of Short by Short matings.

For some years the only genotypes for which a large number of second backcross progenies had bee scored were bisimplex coupling, *RS/rs/rs/rs*, an bisimplex repulsion, *Rs/rS/rs/rs*. About 1¼ per cen of these appeared to come from gametes with tw dominant genes, *R*, so indicating[2] about 6 per cen double reduction at the *R* locus. The percentag however, was small, and in consequence a sma proportion of alien pollen carrying the *R* gene coul have seriously vitiated the estimated frequency. A the Short locus, for which the corresponding estima was about 2½ per cent, the danger of similar co tamination is obviated by the bar to illegitima pollination.

A few years ago, therefore, preparations were mad for a direct test of double reduction at the Ros locus by preparing triplex plants *rS/Rs/Rs/Rs*, an in 1954 progenies amounting to 2,057 plants wer grown, of which one only proved to be rosy, showin that the previous estimate was much too high. Th new estimate would be 0·2 per cent, if the exception plant was accepted as genuinely from the same see parent as the others, and, as any exception so rar as this is necessarily suspect, the true frequenc might be even less.

That the parents of these 2,000 plants were certain triplex at the Rosy locus has been demonstrated th year, 1955, by growing progenies of a hundred eac from a second backcross of sixteen purple Short plant from last year. If the parents were of the genotyp presumed, the expectation would be about six duple *RS/Rs/rs/rs*, and ten simplex in repulsion, *Rs/rS/rs/r* These were the only two genotypes recognized; ther were in fact four and eleven respectively, one progen being aberrant. The parents were evidently triple and the very low frequency of double reduction a the Rosy locus is confirmed.

The case illustrates well the efficacy of employin a second backcross for tetrasomic analysis. Wit the co-operation of Dr. O. H. Frankel at Canberr and Prof. H. N. Barber at Hobart, it is now hope that the difficulties of obtaining tetraploids triplex a the Short locus also may be overcome in a few year

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Aug. 5.

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## Monœcy and Incompatibility

It is customary when classifying breeding system in Angiosperms to make a clear distinction betwee three main mechanisms promoting outbreeding These are incompatibility in hermaphrodites, and separation of the sexes on the same plant (monœcy or on different plants (diœcy). With incompatibilit and diœcy outcrossing is obligatory. On the othe hand, separation of the sexes on monœcious plant merely decreases the probability of self-fertilization although this may be further avoided by difference in time of maturity of the two types of flower.

Clearly, however, wherever the sexes matur together on a monœcious plant, an incompatibility system could be of distinct advantage. This possibility not discussed in recent articles on incompatibility[1,2]. he following examples which I have found recorded ay serve to focus attention on this matter.

Cross- and self-incompatibility were found in *uphorbia cyparissias* by Muenscher[3], and it was oted by East[4] that "this experiment is the first to stablish that physiological incompatibility may exist a monoecious species". Clapper[5] showed that the apanese chestnut (*Castanea crenata*) and the Chinese estnut (*C. mollissima*) only rarely set fruit after lf-pollination. From a review of pollination experiments with *Hevea brasiliensis* (Euphorbiaceae)[6] it ppears that self- and cross-incompatibility occur, d that there may be reciprocal differences in seedtting. Whether this is an example of sporophytic ntrol of incompatibility remains to be seen.

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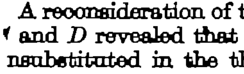
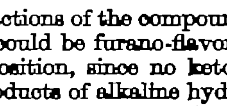
## New Flavones from *Pongamia pinnata* (L.) Merr.: Identification of Compound *D*

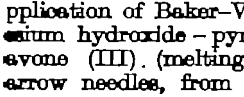
Two new furano-flavones (compounds *C* and *D*) ere reported by Row[1] from the root bark of *Pongamia innata* (L.) Merr., besides karanjin (I) and its ethylene dioxy derivative, named pongapin. From study of the alkaline degradation and other reactions, hey were regarded as isomeric with pongapin and aranjin respectively.

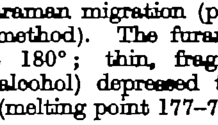
In an effort to identify these compounds, the imple linear isomer of karanjin, 3-methoxy-furano-: 6 : 2′ : 3′-flavone (II), was synthesized by Pavanram and Row[2]; but it was not identical with ompound *D*.

A reconsideration of the reactions of the compounds and *D* revealed that they could be furano-flavones nsubstituted in the third position, since no ketone ould be isolated from the products of alkaline hydroysis of these compounds. To test this possibility, -methoxy-furano-7 : 8 : 2′ : 3′-flavone (III) was obained synthetically from the O-benzoyl derivative of -hydroxy-5-acetyl-6-methoxy coumarone[3] by an pplication of Baker–Venkataraman migration (potsium hydroxide – pyridine method). The furanoavone (III) (melting point 180°; thin, fragile, arrow needles, from ethyl alcohol) depressed the elting point of compound *D* (melting point 177–79°) considerably (130–45°), thus establishing their non-identity.


(I)


(II)


(III)


(IV)

The linear 5-methoxy-furano-7 : 6 : 2′ : 3′-flavone (IV) was also prepared from the benzoate of visnaginone by the Baker–Venkataraman method (using potassium hydroxide – pyridine). The furano-flavone (IV) (melting point 181–82°; broad rectangular prisms with a tendency to taper at one end) did not depress the melting point of compound *D* and was absolutely identical in its reactions.

The synthesis of 3′ : 4′-methylene dioxy derivative of the furano-flavone (III) was accomplished similarly. Its melting point was 263–64° and was different from compound *C* (melting point 232–33°). The synthesis of the isomeric 3′ : 4′-methylene dioxy derivative of the other furano-flavone (IV) is in progress.

With the identification of compound *D*, a new group of furano-flavones unsubstituted in the third position comes to light. Unlike karanjin (I), it belongs to the linear type. In this connexion, it is interesting to note that the only other naturally occurring furano-flavone so far reported is the unsubstituted furano-7 : 8 : 2′ : 3′-flavone (lanceolatin *B*), isolated from the roots of *Tephrosia lanceolata* Grab[4].

We are indebted to Prof. Alexander Schönberg, of the University of Cairo, for a gift of visnagin used in this investigation. We learn from him that the furano-flavone (IV) was also recently synthesized in his laboratories from visnaginone. Full details of the present investigation will be published elsewhere.

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## Two Indo-Pacific Fishes, *Dasyatis uarnak* and *Upeneus moluccensis*, in the Eastern Mediterranean

DURING 1954, several specimens of *Dasyatis uarnak* (Forskål) were observed along the Mediterranean coast of Israel. They were caught by trawlers in depths of 15–40 fathoms. The captured fishes were usually big, with the disk often more than 100 cm. in diameter. One comparatively small specimen is preserved in the collection of the Sea Fisheries Research Station, Haifa. Its dimensions are: length of disk 440 mm., width of disk 470 mm., length of tail 1,215 mm.

The fish has not been recorded hitherto from the Mediterranean. It seems to be a common fish in the Indo-Pacific, and has been reported from the Suez Canal[1], through which the species has apparently passed to the Levant.

*Upeneus moluccensis* (Bleeker) is now common enough in the eastern Mediterranean to be of economic importance and has been mentioned several times under a wrong identification as *Mulloidichthys auriflamma* (Forskål)[2]. A careful examination of an extensive material from the Israeli coast and from Mersin, Turkey, revealed that all the fish belong to a single species, *U. moluccensis*. I have been able to compare the specimens from Israel with four paratypes of *U. moluccensis* lent me from the collection of the Rijksmuseum van Natuurlijke Historie, Leyden, and I can find no differences between them. Vomerine teeth, stated to characterize the genus *Upeneus*[1], are absent from both samples in specimens more than 65 mm. long, and this has led authors[3] to place it in another genus, in spite of the fact that the presence of palatine teeth should exclude it from *Mulloidichthys*.

Unlike other Indo-Pacific species recently recognized in the Mediterranean, *U. moluccensis* has never been recorded from the Red Sea; but if, as seems probable, it came through the Suez Canal, it must surely occur there.

A systematic analysis of these species will be published elsewhere. I am indebted to Dr. E. Trewavas for reading this manuscript and to Mr. N. B. Marshall and Dr. M. Boeseman for their help in securing a loan of the paratypes of *U. moluccensis*.

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## Aeration of Coliform Cultures

PERIODICALLY, cultures of coliform organisms in simple synthetic medium (glucose–phosphate–ammonium salt) have failed to grow when aerated in this laboratory, contrary to experience in other towns. This culminated in a few weeks when such cultures refused to grow at all, so that the possible presence of poisons in the air was suspected. Consequently the air intake of the compressor was placed outside the laboratory buildings. The phenomenon persisted during the daylight hours but was eliminated at night time.

Two points now emerged: at the time, this area was suffering excessive and almost continuous rainfall, and the air intake was just above a mass of actively growing plants. This suggested that the trouble might be due to carbon dioxide deficiency in the atmosphere, which was being rectified by the metabolism of the plants when it was dark. Chemical investigation showed that in fact there was about five times as much carbon dioxide in this air at night as during the day, and about twice as much as in air taken from the laboratory during the day.

Various workers have noted the need for carbon dioxide by these organisms, probably to permit the formation of the $C_4$ dicarboxylic acids[1-5]. The addition of chemically prepared carbon dioxide or of extremely small quantities of succinic acid eliminated the phenomenon. From the work of Dagley and Hinshelwood[2], it can be calculated that a very small gas flame produces sufficient carbon dioxide to meet the requirements of a considerable number of cultures.

The air intake was now transferred to the space below a gas-operated incubator to ensure a sufficiency of carbon dioxide. The gas sucked in was purified by spraying as an oil–air emulsion, filtering and then passing through an efficient washing system filled with strong chromic acid. This removed dus alkaline vapours and oxidized volatile substance The gas was washed efficiently with bicarbonate sol tion to absorb all acid vapours and replace the with carbon dioxide. It then passed through bacteriological filter. The use of this air has eliminate the trouble completely.

The importance of adequate carbon dioxide h since been repeatedly emphasized: many phenomen being studied have been much more reproducible an in many cases the intrusion of lag phenomena eliminated. Such an example is the effect of phenol in lo concentration on one organism. Originally there w a progressive increase in observable lag and of th mean generation time with increase of phenol concentration; but with the new air supply no la phenomena are observed.

There may be many instances elsewhere whe fluctuating carbon dioxide content of the atmosphe and/or a bare average sufficiency are producin artefacts: here the problem became acute becau of a prevailing wind blowing from the open sea pa an extremely well-ventilated coastal laboratory.

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## Resistance to Lymphomatosis in the Fowl i Relation to Reproduction

OVER the past twenty years, the feasibility breeding strains of fowls in which mortality fron lymphomatosis is reduced to negligible levels ha been demonstrated[1,2]. Many poultry breeders ar now developing resistant strains. If families resistan to this disease do not hatch as well as families tha are susceptible, as Coles and Underwood have stated the desirability of attempting to develop resistan stock may seem dubious. Accordingly, we hav examined our records for the past six years fo evidence of any such relationship.

In so doing, we have compared (as did Coles an Underwood) families of full sisters showing one o more deaths from lymphomatosis with families i which no females died of that disease during ou test period, which is from 42 to 500 days of age Since, in a later exposition of the same data[4] both fertility and hatchability of resistant familie were said to be lower than in susceptible familie we have considered both these important factor which influence the efficiency of reproduction.

Records for matings of proved sires in our *K* resistant strain of White Leghorns (Table 1) show the variation from year to year that is inevitable wit relatively small numbers. Over the whole period o six years, in families free of lymphomatosis, fertility (of their dams) was lower by 1·9 per cent; but hatchability was higher by 2·0 per cent, than in families losing one or more birds from that disease. Neither difference is significant. These data show no consistent relationship between resistance to lymphomatosis and efficiency of reproduction.

It is probable that this finding differs from that of Coles and Underwood because the data in Table 1 are restricted to dams' families comprising not less than ten tested daughters. Altogether there were ,685 such daughters, and in these the incidence of tal lymphomatosis during the test period was ·7 per cent. Among 726 females in the 44 dams' families that had one or more cases. the incidence was 9·8 per cent. With such low frequencies, small families have much less chance to show a single case f lymphomatosis than large ones. Since the smaller families result from poor reproduction and the larger ones from good reproduction, any division of the opulation into families that have either (*a*) no lymphomatosis or (*b*) one or more cases of it must throw most of the poor reproducers into the former class and the better reproducers into the latter one. Thus, in the birds considered by Coles and Underwood[3] the average size of family ranged in four years from 7·3 to 10·8 for those free of lymphomatosis, ut was 9·0 to 15·2 for those showing one or more cases[4]. Under such conditions, even if the incidence of lymphomatosis were as high as 15 or 20 per cent, ny apparent relationship between susceptibility to the disease and efficient reproduction is completely spurious.

Much of the error in such an analysis is removed by restricting the data to larger families. In those onsidered in Table 1, the average number of daughters per dam was 16·4 in families showing lymphomatosis and 15·8 in families that did not. All the error can be eliminated by using a better ype of analysis. The susceptibility of any family r group of birds to any disease is best measured. not by the presence or absence of a single case of that disease, but by the proportion of susceptible birds, that is, the incidence of the disease. Thus, in wo groups of 100 birds each, one comprising 20 mall families and the other five large ones, the ncidence of lymphomatosis should, *ceteris paribus* be about the same.

Among families[2] from proved sires in our *K*-esistant White Leghorns from 1949 until 1954 there were seven in which no daughters died of lymphmatosis. In each of the remaining nineteen sire amilies, the dams were separated into two classes as having hatchability either (*a*) above average for the pen, or (*b*) below that average. The incidence of lymphomatosis in the pullets hatched from these two groups was as shown in Table 2.

able 1. REPRODUCTION OF HENS PRODUCING FAMILIES WITH OR WITHOUT SUBSEQUENT LYMPHOMATOSIS

| Year | Dams | Eggs incubated | Fertile) (per cent) | Fertile eggs hatched (per cent) | Daughters tested |
|---|---|---|---|---|---|
| | *A*. Families with one or more deaths from lymphomatosis | | | | |
| 1949 | 15 | 579 | 97 | 88 | 217 |
| 1950 | 2 | 81 | 100 | 95 | 24 |
| 1951 | 11 | 441 | 89 | 86 | 160 |
| 1952 | 12 | 646 | 92 | 85 | 253 |
| 1953 | 1 | 40 | 100 | 93 | 25 |
| 1954 | 3 | 104 | 98 | 91 | 46 |
| Averages | | | 93·4 | 87 1 | |
| | *B*. Families with no deaths from lymphomatosis | | | | |
| 1949 | 10 | 381 | 94 | 91 | 157 |
| 1950 | 19 | 748 | 95 | 89 | 262 |
| 1951 | 29 | 1,143 | 90 | 91 | 444 |
| 1952 | 14 | 651 | 80 | 89 | 221 |
| 1953 | 27 | 1,100 | 92 | 86 | 397 |
| 1954 | 31 | 1,160 | 97 | 89 | 479 |
| Averages | | | 91·5 | 80 1 | |

Table 2

| | Dams | Daughters | Lymphomatosis (per cent) |
|---|---|---|---|
| Hatchability above average | 110 | 1,595 | 3 7 |
| Hatchability below average | 73 | 708 | 3 4 |

Dams below average are fewer than those above because, when hatchability is high, the distribution of dams with respect to it is skewed, and most hens below average depress that figure more than it can be raised by individual hens above it. The average numbers of daughters per dam in the two groups were 14·5 and 10·9, but, since the smaller families are grouped together, bias from that source is eliminated. Actually the two groups are not strictly comparable. The hens with hatchability below average included most of the oldest proved dams, which produced highly resistant daughters but (because of old age) fewer of them. Conversely, the hens above average included some not previously progeny-tested, but considered (from viability of their sisters) to be worth trying. These birds, being younger, reproduced well, but in some cases yielded rather susceptible families.

In spite of this, the two groups compared do not differ significantly in the incidence of lymphomatosis. It is clear from these data, as from those in Table 1, that resistance and susceptibility to lymphomatosis in the progeny are not related to the efficiency of reproduction in the dam.

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## Relationship between Blood Factors *P* and *Q*

THE relationship between blood factors *P* and *Q* has been investigated by comparing an anti-*Q* agglutinin (Japanese) with several anti-*P* of human and animal origin.

The anti-*Q* has been used for agglutination tests only, while the *P* factor has been determined by absorption as well as by agglutination.

A total of 224 samples were tested. giving the following results :

| | *Q*+ | *Q*− | Total |
|---|---|---|---|
| *P*+ | 113 | 0 | 113 |
| *P*− | 0 | 111 | 111 |
| Total | 113 | 111 | 224 |

Cross-absorption experiments have not been carried out, as no discrepancies have been found.

Furthermore, the receptor strength of each positive sample was estimated by the strength of agglutination. In this respect, too, the reactions of anti-*Q* were found to parallel closely the reactions of anti-*P*.

Further details will be published elsewhere.

In our opinion, the result of the present investigation—until further irrefutable proof of the separate identity of the properties is found—justifies the assumption that *P* and *Q* are identical.

Our thanks are due to Prof. Tanemoto Furuhata, Tokyo, for a gift of anti-*Q*.

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TYGE JACOBSEN
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Copenhagen, Denmark. July 13.

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## A Caliper for measuring Photographs, X-Rays and Drawings

THERE is at present no instrument on the market suitable for measuring distances in photographs, X-rays or drawings both accurately and in considerable numbers. Our particular problem was to measure various dimensions of the human figure on 12 in. × 10 in. pictures of subjects photographed in the nude for studies of body-build. The measurements had to be accurate to 0·1 mm., and a large number of them had to be recorded. In this technique, known as photogrammetric anthropometry, needle-pointed calipers are used, so as to locate the precise point at which the edge of the body shades into the white background of the picture. Some form of enlargement of the scale of measurement other than a vernier, which is awkward to read and thus gives rise to too many reading errors, was clearly desirable. We first used calipers based on a scissors principle, with a magnification of scale of about × 5 due to the needle-pointed arms being shorter than the arms carrying the reading scale[1]. However, these proved unsatisfactory in practice due to the scale being on the chord rather than the arc of the opening circle, and because adjustment to remedy this varied from one instrument to another and was not entirely reliable.

A straight-bar design appeared to be better, and eventually the question of how to achieve the required scale enlargement was solved by the use of a dial gauge. The new instrument, made by British Indicators, Ltd., Sutton Road, St. Albans, Herts, is illustrated in Fig. 1. It rests flat on the photograph with the needle-tips adjusted so as just to clear the surface until tilted a fraction downward. The dial reads a total of 10 mm. in 0·1 mm. divisions and is linked to the right-hand needle point, which is moved by operating the thumbscrew at the far right-hand end. The left-hand needle point can be fixed at 1 cm. intervals up to 15 cm. by releasing the trigger seen underneath the left-hand bar, and moving the bar along until the desired figure appears in the round window at its right-hand end. This provides the coarse adjustment mechanism and enables the instrument to read in divisions of 0·1 mm. from zero up to as much as 15 cm. There is play of about 0·1 mm. in the thumbscrew mechanism, but this can be practically entirely obviated by arranging always to rack the dial in the same direction before taking the final reading.

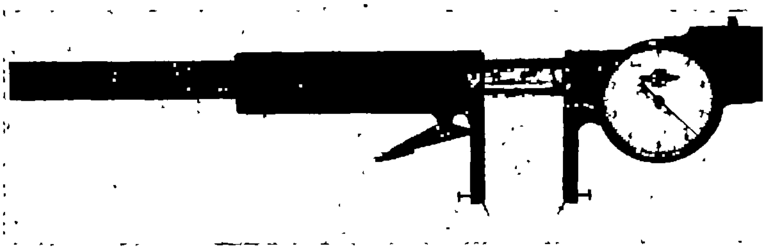

Fig 1

We have recently found this instrument useful for measuring the relative amounts of bone, muscle and fat along given diameters in X-rays of the legs and arms (see ref. 2), and in measuring the growth of epiphyses in serial X-rays of growing children. Hov ever, it is so much less tedious in operation tha conventional dividers that it seems likely to be use to research workers and engineers in a variet of fields.

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## Removal of Mineral Nutrients from Tree Crowns by Rain

IN 1951, C. O. Tamm[1] gave figures for the miner nutrient composition of rain-water collected und three species of forest trees. M. G. Mes[2] has sinc published experimental work on the loss of phosphoru and other mineral elements from living leaves due t the influence of rain.

This communication reports the composition c rain-water collected under a thirty-year old plantatio of *Pinus radiata* D. Don in Whakarewarewa Fores Rotorua Conservancy.

The supply of nutrients to the soil in rain-water compared with the return contained in the litter-fa from the stand. The results in Table 1 cover th period November 26, 1954–June 2, 1955.

Table 1. NUTRIENT CONTENT OF RAIN-WATER AND LITTER COLLECT BENEATH *P. radiata*

| | Rain-fall (cm.) | Litter-fall (gm./m.²) | Nutrient return to soil (m. equiv./m.²) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Ca | Mg | K | Na | P |
| Rain-water 30 yd. from trees | 68·7 | — | 1·3 | 1·4 | 2·2 | 23·4 | — |
| Rain-water beneath trees | 42·0 | — | 4·7 | 12·6 | 21·5 | 81·4 | 4·9 |
| Litter beneath trees | — | 252 | 61·6 | 21·2 | 16·5 | 10·4 | 24·6 |

It seems that when considering the return c mineral nutrients to the soil under *P. radiata*, bot litter-fall and rainfall must be taken into considera tion, since in the cases of potassium and sodiu a large proportion of the total return to the soil contained in the rainfall.

A fuller account of this work will be published at later date.

G. M. WILL
Forest Research Institute,
Whakarewarewa,
Rotorua, New Zealand.
July 12.

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[1] Tamm, C. O., *Physiol. Plant.*, 4, 184 (1951).

[2] Mes, M. G., *South Afr. J. Sci.*, 50, 167 (1954).

# FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

## Monday, December 19

Royal Geographical Society (at 1 Kensington Gore, London, .W.7), at 5 p.m.—Prof. S. W. Wooldridge and Miss E. M. J. Campbell: "Between Two Forests".

Institute of Metal Finishing (at the Northampton Polytechnic, t. John Street, London, E.C.1), at 6.15 p m.—Dr. A. E. Davies: Tin-Cadmium Alloy Plating".

## Tuesday, December 20

Royal Aeronautical Society (at 4 Hamilton Place, London, V.1), at 7 p.m.—Dr. N. A. de Bruyne: "Recent Advances in Aircraft Adhesives".

## Wednesday, December 21

Royal Meteorological Society (at 49 Cromwell Road, London, .W.7), at 5 p m.—Mr. C. H. B. Priestley: "Free and Forced Convection in the Atmosphere Near the Ground"; Mr. R. Anderson, Ir B. W. Boville and Mr. D. E. McClellan: "An Operational Frontal ontour Analysis Model".*

Royal Statistical Society (at the London School of Hygiene nd Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—rof. H. Wold: "Explanatory Approaches with Observational Data A Review of Ends and Means)".

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5 30 p.m.—Dr. J. M. Rowson: 'Comfrey (*Symphytum Officinale* L) Root: Its Anatomy and its Detection in Admixture with Chicory in Dandelion Coffee".

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (male, single, with a university degree or diploma in horticulture and a sound knowledge of practical horticulture) in Horticulture—The Principal Agricultural Officer, Lancashire County Institute of Agriculture, Hutton, near Preston December 24).

Scientific Officers (with a first- or second-class honours degree n engineering, physics or mathematics or equivalent qualifications), and Assistant Experimental Officers (with at least G.C.E. advanced level) in mathematics or equivalent qualifications), in the Mechanical Engineering Research Laboratory (D.S.I.R.), East Kilbride, Glasgow, for work on fluid flow, heat-transfer, lubrication, materials and mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, W.1, quoting C 886/5A (December 24)

Assistant (registered veterinary surgeon) in the Department of Veterinary Anatomy, Royal (Dick) School of Veterinary Studies—The Secretary, The University, Edinburgh (December 28).

Animal Pathologist (with a veterinary qualification) to take charge of the Department of Animal Pathology, Zoological Gardens, Regent's Park—The Director and Permanent Secretary, Zoological Society of London, Regent's Park, London, N.W.1 (December 31).

Assistant Lecturer in Psychology, with special reference to ndustrial and occupational psychology—The Registrar, The University, Hull (December 31).

Lecturer in the Department of Pathology—The Secretary, The University, Edinburgh (December 31).

Lecturer (with special qualifications in inorganic chemistry, ncluding experience in teaching from elementary level upwards) in Chemistry in St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (December 31).

Physiologist (with a university degree, preferably with physiology s a main subject, and between the ages of 21 and 28 years) in the General Post Office, to undertake field and laboratory studies on problems relating to factors affecting individual performance, and to work under the general direction of the Consultant Physiologist to he Post Office in London—P.O. Engineering Department (Stl/4), Alder House, Aldersgate Street, London, E.C.1 (December 31).

May and Baker Research Fellow (graduate in chemistry) to undertake research work under the direction of Prof. R. L Wain in organic chemistry in the fields of growth regulating substances or systematic fungicides—The Registrar, Wye College, near Ashford, Kent (January 7).

Physicist (with a first- or second-class honours degree and preferably have worked for at least two years in a radiotherapy department) o work in the Physics Department, but with special duties in the Radiotherapy Department—The Superintendent, Guy's Hospital, London, S.E.1 (January 7)

Biochemist (non-medical), Scientific Officer (Senior grade), for duties at the Central Laboratory, 51 Lisburn Road, Belfast—The Secretary, Northern Ireland Hospitals Authority, Victory Buildings, 44–46 Queen Street, Belfast (January 13)

Research Fellow in Mathematical Physics at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 Australia, January 15).

Veterinary Research Officer (with a veterinary qualification and experience in the organization and execution of field experiments, particularly with farm animals), to take an active part in research work, and a Biochemist (with a veterinary qualification or a good degree in chemistry or biochemistry, and experience in the field of animal nutrition and disease), to organize and initiate research, at the Animal Health Trust Farm Livestock Research Station, Stock, Essex—The Scientific Director, The Animal Health Trust, 14 Ashley Place, Westminster, London, S.W.1 (January 17).

Senior Lecturer or Lecturer in Clinical Pathology, Lecturer in Morbid Anatomy, and a Lecturer in Bacteriology in the Department of Pathology, University College of the West Indies—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (January 30).

Chair of Experimental Physics—The Registrar, The University, Liverpool (January 31).

Reader or Senior Lecturer in the Theory of Computing in the Department of Mathematics—The Registrar, The University, Manchester 13 (January 31).

Research Students/Fellows in the School of Physics—The Registrar, The University, Sydney, Australia (January 31)

Lecturer in Astronomy—The Registrar, The University, Manchester (February 28).

Lecturer (with special qualifications in stratigraphy) in Geology in St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (February 29).

Professor of Agriculture at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, March 15).

Agronomist, Senior Scientific Officer or Scientific Officer grade (with at least a second-class honours degree, and not less than two years appropriate postgraduate experience, and some experience of cocoa research or cocoa production), at the West African Cocoa Research Institute, Gold Coast, to design and conduct field experiments on cocoa, including yield, spacing, establishment, manurial, variety and other trials and to conduct experiments on fermentation and quality of cocoa—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting Ref. No BCD.197/200/05.

Assistant, Grade A (with a good degree) in Mathematics—Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham.

Assistant, Grade B (graduate in physics and preferably with experience in teaching and industry and a knowledge of some branch of applied physics), in the Physics Department, Sunderland Technical College—The Director of Education, 15 John Street, Sunderland

Biochemist or Chemist (with experience in routine biochemical techniques)—The Director, Department for Research in Industrial Medicine, London Hospital, E.1.

Chartered Librarian (with previous experience in a scientific or technical library)—The Secretary, Sir John Cass College, Jewry Street London, E.C.3.

Chemist or Physicist, Experimental Officer or Assistant Experimental Officer grade (preferably with a degree or H.N.C. in chemistry or physics, or at least H.S.C. (science) or equivalent), at a Ministry of Supply Experimental Establishment, Christchurch, Hants, to plan and carry out tests on properties of soils in connexion with their use for roads and airfields, and for investigation of soil stabilization techniques, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.442/5A/ED.

Electronics and Workshop Technician (with some practical experience in the maintenance of electronic or allied apparatus)—The Secretary, University College Hospital Medical School, University Street, London, W.C.1.

Entomologist (with a university degree in zoology (major subject being entomology), and preferably with postgraduate experience in mosquito control), in the Medical Department, H.M. Overseas Civil Service, Tanganyika, for field and laboratory entomological work with special reference to mosquitoes, and for the initiation and management of surveys and control work in urban centres and airports—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. BCD 117/8/024.

Forest Utilization Officer (with a university degree in either forestry or engineering, with postgraduate experience in forest engineering and/or in timber utilization) in Northern Rhodesia, to conduct research into the use of indigenous hardwood timbers by the Rhodesian copper mining industry, with particular attention to fungal decay and the preservative treatment of underground mining timbers, to assist sawmilling and logging firms on improving methods of logging, etc., and to assist in the development of wood-using industries—The Director of Recruitment, Colonial Office, Sanctuary Building, Great Smith Street, London, S.W.1, quoting BCD 61/3/02.

Lecturer in the Department of Electrical Engineering, Technical College, Bradford—The Director of Education, Town Hall, Bradford.

Lecturer (preferably with qualifications in electrical engineering) in Engineering in the University of Malaya—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1.

Mathematician and Statistician (with a degree or equivalent qualification, and preferably some knowledge of economics) in the Operational Research Section of the Association in London, to continue a study of the productivity of steel rolling processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1, quoting "O.R.3".

Physicist (with a first- or second-class honours degree in physics and preferably with some research experience in optics or electronics) at the Royal Aircraft Establishment, Farnborough, for problems of photography from high speed, high altitude aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.450/5A/OB

Physicist (with a university degree in science and not less than three years experience as a physicist in a radiotherapy unit) in Salisbury Hospital, Rhodesia—The Secretary, Federation of Rhodesia and Nyasaland, Rhodesia House, 429 Strand, London, W.C.2

Principal Botanist, Principal or Senior Principal Scientific Officer grade (over 31, with at least a second-class honours degree in botany, with postgraduate training in cytology, genetics or plant physiology, and a good record of achievement in one or more of these branches, preferably in relation to tree crops), at the West African Cocoa Research Institute, Gold Coast, to organize, supervise, and take part in the work of the Botany Division, including cytology, genetics, plant breeding, physiology and general botany, with special reference to cocoa and its allies—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.197/200/011.

SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent in physics or electrical engineering, and preferably with some electronics experience) at the Ministry of Supply Royal Aircraft Establishment, Aberporth, South Wales, for research and development on electronic instrumentation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.461/5A/KA.

SENIOR TECHNICIAN IN THE DEPARTMENT OF PHYSIOLOGY, University College, Ibadan—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1.

TECHNICAL ASSISTANT (preferably with experience of vacuum and high temperature equipment) IN THE GENERAL PHYSICS SECTION of the Physics Department, to assist in research on metal physics problems associated with the solidification processes in metals and with mechanical properties generally—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting G.P.1.

TECHNICIAN for research and general laboratory duties in the BOTANY DEPARTMENT, Dulwich, London, S.E.24, in the fields of biochemistry and microbiology—The Secretary, King's College, Strand, London, W.C.2 (Ref. 9491).

TECHNICIAN IN THE DEPARTMENT OF ANATOMY, Kitchener School of Medicine, University College of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1.

UNIVERSITY DEMONSTRATOR (member of the Royal College of Veterinary Surgeons) IN THE DEPARTMENT OF VETERINARY CLINICAL STUDIES, University of Cambridge—The Secretary, Appointments Committee of the Faculty of Medicine, Department of Experimental Medicine, Tennis Court Road, Cambridge.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Friends of the Lake District. Report and News Letter, August, 1955. Pp. 25. (Ulverston: Friends of the Lake District, 1955.) [310

Ministry of Agriculture, Fisheries and Food. Fishery Investigations. Series 2, Vol. 18, No. 8: Physical Oceanography of the Irish Sea. By K. F. Bowden. Pp. 68. (London: H.M. Stationery Office, 1955.) 7s. 6d. net. [310

Wye College (University of London). Department of Hop Research Annual Report, 1954. Pp. 130. (Ashford, Kent: Wye College (University of London), 1955.) 5s. [310

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National Coal Board: Scientific Department. Research on Medical and Human Problems—Annual Report, 1954. Pp. i+12. (London: National Coal Board, 1955.) [310

The Fate of the Soul: an Interpretation of Some Primitive Concepts. By Prof. Raymond Firth. (Frazer Lecture for 1955.) Pp. 46. (Cambridge: At the University Press, 1955.) 2s. 6d. net. [310

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Privy Council. Medical Research Council Memorandum No. 32: The Diagnosis and Treatment of Haemophilia and Its Related Conditions. By R. G. Macfarlane and Rosemary Biggs. Pp. viii+23. (London: H.M. Stationery Office, 1955.) 2s 6d. net. [310

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 35: Concrete Roads in Belgium and Western Germany, 1954: Their Structural Design and Performance. Pp. vi+24+16 plates. (London: H.M. Stationery Office, 1955.) 3s. net.

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British Iron and Steel Research Association. Specifications for Heavy Duty Electric Overhead Travelling Cranes for Use in Iron and Steel Works. Prepared by the Steelworks Cranes Sub-Committee of the Plant Engineering Division. Revised edition. Pp. ii+33. (London: British Iron & Steel Research Association, 1955.) 10s. [310

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British Commonwealth Scientific Organization (North America). Notes on Science in U.S.A., 1954. Pp. iv+39. (London: H.M. Stationery Office, 1955.) 2s. net. [310

Government Publications. Sectional List No. 3: Department of Scientific and Industrial Research. (Revised to July, 1955.) Pp. 34. (London: H.M. Stationery Office, 1955.) [310

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The Education and Training of Graduate Staff for Industrial Research: Report of the Conference of Industrial Research Directors and Managers. Pp. iv+54. (London: Federation of British Industries, 1955.) 4s. [310

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Nr. 9 fur das Jahr 1954, Pt. 75. (Hamburg. Deutsches Hydr
graphisches Institut, 1955.) [3

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Memoir No. 45: Result of an Investigation into the Possible Presen
of Oil in Karroo Rocks in Parts of the Union of South Africa. By S.
Haughton, J. J. G. Blignaut, P. J. Rossouw, J. J. Spies and S. Zag
Pp. viii+180. (Pretoria: Department of Mines, 1953.) 10s. [3

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Cambrian Pytchopariid Trilobites from Conglomerates of Quebe
By Franco Rasetti. (Publication 4216.) Pp. i+35+6 plates. (Washin
ton, D.C.: Smithsonian Institution, 1955.) [3

United States Department of Agriculture. The Mexican Fruit Fl
How We Fight It: Pp. 8 Picture Sheet No. 28: Alfalfa Weev
Pp 2. 5 cents. Leaflet No. 390: The Housefly: How to control
Pp. 6. 5 cents. Farmers' Bulletin No. 2081. Mormon Crickets: Ho
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(April, 1954–March, 1955.) Pp. ii+16. (Hargeisa, Somaliland Pr
tectorate: Chief Secretary to the Government; London: Crow
Agents for Oversea Governments and Administrations, 1955.) [3

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Josas (5–8 Avril, 1954). Par René-Guy Busnel. (5e Année (Trimestri
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Recherche Agronomique, 1955.) [31

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Concept of Inhibited Growth. By Dr. Caron Kent. Pp. ii+2
Melbourne: Clinic for Psychotherapy, 1955. [31

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Zealand Forestry Research Note No. 2: Knot Sealer and Pai
Service Test on Radiata Pine Weatherboards. By T. A. Fole
Pp. 4+4 plates. Technical Paper No. 5: Heartwood Formation
Pinus Radiata. By J. Madden Harris. Pp. 8. Technical Paper No 6
Diffusion Impregnation of Timber by the Momentary Immersio
Process. By D. R. Carr. Pp. 12. (Wellington: Director of Forestr
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University of Helsinki, 1955.) [31

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Berlin. Klasse für Mathematik und allgemeine Naturwissenschafte
Jahrgang 1954. No. 4: Kanonischer Algorithmus Hydrodynamische
Wirbelgleichungen. Von Hans Ertel. Pp. 10. 1 D. mark. No. 5: Ei
Neues Wirbel-Theorem der Hydrodynamik. Von Hans Ertel. Pp. 1
1 D mark. (Berlin: Akademie-Verlag, 1955.) [31

Institut Royal Météorologique de Belgique. Publications, Série
No. 16: Techniques modernes de mesure de l'éclairement énergétiqu
solaire. Par R. Dogniaux et R. Pastiels. Pp. 49. No 17: Contribu
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No. 23: Projet d'une expédition scientifique sur le continent ant
arctique: Par Dr Edmond Hoge. Pp. 6. Publications, Série A, Vol. 1
Études Microclimatiques: Opuscule 1: Vallée de la Meus
Anseremme, Aout, 1953. Pp. 12+1 plate. (Uccle-Bruxelles: Institu
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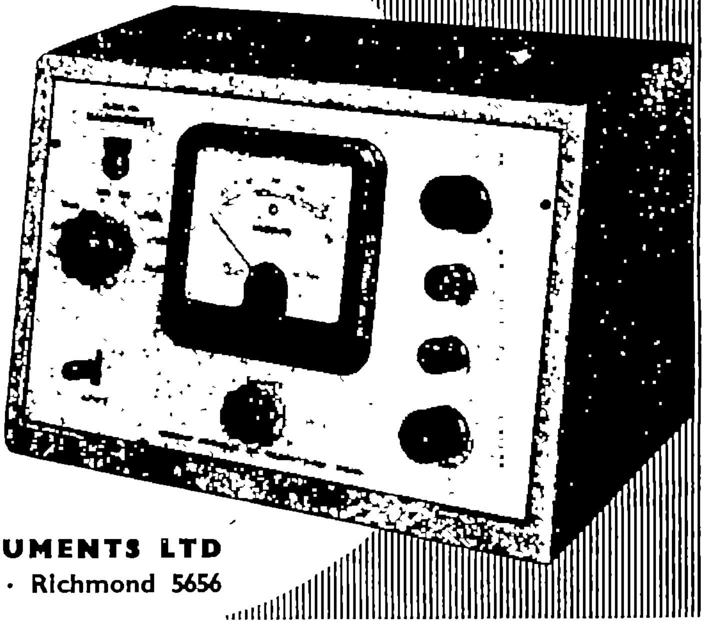

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# ATOMIC ENERGY DEVELOPMENTS AND MAN-POWER PROBLEMS IN BRITAIN

WITHIN the limits set by security, the first annual report of the United Kingdom Atomic Energy Authority gives a reasonably full account of the Authority's activities (see p. 1193). Quite apart from the fact that, on the technical side, much of this has already been made known in other ways, the outstanding features of the report are, first, the way in which the rate of progress is set by the availability of skilled man-power, and second, the wide range of research on which both the civil and military programmes of the Authority are based. "Her Majesty's Government", states the report, "have never hesitated to furnish the money needed for buildings, plant and equipment for the atomic energy programme: material shortages have never been insuperable; but the difficulty of recruiting and retaining sufficient skilled scientists, engineers and craftsmen has been acute throughout the ten years of the project and shows no signs of becoming easier."

In setting this subject in the forefront of the report, the Authority recognizes that there is a national shortage of technological skill, and that it is in competition with industry (and notably with sections of industry that are themselves building up staff to enter the field of nuclear energy) for staff for its development programmes. More important still, it recognizes that the development of nuclear energy is unique in the variety of specialized skills which it demands. Since this demand is not at present being met, it is essential not merely to consider the steps already being taken to mitigate the shortage and the factors which may be responsible for the Authority's difficulty in recruitment, but also the distribution and use made of scientific and technical man-power in Great Britain as a whole.

The problem is, in fact, closely linked to that of the balance of the scientific effort of the country generally. The range of fundamental research, not only in physics but also in chemistry and metallurgy, which the efficient conduct of the Authority's development programmes urgently demands, is bound to suggest the possibility that there may be some distortion of that effort in other sciences besides physics, on which doubts have already been freely voiced. As the report notes, while fundamental work in physics, chemistry and metallurgy is carried out at the Authority's own establishments, extra-mural research at the universities and other institutions has made a major contribution to the work of the Research and Development Groups, while many research contracts have been placed with industrial firms. There is, however, nothing in the report which enables even an approximate estimate to be formed of the scale of this effort and its demands in terms of man-power, materials or finance relative to the nation's resources as a whole. Quite rightly, the report emphasizes the danger that even if the programmes are fulfilled according to the time-tables, the inadequacy of staff will lead to the skimping of details that will be the cause of operating troubles in future and possibly serious waste of resources. Even with adequate staff, there is always serious risk of premature development in the conditions under which the Authority operates.

It would be unreasonable to expect the Authority to discuss in this report the impact of its research programmes and contracts on academic or industrial research generally; but it is disappointing to find that the chapter on staff gives no figures which would enable the magnitude of the problem to be assessed. The report merely states that all but a handful of the senior staff in the former Department of Atomic Energy, and most of the industrial employees, have accepted employment under the Authority; that the staff taken over on August 1, 1954, was materially below the required level for the programmes then in hand; and that while the programmes have since been enlarged, there has been no corresponding increase in man-power. In the Industrial Group, in particular, recruitment of professional and scientific staff has done no more, during the past eighteen months, than keep pace with wastage; and the Authority is particularly disturbed at its difficulty in recruiting the younger engineers and technicians who are needed to form the base of the pyramid to-day and to provide the leaders in years to come.

Apart from the serious national shortage of most types of scientists and engineers and of many technical and craft grades, no reason is suggested for this failure; nor is any evidence adduced that the Authority is not recruiting a reasonable proportion of those available. It recognizes, indeed, that in attempting to recruit from outside the large number of senior staff required for its heavy new commitments, most of whom in normal expansion would be recruited from among its own staff, it is not easy to attract men who have long been settled in other employment and most of whom would sacrifice valuable pension rights on changing jobs. Here, perhaps, the lack of freedom of movement of the Authority, as compared with industry, in the matter of salaries may be a factor; and on this point the report notes that three salary bands have been established for managerial staff, within which officers will have their salaries assessed periodically according to individual responsibility and merit.

The report has already been used for urging a further considerable expansion in the number of students of science and technology. That may still be required, but there are questions to be asked and answered before such expansion is justified on the situation disclosed by this report. Some of these questions are indicated in the Haldane Memorial Lecture, "A Scientist In and Out of the Civil Service", which Sir Henry Tizard gave last March. Sir Henry is clearly one of those who have doubts as to whether in doubling the number of scientists and technologists we have increased in anything like the same proportion the number of really first-class minds. The report adopted by the Board of the Institute of Physics last July on the availability of places for physics students in universities and technical colleges, for example, emphasized that the most important factor determining the number of potential honours students of physics is that the course demands a degree of mathematical ability and a capacity to grasp difficult abstract concepts that are comparatively rare. It is highly probable that for a like reason the main obstacle to the expansion of the facilities for higher technological education in other sciences and in technology is the availability of students of adequate quality.

If this position holds, it is essential to give close consideration to the use which is made of the limited supply of outstanding talent. It follows, in the first place, that we cannot produce many more men capable, as Sir Henry Tizard puts it, of dealing with circumstances for which there is no direct precedent, whether in industry or in the public service, without diverting the interests of many young men from pure science or from other subjects. The sample survey of "Graduates' Jobs" recently made by Political and Economic Planning disclosed that, apart from the universities, manufacturing industry and the Scientific Civil Service already take much the highest proportion of first-class honours men, the Scientific Civil Service in fact taking 11 per cent as compared with 3·6 per cent entering the Civil Service. The Scientific Civil Service, moreover, lost almost 7 per cent of its recruits during the four years survey (compared with 10 per cent lost by industry).

Now although Sir Henry Tizard does not suggest that there is, as a rule, a lack of sympathy between scientists and administrators, he is concerned at a lack of understanding which will continue until far more administrators have had a scientific education. At present, he pointed out, on an average only one scientifically educated man enters the administrative Civil Service by competition each year. This is manifestly not enough to overcome the difference in outlook that exists between those who have had a scientific education and those who have not. This great need for more administrators who have had a broad scientific education is something to be kept in mind, equally with Sir Henry's remark about the ineffectiveness as an instrument of policy of a committee consisting solely of scientists, and the need for a leaven of hardened administrators, or their like, in considering the expansion of higher technological education. It is also worth remembering, in connexion with the recommendation by the standing committee of the Convocation of the University of London on the shortage of science teachers, that the University should consider jointly with other universities, so far as may be practicable, provision for an increase of science places of 60–100 per cent during the next five years for both school leavers and those of more mature age.

A fuller understanding and more sympathy between the scientist and the administrator in the Scientific Civil Service and in the public service generally could help to reduce the wastage indicated both by the P.E.P. inquiry and the annual report of the Atomic Energy Authority; indeed, it might well make the public service more attractive to the scientist. At the same time, it points to the need for a reasonable proportion of first-class minds on the administrative side as well as on the scientific and technical side. The need is one to be considered particularly in the plans for the expansion of the Imperial College of Science and Technology, of which Dr. Linstead recently spoke, and when graduates in science are no longer actively discouraged from the postgraduate study of some branch of technology.

Since it would seem that we cannot hope ever to produce enough scientists or technologists of the highest quality, and since also the cost per student in such a technological institution as the Imperial College is necessarily far higher than the average cost elsewhere in the universities, it is important that the target for expansion of technological education in Britain should not be set without some consideration of the possibilities of diminishing the demand by making sure that the fullest and wisest use is made of the services of the graduates to be trained in such institutions. It may well be uneconomic to attempt to use such institutions for the production of administrators with a broad scientific education, though they may help to produce scientists and engineers qualified to fill administrative positions. Here, however, devices in later life, such as the formation of a central scientific staff, engaged only on studying questions of policy under the immediate direction of the Advisory Council for Scientific Policy, to which young scientists could be seconded for a year or two from the research establishments, might serve better. As Sir Henry Tizard suggests, such a device would soon discover if the scientist possessed the necessary qualities for higher administration. It presupposes, however, that the research establishments are fully staffed, apart from the natural reluctance of a director to spare the men really worth transfer.

It cannot, therefore, be emphasized too firmly that every care must be taken in industry, as in the public services, to ensure that scientific and technological talent is really employed to the best advantage. Furthermore, granted the need for more first-class minds to study technology, and possibly also to some extent the sciences, the major need is for more men of the general practitioner type who will be dealing with conditions for which precedents exist. Most of these men will come from the colleges of technology or the universities, and a modicum of them may well prove suitable for administrative or managerial positions; but it is as well to remember that many leaders of industry have had no university training, and Sir Henry Tizard wondered whether all of them would have been better for a university education. On this point, Mr. M. L. Jacks has some wise words in his recent book, "The Education of Good Men", which point to the need for further inquiry as to the content of technological education before the lines on which it is to be expanded are rigidly set.

What is needed meanwhile, however, is a reasonable estimate of the demand for the ordinary graduate in science and technology, taking into account the wastage revealed by the P.E.P. inquiry. This should be supplemented by inquiry into the causes of that wastage and into the possibility of making better use of the services of the more outstanding men. Such inquiries might enable us to plan the expansion of technological education more economically and to make wiser use of our limited resources. It could also suggest ways in which both industry and the public services could be made more attractive to the scientist.

Any such estimate involves a survey of the national research effort, even if its present balance is accepted as reasonable. Whether an excessive proportion of that effort is already devoted to the Atomic Energy Authority, in spite of the vital importance of the Authority's developments for our economic position, as well as in national defence, remains for examination; it is a risk which might be more serious but for the broad basis of research on which those developments rest. That to some extent is a safeguard against excessive distortion between the sciences; though at the same time it increases the extent to which the Authority's programmes can affect the direction of fundamental research in the universities and elsewhere. When all due allowance is made for the limits set by secrecy requirements, those requirements, in this field at least, should be reconsidered in the light of the Geneva Conference last August, and it might well be that some adjustment might also facilitate recruitment of staff by the Authority. The scale of the effort now going into nuclear energy research and development in Britain, however, appears to be such that a broad picture of it in relation to the country's effort in research as a whole, both fundamental and applied, should be presented to Parliament and the nation in a way that would permit well-informed and constructive criticism, such as Sir Henry Tizard adumbrates, and at an early enough stage, when facts are being sorted out and the pointers to future policy are being formulated.

In this respect the first report of the Atomic Energy Authority clearly displays the need while supplying little information, even within its own field, towards enabling sound judgment to be formed or effective criticism made. In some respects it does not even indicate fully how important to Britain the early development of nuclear energy really is, and how urgent it is, from an economic point of view, that every effort should be made to utilize the advantages she at present possesses. None the less, that effort and its implications, both in respect of man-power and materials, must be seen in the perspective of the nation's resources and effort as a whole; otherwise development cannot proceed smoothly, because by drawing to itself an excessive proportion of man-power or other resources, advance has been checked in other fields of knowledge essential for the development of nuclear energy itself. The wise development of nuclear energy requires further surveys such as that now being made of the work of the Department of Scientific and Industrial Research. The Lord President of the Council carries no greater or more urgent responsibility than that of seeing that by such means, or in other ways, there is placed before Parliament sufficient information to enable the scientific and technical opinion of the country to satisfy itself that the research effort and the development work in this and other fields are in balance and in proportion with available resources.

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# THEORY OF MOLECULAR VIBRATIONAL SPECTRA

## Molecular Vibrations

The Theory of Infrared and Raman Vibrational Spectra. By Prof. E. Bright Wilson, Jr., Prof. J. C. Decius and Prof. Paul C. Cross. Pp. xi+388. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 64s.

During the past twenty-five years the infra-red and Raman vibrational spectra of a great number of organic and inorganic molecules have been measured. Only a very few of these have been considered theoretically in any detail. This is partly due to the difficulties involved, but partly due also, I think, to the fact that there has been no book presenting fully in one place the mathematical theory of molecular vibrations. This book by Profs. E. B. Wilson, J. C. Decius and P. C. Cross is therefore a much-needed one. It is particularly valuable that one of the authors should be Prof. Wilson, for, during recent years, he, together with his students, has contributed more than anyone else to the theory of molecular vibrations and to devising methods of handling the mathematical and numerical problems arising therefrom.

The approach presented in the book is, of course, necessarily mathematical, and to most chemists the mathematics is not easy, for it involves procedures, such as matrix algebra, with which many are unfamiliar. However, in this respect, the authors have made great efforts to help such readers. For example, there is an appendix of ten pages summarizing matrix notation and those procedures involved in the application of matrix methods to the problems of molecular vibrations. Also, several examples of the construction of the various types of matrix that have to be used are given in the text so that the reader can see how it is done and can then test his own skill. This is so much less time-consuming than learning from the appropriate mathematics book, for the information obtained has then to be adapted to the problem in hand. Here it is presented in relation to the vibration problem. It is not possible for the authors to make all the mathematics involved easy for those who have little training in that subject, since many of the arguments and processes are difficult and complex. However, they do go to considerable lengths to see that, between the covers of this book, there is a great deal of help regarding the mathematical methods involved. It seems to me that they might perhaps have included a further brief appendix on vector notation, which would have been helpful to those finding the beginning of Chapter 4 unfamiliar.

Examining the contents in more detail, the first two chapters provide a valuable introduction to the theory of molecular vibrations and normal co-ordinates. The third considers the application of wave mechanics to this subject, a consideration of Raman and infra-red spectral intensities being introduced here. The next three chapters present the methods that have been devised, largely by Prof. Wilson and his students, for handling the mathematical problems and for making use of symmetry and group theory. In Chapter 7 selection rules and intensities are considered in more detail, and, in the following chapter, the authors discuss the form of the molecular potential-energy function together with information that can be obtained about it. This is followed by a chapter which describes the methods, both numerical and instrumental, which can be used for solving the equations that are obtained as a result of the procedures previously described. Finally, there is a most useful chapter which presents a sample vibrational analysis of the molecule of benzene. The inclusion of this chapter is a very happy idea, for it enables the reader who is not a mathematician to test whether he has learnt correctly the lessons of the earlier chapters. Another excellent feature of the book is the long list of appendixes which occupy about a hundred pages. These contain much extremely useful information which, had it been included in the body of the book, would have been distracting to the development of the ideas presented there. The subject and author indexes are good, and the table of contents at the beginning is very complete. It is easy, therefore, to find one's way to the page or section one wants.

This book certainly meets a great need and meets it most successfully. For many of those who want to, and should, read it, it will not be an easy book; but it does provide the easiest and quickest route to acquiring skill in handling the mathematics of molecular vibrations, a skill which many are interested in obtaining. J. W. Linnett

# NIELS BOHR BIRTHDAY ESSAYS

## Niels Bohr and the Development of Physics

Essays dedicated to Niels Bohr on the Occasion of his Seventieth Birthday. Edited by W. Pauli, with the assistance of L. Rosenfeld and V. Weisskopf. Pp. vii+195. (London: Pergamon Press, Ltd., 1955.) 30s. net.

THE custom in many countries of honouring an eminent scientist by dedicating to him a birthday volume, or an issue of a learned journal, is an agreeable one which has been rarely, if ever, practised in Great Britain. The present book of essays pays tribute to a man who, both by his achievements and by his leadership, has profoundly influenced the development of modern physics. Niels Bohr was awarded the Nobel Prize for Physics in 1922 for "investigations on the structure of atoms and of the radiation emanating from them"; and this work, which taught us the theory of the hydrogen spectrum, stood only at the beginning of a series of major contributions to atomic and nuclear physics. The chapters of this book have been selected by the editors to represent some of the problems with which Bohr has been concerned; they have been written by well-known physicists who at one time or another worked with him in Copenhagen or elsewhere.

The essay by Sir Charles Darwin on the discovery of atomic number traces the development of atomic theory through the nineteenth century and up to the discovery of the nucleus by Rutherford in Manchester in 1911. The theory of the hydrogen atom followed soon after Bohr's arrival in Manchester at about that time. The following years were taken up with further developments of the Bohr theory; but at the same time attention was being directed to the fundamental principles of quantum mechanics. W. Heisenberg, in his essay on the development of the interpretation of the quantum theory, shows how, following the work of Bohr, Kramers and Slater, many serious attempts have been made (and are still being made) to clarify the relationship between the production, absorption and propagation of quanta and of material particles. W. Pauli, writing on the exclusion principle, Lorentz group and reflexion of space-time and charge, discusses the connexion between spin and statistics in a way which illustrates the fact that rigorous mathematical analysis and physical insight should be complementary, as indeed they are in the work of Bohr. Then follow two papers on field theory: on the quantum theory of fields, by L. Landau; and on quantum electrodynamics, by L. Rosenfeld. They discuss the present state of development of a subject which has its roots in Bohr's correspondence principle, and which is at present actively engaging the attention of a great many theoretical physicists. O. Klein contributes an article on quantum theory and relativity, in which the relation between these two great physical theories of the twentieth century is treated and which ends with an interesting reminiscence of an encounter between Bohr and Einstein.

The remaining essays come, like the first of the volume, nearer to experimental physics. H. B. G. Casimir, writing on the theory of superconductivity, reminds us that Bohr's thesis in the University of Copenhagen was on the subject of electrons in metals. F. L. Friedman and V. F. Weisskopf contribute a very clear account of the compound nucleus, which has been accepted as one of the basic concepts of the theory of nuclear reactions ever since it was suggested by Bohr in 1936. Finally, the articles by J. A. Wheeler on nuclear fission and nuclear stability, and by J. Lindhard on the passage through matter of swift charged particles, touch on subjects which, although of a less fundamental character than the basis of quantum theory, have been treated by Bohr with no less understanding and insight.

Most of the chapters in this volume are brief but expert essays; several of them include personal memories. Taken together in the light of their common theme, they are a record of remarkable achievement. The editors and publisher are to be congratulated on having made such a record available. W. E. Burcham

# UNITED STATES PHARMACOPEIA

## The Pharmacopeia of the United States of America

Fifteenth Revision. (U.S.P. 15.) Pp. lii+1178. (New York: United States Pharmacopeial Convention, Inc., 1955. Distributed by Mack Publishing Company, Easton, Pa.) 10 dollars.

THE first "United States Pharmacopeia" appeared in 1820; the fifteenth revision follows the fourteenth after an interval of five years. The Committee of Revision has been enlarged, and the full-time staff is now housed in permanent headquarters at 46 Park Avenue, New York City, working under a new director—Dr. Lloyd C. Miller. The Committee of

Revision contains about sixty members and, as the preface puts it, "the organization plan has been thoroughly revamped". There are ten subcommittees, one of which, the Subcommittee on Scope, is advised by fifteen panels, the members of which are not necessarily members of the Committee of Revision. There are also eighteen additional committees, advisory boards and panels dealing with such problems as insulin, steroids, vitamins, hyaluronidase, pyrogens and style.

Latin titles have been dropped practically entirely, and this is a good thing because a large proportion of the Latin names used for describing drugs have been invented during recent years and invented differently in different countries. Pharmaceutical Latin is no longer an international language. It is satisfactory to see that the titles of new articles are generally the non-proprietary names recommended by the United Nations World Health Organization, but sad that so many of these names are far too long. In each monograph there is a statement of category which indicates, often in a single word, the main use or action of the drug described. This new and original feature will be useful to those who are puzzled by some of the new names. The abbreviation mcg. is used to mean microgram; and this is unlikely to be generally accepted because a logical application of traditional usage suggests that it means millicentigram.

A new section is devoted to the mathematical procedures used in connexion with biological assays. This is by no means a faithful copy of the similar section which appeared in the last "British Pharmacopœia". It is more complicated and less general in its scope, being specially adapted to the methods of assay which actually appear in the "United States Pharmacopeia". The methods used by the microbiologists, however, vary among themselves so much in arbitrary details that it would be impossible to provide formulæ for all of them, and the final interpretation of the results often depends on the actual drawing of the curve of best fit. There is nothing about probits because probits are not used in any official method of assay. This section will undoubtedly be useful to those who have to fulfil the official requirements laid down in this book.

The Committee of Revision must be warmly congratulated on the successful completion of a gigantic task. Necessary expenses are financed by the sale of the book, and the whole project is a fine example of what can be accomplished by unofficial enterprise aided by unselfish public spirit. J. H. Gaddum

# THE LETTERS OF JOHANN BERNOULLI

Der Briefwechsel von Johann Bernoulli

Herausgegeben von der Naturforschenden Gesellschaft in Basel. Band 1. Pp. 532. (Basel: Birkhauser Verlag, 1955.) 60 francs. 60 D. marks.

THE city of Basle produced, in about a century, twelve mathematicians of significance, of whom eight were bearers of the name Bernoulli. Four of the twelve were really distinguished mathematicians; these were the immortal Euler and three of the Bernoullis—Johann, his elder brother Jakob and his son Daniel. The publication of the complete works of Euler was undertaken more than forty years ago; now a similar publication of the works of the Bernoullis is being begun. A complete publication of the works of the greater Bernoullis is being attempted, except that letters which have been printed before—for example, in the complete works of Leibniz and Euler—are excluded; a selection will also be given of the works of the lesser Bernoullis and of J. Hermann, a pupil of Jakob. The whole is expected to run to about twenty-two volumes.

The first volume is devoted to correspondence to and from Johann Bernoulli. It covers the period from 1690 to 1706, when Johann succeeded his brother Jakob as professor of mathematics at Basle on the death of the latter. The first eighty pages of the volume are an editor's foreword to the whole series. This includes historical notes, in particular a most interesting account of the disappearance of most of the Bernoulli papers from sight about the year 1800, and their rediscovery after a long search nearly a hundred years later. This account reads like a detective story, with most of the mathematical detectives following their clues with an acumen worthy of Dr. Watson rather than of Sherlock Holmes.

The letters published fall into three groups. First come four letters from Johann to Jakob, the only ones between them known to survive. The rest were apparently destroyed by Johann's descendants out of filial piety, because they depicted too well the quarrel between the brothers. The four remaining are, however, enough to illustrate why the quarrel arose. They show Johann as a person very conscious of being cleverer than Jakob, who had taught him mathematics, and unwilling to allow in others claims for priority which he always expected to be conceded to himself.

The second group is of letters to and from l'Hôpital (mainly from him). The editor makes it clear, in a lengthy introductory note, that these letters, together with lessons earlier given to l'Hôpital in Paris by Johann, were in fact the main source of l'Hôpital's celebrated book on the calculus: "Analyse des infiniment petits". The essentials of the book were provided by Johann, who was for some years a pensioner of l'Hôpital; the latter's chief contribution was the clarity with which the ideas were expressed. The letters are mainly concerned with the application of the calculus to geometry; they include Johann's discovery of the rule, usually called l'Hôpital's, for the evaluation of indeterminate forms of the type 0/0. During his lifetime Johann claimed that much of l'Hôpital's work was really his own, quoted without acknowledgment. Johann's known predilection for imputing plagiarism to others has led earlier historians to be scornful of his claims; but in this instance they appear to have been justified.

These groups of letters are in French; the third group is a heterogeneous set, in French, German, Latin and Dutch. It has little mathematical interest, but some historical. It is mainly concerned with Johann's tenure of a chair of mathematics in Groningen, 1695–1705, and with negotiations for his transfer to Utrecht. One is reminded of the many-sided character of learning in those days on first reading a letter on a medical subject (Johann was originally trained as a doctor) and then finding an epigram in Latin verse addressed to him, to which he replies in similar verse.

The whole has been very carefully edited, with copious notes and indexing. The volume is beautifully produced and will form a valuable addition to any library. T. G. Cowling

# SORTING MOLECULES

AT the British Association meeting in Bristol, Section B (Chemistry) arranged a session, held on September 5, at which the subject of "Sorting Molecules" was discussed. An introduction was given by the chairman, Prof. W. Baker (Bristol), who referred to the importance of sorting molecules by physical processes, and to the earliest methods of crystallization, distillation and sublimation. The first two of these are still by far the most used, and reference was made by Prof. Baker to fractionating columns, distillation in vacua, molecular stills and falling-film evaporators. The potentialities of co-distillation with non-aqueous liquids have been little explored. Other methods of sorting molecules are selective surface adsorption, gaseous diffusion, sedimentation by means of the ultracentrifuge, electrophoresis, and the method of distribution between two incompletely miscible solvents which has reached a high state of perfection in the Craig counter-current distribution machine.

During recent years the methods of chromatography have become commonplace in almost every chemical laboratory. In its various forms, there are elution and displacement chromatography on columns of adsorbents, or on liquid phases suspended on solids or paper. The extension of adsorption and displacement chromatography to vapours is the technique of gas chromatography, and its delicacy and rapidity mark it as perhaps the most important recent advance in analytical procedures. A further method for sorting molecules, depending on molecular size and shape only, is by means of inclusion compounds, in which a 'guest' molecule is included in cavities or tunnels in the crystal of a 'host' molecule. These holes show a remarkable selectivity in accommodating some molecules and rejecting others, and may even be capable of sorting right- and left-handed forms of the same molecule. A related method is the use of a semi-permeable membrane in dialysis; but a much more selective method is to use as a sieve a crystal lattice containing holes of molecular dimensions which can be penetrated by molecules of suitable size and shape.

In the first paper, which was on "Gas Chromatography", Dr. F. H. Pollard (Bristol) said that some indication of the importance of this new method has been the speed with which many industrial laboratories have adopted and developed this technique. The principle used in gas chromatography consists in causing each substance in a mixture to migrate at a different rate through a column of powdered material. This is achieved by one of two methods: adsorption chromatography, that is, differential adsorption on a solid such as charcoal or alumina; or gas–liquid partition chromatography, that is, differential partition of the vapours between a liquid phase held on an inert powder and a gas such as nitrogen or hydrogen flowing over the solid. For example, a mixture of hydrocarbons is admitted to the top of a column of material, and a stream of nitrogen is then passed downwards through the column, carrying the hydrocarbons with it. If the conditions of operation have been arranged correctly, the components of the mixture will leave the column one by one, and their detection as separated components depends mainly upon instruments which record differences in the physical properties of the gas stream as it emerges from the column. The two physical properties which have been extensively used for this purpose are thermal conductivity and density. Automatic recording can be readily employed, and the emergence of the different components of a mixture is indicated by a series of peaks automatically recorded on paper. From such records the individual components of a mixture can be identified and quantitatively estimated. The time required for the complete analysis can be as little as twenty minutes. For mixtures such as those of fatty acids, automatic titration equipment has been used, and for others simple volume measurements have been employed. At the meeting, demonstrations of separations using the thermal conductivity cell as a method of detection were given on two different commercial machines, arranged by Dr. B. W. Bradford (Imperial Chemical Industries, Ltd., Billingham), and a demonstration of the gas density balance was given by Mr. D. H. Desty (Research Department, British Petroleum Co.) through the courtesy of Dr. S. F. Birch.

Adsorption chromatography has been used for the separation of hydrocarbons and a wide range of organic compounds, using either frontal analysis, displacement analysis, or elution analysis on either carbon or silica gel. Janak has devised a very simple form of apparatus in which a 1–3 ml. sample is passed through a column in a stream of carbon dioxide and the volumes of the separated components measured in an azotometer over potassium hydroxide solution. This method has been applied to rare gases as well as to many organic compounds.

The development of gas–liquid partition chromatography in 1952 by James and Martin marked a great advance in technique which has led to a large number of applications. Since the first separation of milligram amounts of fatty acids on a column of kieselguhr at 137° C. carrying as static phase a mixture of liquid silicone and stearic acid, there have been extensive developments for the separation of aliphatic amines, pyridine homologues, methyl esters of higher fatty acids, halogenated hydrocarbons, organic nitrates and nitrites, and boron hydrides. Higher-temperature columns are being developed, and have already been used for $C_{12}$—$C_{22}$ fatty-acid esters. Methods have been described for identifying unknown organic compounds by comparing retention volumes on two or more columns containing different static phases, which allow of different extents of interaction between the substance and the static phase. This technique of analysis has been applied to problems in chemical kinetics; for example, thermal decomposition of ethyl nitrate; studies in air pollution; identifying polymers by analysing pyrolysis products; the preparation of radiochemically labelled fine chemicals; and the large-scale separation of highly fluorinated organic compounds.

In the second paper at the meeting, Mr. H. M. Powell (Oxford) considered the problem of "Sorting Molecules by Shape and Size". Several methods, in particular those of X-ray crystallography, reveal that different substances are made up of molecules or other groupings of atoms. Their shapes and sizes may be accurately measured, and there is the possibility of separating molecules by sorting, after observation of their shapes and sizes.

Some substances have very large molecules; but many molecules contain only a few atoms, and have no dimension exceeding a ten-millionth of an inch. It is not, therefore, a simple matter to sort molecules, and if they are to be separated by their shapes it must be by something of the same order of size as the molecules themselves—that is, it must be done by other molecules or atoms.

Whenever a crystal grows from a mixture of substances as in a solution, it is automatically separating some particles from others; the crystal grows by adding particles of the same kind. It may not completely reject all others because, within limits, lattices may tolerate other atoms or molecules which are not too dissimilar.

Some substances are able to form crystalline inclusion compounds. The atoms of one component build up a structure which has in it cavities large enough to contain molecules of a second substance. Structurally there are two main types: either the cavities are effectively closed; or they are open, long channels. These structures sort molecules by size and shape because they can contain only those molecules which are of suitable size. Closed cavities may contain molecules up to certain critical sizes and will exclude longer ones, whereas channel structures may include both long and short molecules, but will not take in the shortest ones because the van der Waals interaction between enclosed and enclosing materials is too weak.

Urea adducts form a honeycomb-like structure with long molecules in the channels, and have been used to separate straight-chain from branched-chain aliphatic molecules which are too broad. Separations with up to 95 per cent efficiency have been reported. The method has been applied to compounds with up to thirty carbon atoms, which cannot be distilled; for example, wax esters may be separated from glycerides. *Cis* and *trans* isomers of some compounds have also been separated. The nickel complex, $Ni(CN)_2.NH_3.C_6H_6$, has been used to obtain benzene of 99·992 ± 0·004 per cent purity by a very simple operation.

Some inclusion structures do not give good separations. Thus, 'Dianin's compound' (4-*p*-hydroxyphenyl-2 : 2 : 4-trimethylchroman) includes a great variety of molecules; its cavities are very large and therefore not selective. Tri-*o*-thymotide, which also gives many inclusion compounds, forms enclosing structures held together by van der Waals forces only. In this case the cavities are adaptable to some extent to the included molecule. Although a particular tri-*o*-thymotide structure may occur only with included molecules the dimensions of which lie within certain limits, this does not prevent formation of adducts with other molecules with a different form of tri-*o*-thymotide enclosure. In such circumstances separations through addition compounds may be possible but are not likely to be efficient. There is, however, a form of separation for which tri-*o*-thymotide is very suitable. It normally crystallizes as a racemate, but in many of its adducts it is spontaneously resolved into a conglomerate of *dextro* or *lævo* crystals. The cavities in these crystals are, like the molecules, enantiomorphous, and may include preferentially either *dextro* or *lævo* molecules. Since tri-*o*-thymotide racemizes rapidly in solution, it is possible to remove only the one enantiomorphous form of crystal from a solution and to recover from it the included substance. In this way racemic secondary butyl bromide has been resolved, and the efficiency of the process approaches 100 per cent. Optical resolutions may also be carried out with urea adducts; the process depends on the left- or right-handed spiral arrangement of the enclosing urea molecules, but seems to require many repetitions. The cyclodextrins have also been used for optical separation.

The enclosing components described have been found largely by accident. Once such a structure is known, it is possible to foresee which molecules it is likely to accept or reject and thus to employ inclusion compounds for separation purposes. It is not so easy to predict which molecules will form enclosing structures. It is desirable to have cavities which can be modified to fit a particular encloseable molecule, and the observation of large cavities in some inclusion compounds suggests how this might be done. If a molecular arrangement analogous to that of β-quinol but with much larger cavities could be built up, it might be possible to vary the cage-forming component by the addition of a substituent without drastic change in the main structure.

A major problem in industrial and academic science is how to separate the multitudes of chemical species from one another, by neat, simple and effective methods, and new principles for doing this are constantly being sought. A novel method consists in using crystal lattices as molecular sieves, and this was discussed in the third, and last, paper, given by Prof. R. M. Barrer (Imperial College, London), his paper being entitled the "Separation of Molecular Mixtures using Crystal Sieves". A crystal with an open lattice is employed quite literally to sift molecules. Those molecules of the wrong shape or size are held back, while others of appropriate form pass easily into the crystal, which then occludes them copiously. The separations achieved are fully quantitative in a great many cases, by the single, clear-cut operation of exposing the crystal powder to the molecular mixture, or filtering the molecular mixture through a bed of the crystals. An account was given of some of the work done in Prof. Barrer's laboratory in introducing the molecular sieve method, and in characterizing, operating, modifying and synthesizing crystal sieves of various kinds.

Naturally occurring crystal sieves were discovered among the crystalline zeolites. In these species, which are all aluminosilicates, $SiO_4$ or $AlO_4$ tetrahedra are built into more complex structural units, often polyhedra. These polyhedra may have considerable cavities at their centres (chabazite), or it may be the stacking of the polyhedra which creates new and larger cavities (faujasite; natrolite, thomsonite, scolecite). Windows open into the cavities and provide ready means of entry or exit for sorbed molecules and means of transit from one cavity to another. These windows also determine the molecular sieve properties of the crystal as a whole. By sharing of oxygen atoms, the polyhedra are built into three-dimensional structures which often display remarkable rigidity and permanence, while being permeated by cavities interconnected by windows. The volume of the cavities may be more than 50 per cent of the volume of the crystal. Four major categories of crystal sieve were then characterized by Prof. Barrer, using certain molecules of known dimensions as yardsticks. A general order of openness of the crystal lattices in a few cases is: faujasite > calcium-rich chabazite > sodium-rich mordenite > calcium-rich mordenite or calcium-rich levynite > analcite.

Faujasite, when freed of its crystal water by heat and evacuation, freely occludes *iso*-paraffins and simple aromatics and naphthenes; chabazite will not occlude *iso*-paraffins, aromatics and naphthenes, but does occlude *n*-paraffins, and molecules of smaller cross-section; sodium mordenite will not occlude *n*-paraffins, from $C_3$ upwards, but sorbs $C_1$ and $C_2$ paraffins, argon atoms, and nitrogen, oxygen and similar small molecules; while calcium-mordenite or levynite does not sorb even $C_1$ and $C_2$ paraffins, and yet still occludes nitrogen, oxygen and similar small molecules. Typical quantitative separations, using the appropriate crystal sieve, have been made, *inter alia*, of aromatics, naphthenes or *iso*-paraffins from *n*-paraffins; of mono-substituted methanes and ethanes with amine, hydroxyl, chloride, bromide or cyanide as substituents from similar mono-substituted *n*-paraffins having the substituent group at a secondary carbon atom; of mono-substituted methanes from similar mono-substituted ethanes; or of simple inorganic species (water, ammonia) from organic species. Mixtures which are azeotropic, or in which the constituents have virtually the same boiling point, can readily be separated if appropriate size and shape differences arise between their molecules (for example, water–ethyl alcohol; or *n*-$C_7H_{16}$–*iso*-$C_8H_{18}$).

The crystal sieves have been modified, within limits set by a given aluminosilicate framework, by ion exchanges of the type: 2Na ⇌ Ca (change of valence), Na ⇌ K (change in radius of cation); and by more complex isomorphous replacements such as NaAl ⇌ Si. The sieve characteristics can also be changed by leaving small amounts of polar molecules (for example, water, ammonia, methylamine) in the crystal lattice. In these ways a great diversification of sieve types can be effected, and an almost continuous gradation of such sieves now appears possible. Finally, a substantial number of zeolites has been synthesized by hydrothermal growth from gels, representative of all main classes of sieve. Many of these zeolites have no natural counterparts, and raise interesting problems in crystal chemistry and crystal growth.

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# INFLUENCE OF SPACE FLIGHT ON ENGINEERING AND SCIENCE*

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WITHIN the past few years many scientists have predicted seriously and confidently that human beings from the Earth would, in the foreseeable future, travel to the Moon and the nearer planets. The ranks of those who would dispute this prospect are diminishing rapidly. Although much of the progress is still guarded by military necessity, space flight is emerging as an activity in its own right—one that can command the efforts of many engineers and scientists.

In the United States the exploration of the upper atmosphere, the frontier to space, is being conducted vigorously. Pilots of rocket aircraft have experienced conditions approximating to those in free space, if only for a few minutes. The effect of space flight upon the human organism is being investigated—the U.S. Air Force maintains a Department of Space Medicine. There is an international organization devoted to the promotion of space travel, and there are space flight societies in twenty-three countries.

The ancients, except for a few rare individuals with greater insight, conceived of the world as an enclosure; they stood upon the Earth at the bottom and gazed upward at a blue ceiling upon which a multitude of lights, a few great and many small, seemed to move under the influence of an unseen hand. The atmosphere filled this enclosure, and it was believed that if man had wings he could fly to the ceiling and determine the source of the lights. If a few philosophers guessed more nearly at the truth, certainly the average man had no better conception of the universe than the fanciful picture just described. There could be no valid idea of space flight until Copernicus, Kepler and Galileo placed the Earth in its true relation to the universe and at the same time gave dimensions to space.

When at last the Moon and the planets were found to be material bodies not unlike our Earth, it was possible to ponder whether the immense separating distances could be traversed by man or any man-made device. The situation was made even more discouraging when, in 1686, Newton[1] defined the nature and the magnitude of gravitational attraction. If previously there had been some fanciful hope of visiting celestial bodies, now surely it appeared that man was destined to remain for ever a prisoner of his own planet. In view of the great distances, it seemed unlikely that the atmosphere could extend through interplanetary space, and any suspicion that it might was laid to rest when Torricelli's barometer was carried to a mountain-top and taken aloft by the early balloonists.

Although Newton brought man face-to-face with one formidable aspect of the problem, namely, gravity, he also provided, in his three laws of motion, the key that would unlock the door to space. The fundamental equation of rocket action in free space and hence of space flight:

$$V_b = C \ln \frac{M_0}{M_b}$$

where $V_b$ is velocity of rocket at the end of burning, $C$ is velocity of exhaust jet, $M_0$ is initial mass of rocket, and $M_b$ is mass of rocket at the end of burning, is derived by integrating Newton's third law of motion. Nevertheless, more than two centuries were to pass before anyone performed the integration or realized that the simplest embodiment of Newton's third law, a rocket, is the only machine capable of propelling itself in a vacuum.

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* Substance of a paper read before Section G (Engineering) at the Bristol meeting of the British Association on September 1.

By the beginning of the twentieth century the physical sciences had advanced to the point where it was inevitable that someone would develop a valid theory of rocket action and would apply the theory to the problem of escape from the Earth. The task was accomplished by three men working independently in three different countries. The three had much in common—they were teachers, one at a small university, the other two in secondary schools. All three were motivated by the desire to explore interplanetary space and presented their findings with conviction, even though they were regarded by most of their contemporaries as prophetic dreamers. The men and their works are: Ziolkovsky, "The Exploration of Cosmic Space by Reaction Machines" (1903); Goddard, "A Method of Reaching Extreme Altitudes" (1919); Oberth, "The Rocket into Interplanetary Space" (1923). Any one of these three publications, had it been widely read and accepted, would have sufficed to lay the groundwork for space travel, because each man clearly understood and asserted the following fundamental concepts: (1) Escape from the Earth is possible by the application of a moderate acceleration over a substantial period of time—at least several minutes. (2) Such acceleration can be produced in a vacuum by a rocket. (3) The rocket must (*a*) have high thermal efficiency (that is, high velocity of the ejected matter), and (*b*) consist mainly of propellant material (that is, have a high ratio of fuel weight to total weight). (4) High thermal efficiency would be obtained most readily from the chemical combustion of liquid fuels.

Ziolkovsky[2] started by examining Jules Verne's cannon and also the balloon as a means of reaching very high altitudes. Both approaches died quickly under mathematical analysis. He proceeded next to the rocket and developed the fundamental equation previously noted. Realizing that energetic fuels were required, he determined from thermochemical calculations the heat release of various liquid combinations. When he computed the velocity that could be attained, in theory at least, he realized it was sufficient for escape from the Earth.

Goddard[3], alone of the three, proceeded from experiment to theory. Using smokeless powder in a heavy-walled steel combustion chamber, he produced a jet velocity of almost 8,000 ft. per sec., a seven-fold improvement over ordinary rockets and the highest velocity of matter attained up to that time outside electrical discharge tubes. Also, he proved by tests in a vacuum that a rocket does not produce its force by pushing on the air behind it—a fact that he knew from basic physics, but felt had to be demonstrated. He observed correctly that the jet velocity was greater in a vacuum, but he attributed it erroneously to more efficient ignition. Although Goddard did not turn to liquid fuels until after his basic paper was published, he achieved the first flight of a liquid-fuel rocket, an event that took place on March 16, 1926. Goddard[4] continued his experiments for more than two decades, during which time he developed, in rudimentary form, almost every component of modern rocketry. Not one of his components would be considered reliable by present-day standards; realizing the prodigious task he had set out to accomplish, he would repeatedly add a new component before perfecting the previous one. In retrospect, it appears that Goddard was attempting, single-handed, to encompass the entire field of liquid-fuel rocket development, a task that would eventually tax the abilities of thousands of engineers and scientists.

Oberth[5], in his treatise, gave the most complete theoretical analysis and carried it farther into the realm of space travel than either of the others. He stated at the outset the four propositions he would attempt to prove: (1) considering the present state of science and technology, it is possible to build machines that could rise beyond the atmosphere; (2) after further development these machines will be able to attain such velocities that, left undisturbed in the depths of outer space, they will not fall back to the Earth and will even be able to leave the zone of terrestrial attraction; (3) these machines could be constructed so as to transport human beings, probably without damage to their health; (4) under certain economic conditions the construction of such machines might be profitable.

Oberth began by developing the theory of the liquid-fuel rocket and describing its construction. He proceeded to discuss applications of the rocket, first as a high-altitude sounding vehicle, then as an Earth satellite, and finally as a space-ship for interplanetary travel. He developed the concept of synergic (minimum energy) ascent trajectories. Without doubt, almost every later book on space flight owes much to Oberth's encompassing study.

Whereas the first quarter of this century provided the theoretical background for space flight, the second twenty-five years may be viewed as the period of experimental preparation. It saw the liquid-fuel rocket develop as a practical engine for the propulsion of aircraft and guided missiles. Many fuels and oxidizers were explored—a few saw widespread use. An assortment of auxiliary apparatus—pumps, turbines, valves and regulators—was developed to feed and control the rocket motor. The steering of a large rocket vehicle was mastered by means of gyroscopes and jet controls. Great progress was made in the aerodynamics of supersonic flight, in structural design and in the use of high-temperature materials.

Of the early experimenters, three groups were most noteworthy. The work of Goddard as an individual has been referred to previously. In Germany, the Verein für Raumschiffahrt, fired by Oberth's monumental work, undertook to develop a small workable rocket called, appropriately, 'minimum-rakete' ('Mirak' for short)[6]. In the course of several years they made hundreds of static firings and numerous brief flights. The American Interplanetary Society drew its inspiration largely from abroad, so secretive was Goddard about his experiments. Indeed, when in May 1933 the Society finally achieved a first liquid-fuel rocket flight, they were unaware that Goddard had progressed far beyond his first flight seven years before.

The *V2*, the development of which started in the middle of this period, was the largest single engineering advance in the field of rocketry. By applying thousands of engineers and scientists in a concerted effort, the German Government was able in six years to transform the liquid-fuel rocket from a small, sputtering vehicle, capable of ascending a few hundred feet, into a giant projectile with a range of 200 miles and a velocity of one mile per second. The *V2* was a material embodiment of Oberth's ideas and, although he conceived the liquid-fuel rocket as a vehicle for space travel, he also foresaw its possible use as a bombardment weapon. Actually, he hoped that the rocket missile would be a deterrent to, rather than a tool of, war.

After the War, the major activity leading to space flight took place in the United States in the form of upper-air research with instruments carried in rockets. In a programme which is still continuing, scientists from government laboratories and universities explored the upper atmosphere using at first captured *V2* rockets and later, as they became available, 'Aerobees' and 'Vikings', both of which were designed specifically for probing the atmosphere in the region between 50 and 150 miles above the earth. In this way, knowledge of the pressure, temperature, density and ionic content of the atmosphere has been extended up to 135 miles by direct measurements. The solar spectrum has been recorded in the far ultra-violet. X-rays have been detected in solar radiation and their role in the formation of the ionosphere has been postulated. The number and the mass distribution of primary cosmic rays have been recorded in emulsions carried aloft in rockets. Small animals (monkeys and mice) were sent aloft, and their physiological reactions observed during a period of weightlessness. For nine years man has been exploring the frontier of space as a prelude to flight beyond the atmosphere.

It is always tempting to draw parallels, and it might appear, at first glance, that the advance toward space flight parallels the progress of aviation, with the latter preceding in time. The same elements of progress are evident in both fields, but one cannot fail to note the differences and contrasts. Although much theoretical work had been done on fluid mechanics and experiments performed in wind tunnels and with gliders, there was at the time of the first mechanical flight no adequate theory to explain the lift of a winged vehicle[7]. We knew that the Wright Brothers' aeroplane flew; but we could not explain why or how it flew. By contrast, the motion of a rocket, as we have seen before, was well understood before Goddard's first attempted flight. This is no paradox—it is apparent that the mathematical treatment of flight within the atmosphere is much more difficult than the analysis of flight in free space.

In both fields there was a period when development was nourished mainly by amateurs; in aviation it was the first decade of this century, for rocketry the late 'twenties and early 'thirties. In both cases the advance was given great impetus by a war; the First World War for aviation, the Second for rocketry. But I doubt if there is in the history of aviation any single step forward comparable in magnitude to the creation of the *V2*. Aviation has been characterized by gradual, steady development, fostered to a large extent by its economic returns as well as its military advantages. There have been several significant milestones; one of the most noteworthy was the development by Whittle and others of the turbojet engine, which in the short space of a dozen years has completely displaced the piston-driven propeller in high-speed military aircraft and may soon dominate the field of commercial aviation.

In pursuing this rather loose parallelism I have tried to estimate what period in the history of aviation corresponds to the present status of space flight. It seems to me that we are now at a point roughly corresponding to the period before Lindbergh's historic flight across the Atlantic. The significant event we are awaiting is the first orbital flight of a manned earth satellite[8]. In both cases, at the time being considered, the vehicle had been developed to a reasonable degree of reliability and many flights of shorter range and duration had been made. But again, there is a significant difference. Aviation has always implied manned flight; in rocketry most of the progress thus far has been made in unmanned, automatically controlled vehicles. Our technology has advanced to the point where we need not risk human life in experimental rocket flights; on the road to space, instruments will always go first and will point the way for men to follow.

Prior to establishing the first manned satellite, two important techniques will have to be mastered. First, there will be a period of experimentation with unmanned, instrumented satellites during which time problems of propulsion, staging and navigational control will be worked out. The environmental hazards—cosmic radiation, meteors, solar heat (and the absence of it), and possibly weightlessness—can be evaluated. World-wide realization that this first problem is being attacked vigorously came when, on July 29, 1955, President Eisenhower announced that the United States would launch small instrumented satellites during the International Geophysical Year (1957–58). By their statements in support of the President's announcement, many noted scientists attested to the feasibility and usefulness of the instrumented satellite. It is significant, also, that the United States invited international co-operation and offered to make its scientific findings available to all nations.

The second problem is the one of safe return to the Earth's surface. The relative speed of roughly five miles per second between the orbiting vehicle and the earth's surface must be brought to zero. Obviously, this will be done by allowing the satellite to transfer its energy to the atmosphere. But this process must be controlled with great precision, lest the satellite absorb too much of the energy in the form of heat. Much will be learned by observing the return of instrumented satellites; but the final preparatory steps will probably involve manned flights at gradually increasing re-entry speeds.

I have placed Lindbergh's flight and the first manned satellite in juxtaposition because one has, and the other will, I believe, so excite the world's imagination that future progress will be greatly accelerated. One cannot say when the desired event will take place—much hard work remains to be done—but it is not uncommon for scientific achievements to precede their predicted arrival. The mechanical components—engines of sufficient power and controls of requisite precision—are within sight. If it is argued that the human hazards are great and, at present, poorly understood, let it be remembered that the first orbital flight need only be brief—a matter of several hours. In this respect the ordeal may be less prolonged than Lindbergh's flight, but certainly no less demanding upon the pilot's judgment and courage.

We have seen that although space flight is yet to be achieved, its prospect has had, in the past fifty years, an appreciable influence upon science. The greater influence by far lies in the future. The advances in our technology necessary to achieve manned flight in space and those required to exploit it can be readily delineated. But a more important result will, I believe, be the impact of space flight upon scientific thought and education.

In the United States to-day we are faced with a serious shortage of engineers and scientists even though the demand is great and the remuneration is ample. Almost every prospective technical graduate of American universities is showered with offers of employment, and our newspapers and magazines are filled with advertisements for men with technical training. The most appalling aspect of this situation is that it is likely to continue for many years. A recent survey shows that the study of physics in American public high schools has been declining for more than half a century. Whereas in 1895 more than 95 per cent of high-school graduates had taken a course in physics, by 1952 only 21 per cent of graduates had ever studied it[8]. For many years the increase in high-school enrolment more than offset the decrease of specialization in physics, but now the waning interest is taking its toll. To-day only about half the public schools offer a course in physics, and a quarter of these have no laboratory facilities. There is a critical shortage of science teachers, due in part to the attractions of industry, but more to the lower status and wages accorded the teaching profession. But these factors can be remedied with sufficient effort—a deeper and more serious cause is the lack of interest on the part of our youth. Why do they turn away from a career in science ? We can only grope for the answer. Perhaps they sense, better than their elders, that too much of our scientific talent is engaged in the unproductive task of developing weapons for war. Is there much inspiration to devote one's life to this end, especially when we are rapidly approaching the borderline of total destruction ?

I believe that space flight might serve in no small measure to turn men's minds toward a more appealing scientific goal. As the exploits of Cabot, Drake and Davis inspired many generations of Englishmen to turn to the sea, so may the first astronauts reawaken our youth to the romance of scientific exploration.

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[2] Ziolkovsky, K. E., "Collected Works" (1933).
[3] Goddard, R. H., "A Method of reaching Extreme Altitudes" (Smithsonian Miscellaneous Collections, 1919).
[4] Goddard, R. H., "Rocket Development" (Prentice Hall, 1948).
[5] Oberth, H., "Wege zur Raumschiffahrt" (R. Oldenbourg, 1929).
[6] Ley, W., "Rockets, Missiles, and Space Travel" (Viking Press, 1951).
[7] von Kármán, T., "Aerodynamics" (Cornell Univ., 1954).
[8] Kelly, W. C., "Physics in the Public High Schools", *Physics Today* (March 1955).

# UNITED KINGDOM ATOMIC ENERGY AUTHORITY

## ANNUAL REPORT

THE first annual report of the United Kingdom Atomic Energy Authority* covers the period from July 19, 1954, when the Authority came into being, to March 31, 1955. In that period the Government has published the Programme for Nuclear Power and the Defence White Paper announcing the decision to proceed with the development and production of thermonuclear bombs. Further information has also been given in a brochure, "Britain's Atomic Factories", and in the booklet, "The Commonwealth and Nuclear Development", issued by the Central Office of Information last June ; and the technical information made available at the International Conference on the Peaceful Uses of Atomic Energy at Geneva in August has also robbed the report of some of its technical interest. Nevertheless, the report reveals an impressive picture of the continued growth of a project which has been expanding since its inception in 1945, and of the wide range of research on which that expansion is based.

The latter aspect, and the scarcity of skilled man-power, which constitutes the chief threat to the fulfilment of the programmes in accordance with the time-table to which they are closely geared, are discussed elsewhere (see p. 1183) ; but the shortage of technological skill is put in the forefront of the report, as the development of atomic energy is unique in the variety of specialized skills which it demands. After recapitulating briefly the steps that led to the establishment of the Authority, which at present consists of the chairman, Sir Edwin Plowden, and four full-time and three part-time members, the report merely records the net estimates of expenditure for 1954–55 at £53,675,000 and £50,562,000 respectively ; the actual expenditure will be presented to Parliament and published. No figures for staff are included ; but the senior staff are listed in an appendix. As to patent policy, it is stated that the programme for nuclear power will extend to industry and to the electricity authorities the use of atomic energy inventions, some of which also have general applications in the chemical, metallurgical and instrument fields. Where inventions are not secret, the Authority's policy is to grant non-exclusive licences to suitable United Kingdom recipients unless, exceptionally, the invention can be more appropriately exploited by the National Research Development Corporation.

Apart from a brief reference to the weapons programme, the technical aspects of the Authority's work are discussed in a series of chapters dealing successively with the materials, the reactors, the nuclear power programme, the isotope programme and with progress in research. There is a further chapter on health, waste disposal and safety. In regard to materials, the Authority does not normally prospect for new uranium deposits on its own account, and its main contribution to the provision of uranium has been through the encouragement given to producers by the assured market offered by the Colonial Development Agency contracts, from which British atomic energy work has so far drawn all its supplies. As part of its procurement programme it has provided the considerable capital sums necessary to develop and exploit deposits. On arrival in Britain, the uranium ore or concentrate is processed at the Springfields factory of the Industrial Group. The initiation of the nuclear power programme will involve a great increase in the amount of uranium processed, and the creation of capacity for this higher throughput will be used as an opportunity to improve the whole process. A low-separation diffusion plant has been built at Capenhurst in addition to the main plant, and in this the uranium which has been depleted in its content of fissile material can be restored to its original composition by carrying out a partial separation from the uranium-238 atoms, thus permitting much greater economy in the use of uranium, since the restored material can be put through the pile again and used to produce more plutonium. This low-separation plant has worked satisfactorily throughout the period, as has the primary separation plant at Windscale, where the piles have worked efficiently and produced the planned amount of plutonium. Research is being carried out to increase our knowledge of thorium and of the production of uranium-233. A new distillation-column packing of such high capacity that the capital cost could be brought down to nearly half that of a conventional 'bubble-cap' type of packing has been developed for the separation of 'light' and 'heavy' water, and this packing, 'Spraypak', is potentially useful in the general field of distillation.

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* United Kingdom Atomic Energy Authority. First Annual Report for the period 19th July, 1954–31st March, 1955. Pp. vii+35. (London : H.M. Stationery Office, 1955.) 2s. net.

In addition to describing the various reactors under construction, the report outlines some of the research in this field proceeding at Harwell, notably the detailed design study of light-water reactors known as LEO (Low Enrichment Ordinary Water). The Authority expects that by 1957 it will be supplying electricity from Calder Hall to the Central Electricity Authority. Much of what is said in the report as to the programme for nuclear power and the isotope programme is already well known. For the year ended March 31, 1955, the output of isotope consignments totalled 18,835, an increase of 16 per cent, and the value of radioactive products sold was about £450,000, of which 35·6 per cent was exported to some forty countries. There was a marked increase in the use of small amounts of separated fission products for industrial and medical purposes, and the accessibility of many of the commoner compounds of such isotopes as phosphorus-32, iodine-131 and sulphur-35 has been increased by improvements in technique. There is evidence of a growing interest within industry generally in the radioactive tracer technique.

In regard to research generally, facilities available for determining the exact nature of the interactions of neutrons of different speeds with various elements are being extended by developing a novel and much more powerful source of neutrons, and the Authority is also fostering a programme of fundamental research on the unresolved problem of the forces which bind together the elementary particles in atomic nuclei. Studies in the field of radiation chemistry have shown that important chemical and structural changes can be effected in materials irradiated by powerful radioactive sources. Among these are improvements in the heat resistance and other physical properties of plastics and in the properties of lubricating oils. To provide further facilities for this work and to assist industry with advice and tests, a Technological Irradiation Group was established as part of the Isotopes Division of the Atomic Energy Research Establishment in April 1955. A new instrument of value outside its original application is an infra-red spectrometer developed to record continuously the percentage of heavy water in a mixture with ordinary water, while the Research and Development Branch of the Industrial Group has dealt successfully with the development of new solvent processes for the extraction of uranium from its ores and with the application of the 'fluidized bed' technique to processes used by the Group. Metallurgical research on the extraction of uranium, plutonium, thorium, zirconium and beryllium from their ores and on the working of the metals is yielding techniques of increasing application in the manufacture of reactor fuels and the special canning materials which contain them, and much effort is directed to the search for corrosion-resistant alloys and to the modification of the metallurgical structure of reactor fuels or their design so as to control undesirable effects. An electronic analogue computer is being developed to simulate the operation of a large atomic power station by showing directly, and so without the need for elaborate calculation, how the essential factors involved change with time and interact with one another.

Much work has been done on the disposal of radio-active wastes, several methods having been developed which enable this to be dealt with safely, and the report describes the storage and deep-sea disposal methods used for solid wastes. Sea disposal is carried out in the Atlantic beyond the continental shelf. For effluent disposal considerable research and field-tests have established rates of discharge which can in no way affect either the health of the public or the fisheries or seaweed industry. In regard to gaseous effluent, it is pointed out that the prevention of interference with the technical work of the Authority often demands an even more stringent control of discharged activity than is legally demanded for public health or other reasons.

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# SCIENTIFIC FILM ARCHIVES

By DR. A. R. MICHAELIS

PAST and present knowledge can only serve the future if permanently preserved and patiently perpetuated. If this knowledge is recorded in writing, and preserved as a book in a library, then with little trouble, small expense, and by the use of microfilm, practically every word that has ever been printed can to-day be read by anyone in the world. How infinitely worse is the situation if knowledge has been gained by, or recorded on, motion picture film; that many scientists have done so and used cinematography in their biological, anthropological, psychological and medical work was recently shown in a survey on research films[1]. Unfortunately, only a very limited number of these films have found their way into archives and are available for reference to other research workers, anxious to consult them. In the past, one reason for this dearth of scientific film archives has been the difficulty and cost of storing nitrate film; the problems involved and their expensive solutions have been fully and authoritatively discussed by Brown[2] in a recent paper. Since about 1950, however, the universal use of cellulose triacetate safety film base for both 35-mm. and 16-mm. motion pictures has at least removed one of the difficulties hindering the establishment and growth of film archives. It is expected that this type of film base, when stored in conditions similar to those for books in libraries, will last several centuries.

Film archives, devoted to the art of the film, have been in existence for many years, the oldest three and most important being the National Film Archive of the British Film Institute, the Cinémathèque Française in Paris and the Museum of Modern Art in New York. Since the Second World War, many other countries in Europe and overseas have started their own national collections of films; but the British National Film Archive is the only one in the world in which scientific films for permanent preservation have been systematically collected since 1949. The work of selection has been in the hands of the Science Selection Sub-Committee of the British Film Institute; in October 1955 it held its fiftieth meeting, exactly six years after its first gathering. During that time several thousand scientific films have been considered in detail, and about half of these were recommended for inclusion in the archives; owing to the difficulties, however, of obtaining copies and original prints of some of those recommended, not more than about one thousand have so far been actually deposited in the vaults. Scientific films which have been preserved are, of course, available to research workers for study; a request to view them should be addressed to: The Curator, National Film Archive, 164 Shaftesbury Avenue, London, W.C.2.

The first task which the selection committee faced was the adoption of basic principles to guide its decisions. It was agreed that a scientific film should be preserved if the subject-matter was of sufficient interest for the future, and secondly, if the film was an example of the use of a cinematographic technique during the course of a research project—in fact, a research film. The committee has rejected films the contents of which could be preserved better or more cheaply by photographs or by written descriptions. In the main, only British films have been recommended for preservation; but those foreign scientific films which were available in Britain, or which had a marked influence on British scientific thought, have not been excluded. Preference has always been given to actual records of scientific events, and reconstructions have only been accepted when originals were unavailable. Concerning subject-matter, priority has been given to films showing outstanding scientists at work, original experiments, dying native cultures and scientific heterodoxy. The only general rule, however, that was applied in doubtful cases and which was found workable was the question: "Is there any conceivable reason of subject or technique, why this film would be of interest to students of science in fifty or hundred years time, and why its loss might then be deeply regretted?".

Having established its terms of reference, the Committee was confronted in 1949 with an enormous number of scientific films from which to select. The only possible way of proceeding was the division of the whole field of science into its individual disciplines and in each case to call for lists of scientific films. Several lists of this kind were then in existence, and many others were later prepared, either by subject experts, or by committees of the Scientific Film Association, which has in so many ways furthered the work of the Science Selection Sub-Committee. Among the many subjects which the committee considered were, for example, astronomy, chemistry, mathematics, psychology, town planning, veterinary science, medicine, economics, biology, aeronautical engineering, forestry, horticulture and agriculture. In each case, subject experts were asked for their views on particular films; they then reported back to the committee, often only after spending many hours in viewing the original material. Scientific film experts have also given freely of their time to help the committee in its important work of selection, and all who could have served on the committee itself for varying periods. Through its first fifty meetings, the committee has systematically surveyed a very large proportion of past scientific films, and its present task is to select films worthy of preservation from current productions, to discover forgotten research films, and to fill the many gaps that remain.

The committee has received great help from outside bodies, which have generously handed over their own collections of scientific films to ensure their permanent preservation; so, for example, a splendid collection of early aeronautical films was given by the Royal Aeronautical Society, and a similar gift was received from the archives of the Physiological Society. The committee earnestly hopes that other learned societies which have historical film material will follow these examples, as only scientifically controlled archives can fulfil all the rigorous conditions required for the permanent preservation of early scientific films, many of which were recorded on unstable nitrate film. Producers of scientific films have been no less generous, and at present the National Film Archive receives automatically one print of each film made by the Shell Film Unit; the National Coal Board, Guy's Hospital, Imperial Chemical Industries and the Anglo-Iranian Oil Company have also given many of their films. Again the committee hopes that others will present their productions as well, so that complete series will be available for study in a hundred years time.

A very great deal of work remains to be done. At present there is an almost complete lack of biographical film material of eminent scientists, and it might here be suggested that with the award of a Nobel Prize, or the Copley Medal, a short record film of the recipient is prepared. Such a film and its accompanying sound-track would show better than photographs or written descriptions the personality of the prize-winner; it should, of course, give full details of the particular research technique which brought him distinction. Many research films, at present lying forgotten in desks and files of their producers, need to be rescued for preservation, and the committee would gladly accept them. It can assure the donor that he would not lose his copyright and that duplicates will not be made unless his express permission is given. The committee sincerely hopes that other nations will follow its own example and that either national film archives abroad, other scientific film associations, or scientists in overseas countries will form their own scientific film archives to preserve and to perpetuate scientific data for future research. Johnson[3], who also pleaded for such archives in the United States, concluded a paper on this subject: "It is hoped that those who truly wish to serve Science, even though they do not believe that motion pictures will achieve a place of major importance in scientific institutions, will accord posterity the opportunity of deciding the matter by creating libraries or reservoirs of motion picture films".

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[1] Michaelis, A. R., "Research Films" (Academic Press, New York, and Academic Books, London, 1955).

[2] Brown, H. G., *Brit. Kinematogr.*, 20, No. 5 (1952).

[3] Johnson, H. R. F., *Proc. Amer. Phil. Soc.*, 81, 79 (1939).

# THE WENNERGREN INTERNATIONAL CENTRE FOR SCIENTIFIC RESEARCH

THE Swedish industrialist Dr. Axel Wenner-Gren has recently announced a new donation for the benefit of science, to be administered by a new foundation called the WennerGren Centre for Scientific Research. Some of his earlier gifts for science are well known. In 1937 he founded the WennerGren Society in Stockholm and the Institute for Experimental Biology in the University of Stockholm. The Society has supported the Institute as well as many research activities in other fields. In 1941 he created in New York the Foundation for Anthropological Research, which has among other activities not less than five scientific expeditions in South and Central Africa studying the first traces of the early history of man. This Foundation also serves most successfully as a clearing centre for a large number of universities and specialists in the field of social and anthropological sciences. It may be mentioned that the discovery of the carbon-14 method for age-determination by Prof. W. F. Libby was the product of an investigation supported by this Foundation.

Dr. WennerGren's new donation may be considered as a first step for stimulating and supporting international co-operation in scientific research on a broader base. The members of the board of the new Foundation have just been announced. Chairman of this Foundation will be the Lord Chamberlain of Sweden, Birger Ekeberg, who is also chairman of the WennerGren Society and of the Nobel Foundation.

The first undertaking of the new Foundation will be a building to serve as the permanent seat for the central organization. The building also will have—and this is a very important point—accommodation for housing (at moderate costs) foreign scientists who are doing research work at one of the many research institutes in the Stockholm area. For this purpose, there will be furnished apartments and rooms for about a hundred scientists, restaurants, club-rooms, lecture halls, etc. It will also serve as a meeting centre for national and international symposia, as well as for smaller and informal gatherings for the promotion of personal contacts between scientists from different research fields.

It is expected that the Government of Sweden and the City Council of Stockholm, which have shown an active interest in the plans, will provide a suitable, centrally located site for the building. According to the present plans, the new building will be ready for occupation in about two years.

From the communication in which Dr. Wenner-Gren announced his new donation, the following words may be cited: "For a long time I have personally been convinced that many of the great problems of mankind can have a satisfactory solution only on a scientific basis. That is the reason why I have tried to support both pure and applied research for many years and I have now decided to make available—one could say by instalments—my resources for the furthering of such activities".

# OBITUARIES

## Dr. W. G. Shilling

DR. W. G. SHILLING, head of the Materials Division of the Aeronautical Inspection Directorate, Ministry of Supply, died suddenly on October 16.

William George Shilling was born at Faversham, Kent, on February 21, 1899. During 1910–16 he attended the Henry Wreight School, now the Faversham Grammar School, where he passed the Inter.-B.Sc. (London) Examination. He joined the Army at the age of seventeen, was commissioned and was awarded the Military Cross in 1918. His rank on demobilization in 1919 was staff major.

Shilling spent the next eight years at East London (now Queen Mary) College, University of London. He graduated B.Sc. (honours in chemistry) in 1921 and then began research on the specific heat of gases under the direction of Prof. J. R. Partington. After making very accurate determinations at ordinary temperatures, he extended the method, which involved measuring the velocity of sound, to higher temperatures up to 1,800° C. Shilling was a most ingenious and skilful manipulator, expert in devising and perfecting apparatus. He also collaborated with Prof. Partington in writing a book, "The Specific Heat of Gases", a classic in this field. Shilling was awarded the M.Sc. in 1922 and D.Sc. in 1927.

During 1927–43 Shilling was in charge of chemical and physical research for the International Paint and Compositions Co., Ltd., Newcastle upon Tyne. His main work was on ships' under-water paints, but he also dealt with all other types of protective and decorative finishes. During this time he played a leading part in the local civil defence organization.

In 1943 Shilling joined the Aeronautical Inspection Directorate as the assistant director in charge of the non-metallic materials branch, becoming head of the Materials Division in 1947. For some years he was also responsible for the technical direction of the A.I.D. Laboratories at Harefield, being especially concerned with the development of new methods of inspecting and testing the wide range of materials and equipment used in Service aircraft and ground installations.

Throughout his life, Shilling retained his manual dexterity, and he was interested in clock making and the construction of electronic apparatus. He kept his love of the countryside and was never happier than when working on his estate; he was a loyal member of his Church and a keen Mason. His modesty, good nature and integrity won Shilling a host of friends in many walks of life, who mourn his untimely death. He is survived by his widow and two daughters, whose consolation will remain that his happy home was the centre of his life.

H. J. CURNOW

### Dr. J. W. Nicholson, F.R.S.

May I supplement Prof. W. Wilson's account of Dr. J. W. Nicholson in *Nature* of December 3 with a reminder that throughout most of his working life Nicholson was prominent on the British Association Mathematical Tables Committee, of which he was secretary from 1910 until 1920 and then chairman until his retirement ? It is to be regretted that his name is nowhere conspicuous in the volumes issued by the Committee after 1930, for it was under his influence that a number of people, each with a pet function or a pet range of his own, became a body concerned collectively with the principles and problems of computation and presentation. The decade in which the Committee regained and enhanced the prestige which it had enjoyed in the nineteenth century was preceded by a decade of exploration, discussion, and anxious self-criticism ; and it was owing to Nicholson's mathematical versatility and uncanny power of focusing attention on the essential points on both sides of any argument that a decade as unspectacular as a wheatfield in spring was also as rich in vitality and in promise destined to be fulfilled.

E. H. Neville

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# NEWS and VIEWS

## Chemistry at the Royal Holloway College, London: Dr. E. J. Bourne

Dr. E. J. Bourne, reader in organic chemistry in the University of Birmingham, has been appointed to the chair of chemistry at the Royal Holloway College, University of London, in succession to the late Prof. G. Williams. Dr. Bourne, who is thirty-three years old, received his early education at Rugeley Grammar School and entered the University of Birmingham in 1939. He graduated with first-class honours in 1942, gaining the Frankland Medal and Prize and a University research scholarship. He was awarded his Ph.D. in 1945 and his D.Sc. in 1953. He has published some eighty papers and has gained an international reputation for his work on carbohydrates, particularly in the field of starch chemistry. His most notable early work, carried out in close association with the late Sir Norman Haworth and Prof. S. Peat, was on the isolation and characterization of the well-known 'Q' enzyme which synthesizes the amylopectin component of starch. He has made outstanding contributions to the enzymic synthesis and degradation of starch and other polysaccharides such as nigeran and dextran. His more recent work, largely carried out in collaboration with Prof. M. Stacey and numerous pupils, has been concerned with the chromatography and infra-red examination of sugars, application of carbon-14 in carbohydrate synthesis and the biological synthesis of oligosaccharides. With Dr. J. C. Tatlow he has made notable contributions to the reactions of trifluoroacetic acid. At present he is interested in the effects of $\gamma$-radiation on organic reactions and on some theoretical considerations regarding the formation of acetals. At Birmingham he has had wide experience in lecturing and in the organization of various laboratory courses, including extra-mural classes. He has served on the Faculty Boards of Biological Science and of Pure Science. He has been a particularly active member of the Midland Chemists Committee and has served as a local secretary for the meetings of the British Association and the Society of Chemical Industry and at present is a member of council of the Chemical Society.

## Physics in the University of Hull : Prof. G. F. J. Garlick

Dr. G. F. J. Garlick, lecturer in physics in the University of Birmingham, has been appointed to the chair of physics in the University of Hull, which has been vacant since the retirement of Prof. L. S. Palmer in 1954. Dr. Garlick was educated at Wednesbury Boys' High School and in the University of Birmingham. After graduation, he remained at Birmingham to take part in war-time studies of luminescent materials under the leadership of J. T. Randall, who as a Royal Society Research Fellow had already established a laboratory for the study of luminescence within the Department of Physics. During this period, Dr. Garlick gained not only enthusiasm for a branch of physics that was in rapid development, but also knowledge of the physical and chemical techniques upon which its further progress must be based. When Randall was appointed to the chair of physics at St. Andrews, Garlick was the only member of his group to remain in Birmingham and to continue this work, which for some years after the War was supported by the Department of Scientific and Industrial Research. He re-established a small but active group, whose interests were soon extended from polycrystalline materials bombarded with electrons or ultra-violet light to a wider field including the use of $\alpha$-particles and particularly of single crystals, in the growth of which he and his colleagues became highly expert. Latterly, studies have been made of phosphors emitting in the infra-red and of photoconductivity due to infra-red radiation. Dr. Garlick was appointed in 1949 to a University lectureship in Birmingham and has sustained a full share of teaching with no perceptible slackening in the flow of research publications. He is the author of a well-known monograph on luminescent materials and of several review articles.

## Environmental Control in Crop Experimental Work

Dr. J. P. Hudson, of the Department of Horticulture, University of Nottingham, has completed the first draft of a directory of equipment at present in use in universities and research stations in Great Britain for providing control of experimental environments. It is hoped eventually to publish it, under the title "Environmental Control Equipment in Britain", as Miscellaneous Publication No. 8 of the Department. Dr. Hudson is anxious that the directory should be as complete and accurate as possible, and will be pleased to send copies of the draft to any interested individuals or organizations who have not already been referred to, and to incorporate details of their installations in the final publication. The preliminary draft gives an account of the principles of environmental control, and of the different methods used to achieve it, as well as the list of existing installations. The use of controlled-environment equipment is rapidly spreading, and this directory should greatly assist anyone planning a new installation, by making it easy to draw on the experience of users of similar equipment.

## A 'Tropical Storm' photographed from a Rocket

In the June number of the *Monthly Weather Review*, L. F. Hubert and O. Berg, of the United States Weather Bureau and the United States Naval Research Laboratory, respectively, show and describe the first photographs taken from a rocket of the clouds of a tropical storm. The ascent was made in New Mexico on October 5, 1954, and was not made especially for photography of clouds from above. The photographs were taken by two cameras, one giving black-and-white and the other colour photographs, when the rocket was at a height of a hundred miles. The rocket rolled slowly as it moved so that the cameras scanned successive overlapping strips of the Earth. A composite photograph of the clouds over an area of 1,250,000 sq. miles is given in the article. The principal feature is a tropical storm centred near Del Rio, Texas, and the spiral structure of the clouds of the storm is clearly visible. This storm moved inland from the Gulf of Mexico and was quite a mild one, giving winds of only 18 knots over Texas. The convection was strong enough, however, to give three inches of rain at Brownsville, Texas, in three-quarters of an hour and more than six inches in three hours. The rocket photographs show two minor vortices the existence of which had not been suspected from the synoptic observations. From the photographs and other evidence, it is found that the axis of the storm extended about seven miles vertically and fifty-five miles horizontally. The slope of the axis fits well with a formula due to Panofsky giving it in terms of the curvature of the horizontal pressure profile and the horizontal gradient of temperature. The authors state that plans are in hand to fire rockets specifically for research into hurricanes and look forward to photography by rocket of the clouds over widespread tropical regions, such as South Equatorial America, which are as yet but little investigated.

## Higher Education in the Colonies

In a written reply in the House of Commons on December 6, the Secretary of State for the Colonies, the Right Hon. A. Lennox-Boyd, said that the Government had contributed £6,453,301 from 1945 to March 31, 1955, towards the capital cost of universities, university colleges and colleges of art, science and technology in the Colonial Territories. This total included £1,710,804 to University College, Ibadan, £1,087,223 to Makerere College, and £2,423,129 to the University College of the West Indies; but not the allocations of £1,019,000 and £350,000 to the University of Malaya and the Kumasi College of Technology, respectively, on which no call had yet been made. Although grants towards recurrent costs are not normally made, during the period 1954–55 grants for this purpose of £29,775 and £24,000, respectively, had been made to the University College of the West Indies and to Fourah Bay College, Sierra Leone. The total expenditure on education for the current year for the West Indies, Gold Coast, Nigeria, East and Central Africa, Malaya and Singapore was estimated at £56,666,967.

## The Tensor Club of Great Britain

During the past two decades the matrix and tensor calculus has found increasing application in the analysis of practical and particular problems in engineering, especially electrical engineering. About five years ago the Tensor Club of Great Britain was formed for the purpose of bringing together engineers and others interested in matrix and tensor analysis, and for spreading information regarding applications. The Club produces the *Matrix and Tensor Quarterly*, a magazine with about a hundred and sixty pages per volume which is sent out to about a hundred and fifty subscribers. Of the present members of the Club, about a half reside in Great Britain and about a quarter in the United States. There are also members in other countries, including France, Japan and India, and liaison has been established with the Tensor Society of Japan. The Club maintains a small lending library, and reciprocal arrangements exist for the exchange of magazines with the Mathematisch Centrum of Amsterdam, and with two universities in Japan. The membership of the Club is comprised mostly of engineers, physicists, mathematicians and chemists, employed in industry, research establishments, public utility companies and teaching. Information regarding membership can be obtained from S. Austen Stigant, 7 Courtlands Avenue, Hayes, Kent.

## Chemical Composition of the Larger Seaweeds

An account has been given by D. J. Wort (*Canad. J. Bot.*, 33, 4, 323; 1955) of the seasonal variations in the chemical composition of *Macrocystis integrefolia* and *Nereocystis luetkeana* growing in the coastal waters of British Columbia. These two seaweeds were collected at two stations at monthly intervals from October 1949 until September 1951. Analyses of fronds and of stipes were made for dry weight, ash, total nitrogen, total phosphorus, sulphur, copper, zinc, iron, ether-solubles, algin, mannitol, fucoidin, and laminarin. Generally speaking, the fronds had a higher content of all substances measured than did the stipes, and the content of the two species of algae showed parallel variation but differed in values. Dry weight and ash were at maxima in autumn and winter and at minima in April and May. During March, total nitrogen, ether-solubles, mannitol, fucoidin and laminarin were at their highest concentration. The plants in July contained the minima of total nitrogen, phosphorus and ether-solubles. The maximum for phosphorus occurred in December, and during this same month fucoidin was at minimum. The variation of sulphur, copper, zinc, iron and algin was such that well-marked minima and maxima were not evident. The author points out that while photosynthetic processes in the brown algae are considerably less well understood than they are in green plants, it is probable that phosphorylated mannose compounds are involved in the sequence, mannitol, a hexahydric alcohol, being important. The fronds of the two algae investigated have their highest mannitol contents during spring and early summer, the period of most active photosynthesis. The seasonal relationships of the other products of photosynthesis are also discussed.

## Banana Wilt Disease

In recent investigations, in Jamaica, of Panama disease or vascular wilt disease of bananas (*Fusarium oxysporum f. cubense*), J. Rishbeth has confirmed earlier findings on the mode and progress of infection and has contributed some new and interesting information on this important disease and on the biology of its causal organism (*Ann. Bot.*, N.S., 19, No. 75, 293; 1955). The pathogen has proved difficult to isolate from soil by plating, but it can be detected in soil by using a suitable host. Thus when small bananas were grown in pots under appropriate conditions, pathogenic isolates of *F. oxysporum* produced rhizome infections, whereas other isolates did not. When *F. oxysporum* isolates were obtained by plating from various sources, the proportions which proved to be pathogenic were: 91 per cent from the rhizome or pseudostem of plants showing typical wilt; 29 per cent from variously affected roots; and 0 per cent from soil. The information now available suggests that the banana pathogen, like other parasitic forms of *F. oxysporum*, has a limited host range; however, it has now been shown to cause a limited root infection of *Heliconia psittacorum* and may possibly originate on species such as this related to the banana. An account is also given in the paper of the development of the disease in sites which had been replanted after previous infection and abandonment. New cases may arise both spontaneously and in association with pre-existing ones, the rate of appearance of each type tending to decline after an initial rise. Although, on the evidence, *F. oxysporum f. cubense* only survives for a relatively short period in infected plant material, owing to rapid decay, it nevertheless survives for many years in the soil. A marked increase in the population of the pathogen takes place a few months after wilt disease appears, but there is a decline after infected plants are removed. Wide variation was found in the ratio of non-pathogenic to pathogenic strains of *F. oxysporum* in soils, but it is usually very high. The possible mode of survival of the pathogen in soil is discussed.

### *Forestry Abstracts*

FORESTRY is a science of region-wide husbandry and land use, and the training of the forester is based on many sciences; for example, he must survey and map both from the ground and the air, be able to construct, and certainly maintain, roads, bridges, cable-ways and buildings, and handle specialized machinery. These are in addition to his interest in his major object—the production of wood—which takes him a long way into applied biology, genetics, physics, mechanics and chemistry. In a recent number of *Forestry Abstracts* (16, No. 2; 1955; Commonwealth Forestry Bureau, Oxford) an article entitled "The Literature of Forestry: an Appraisal" gives the aims and objects of the *Abstracts*. "In view of its primary function—to act as an effective clearing-house of information for scientists and research workers . . . in forestry—ready access to all of the relevant literature is a constant basic objective of this and of every Bureau of the Commonwealth Agricultural Bureaux Organization. In the world of to-day, with scientific publishing an ill-ordered jungle, and procurement aggravated by post-war political barriers, such an object must remain impossible of attainment." In consequence, material of value to the forester's work must be watched for in a very wide range of non-forestry publications, from a microscopists' journal to the monograph in applied chemistry (of course, these difficulties are shared in varying measure by other sciences). A century ago, there was very little forestry literature published in the English language. The great expansion has taken place during the present century; the most important part, but by no means the whole, is published in the bulletins, reports, etc., issued by research centres and in the leading scientific periodicals. In the article in *Forestry Abstracts* some interesting figures are given of the great increase in the mass of literature both in volume and variety of origin since the Second World War. In January 1947 periodicals numbered 379 and serial sets (including annual reports) 470; total 849. In January 1955, periodicals were 555 and serial sets 755; total 1,310. This mass of publications originated from nearly a hundred countries with more than thirty languages.

### Madrid Observatory Almanac for 1955

A COMPARISON of "The Nautical Almanac" with the "Anuario del Observatorio Astronómico de Madrid para 1955" (pp. 429 + 2 plates. Madrid: Observatorio Astronómico, 1954; 40 pesetas) shows that, while practically the same ground is covered by each, the Spanish publication contains some additional matter which will prove useful to astronomers in other countries. In general, the "Anuario", which is published under the direction of Sr. Martin Lorón, follows the plan that has been in use for some years. Among the additional matter may be noticed a list of forty-four periodic comets which have been observed from 467 B.C. up to A.D. 1942, the first of these being Halley's Comet and the last Comet Oterma. This is followed by a catalogue of the principal constellations, arranged in order of their right ascensions, then by another catalogue of clusters and nebulæ visible from Spain, and also one of double stars. The geographical positions of the chief observatories are given, after which there are 113 pages dealing with visual double stars. This section commences with a short historical sketch, starting with Riccioli's description in 1650 of ζ Urs. Maj., and including an account of the work done by various observers in this branch of astronomy up to recent times. Methods of observation, measurements by means of the interferometer, Hargreaves's comparison micrometer with diagrams explanatory of the principle, etc., are dealt with, and the section ends with a description, covering fifty pages, of the method of determination of binary orbits. This includes two tables for facilitating the computations, and everyone interested in the computation of the orbits of binaries will find this portion very helpful.

### Origin of Stellar Systems and Planets

A LONG article by Alexandre Dauvillier, dealing with the origin of galaxies, planetary systems, satellites, comets, etc. (l'origine de la terre, systèmes stellaires et planétaires: structure et origine), is to be found in *La Revue Scientifique* (No. 3324, July–December 1953), the article being based on an annual inaugural address of the course of cosmic physics given at the Collège de France, Paris; those interested in problems of cosmology will find much in it of considerable importance. The formation of planetary systems is, according to Dauvillier, merely a particular case of stellar interactions, resulting generally in the formation of double and multiple stars. It is estimated that our Galaxy must contain at the least two thousand million planetary systems, though many of the planets may have very eccentric orbits resembling those of comets; others may have planets more massive than Jupiter, and many other variations from what we find in our solar system are inevitable.

### Postgraduate Awards in British Commonwealth Universities

THE Association of Universities of the British Commonwealth has issued as a separate pamphlet Appendixes II and III of the Commonwealth Universities Yearbook, 1955 (pp. 117: from the Association at 36 Gordon Square, London, W.C.1). The first of these, which is printed in accordance with a resolution of the Congress of Universities of the Commonwealth in July 1948, lists postgraduate awards for advanced study and research tenable in the United Kingdom. Each award is differentiated in respect of eligibility for graduates of universities in the United Kingdom, graduates of British universities overseas, and graduates of universities outside the British Commonwealth. The awards are arranged by subject, and those open only to graduates of the university announcing it are not included. Appendix III lists similarly some of the more important postgraduate awards tenable overseas by British graduates, but does not claim to be exhaustive; it is intended primarily for United Kingdom graduates wishing to study abroad. The pamphlet is well printed and produced and constitutes a most convenient pocket reference work. Reference is made to other publications of similar type.

## Paris Academy of Sciences

The following elections have been made by the Paris Academy of Sciences: Prof. R. de Malleman, professor of physics in the University of Nancy, to be a non-resident member in succession to the late Dr. P. Teilhard de Chardin; Prof. G. Darmois, professor of mathematics in the University of Paris, to be member of the Astronomy Section in succession to the late Dr. J. Chazy; Prof. E. Gaumann, professor of plant pathology in the Swiss Federal Institute of Technology, Zurich, and Prof. A. Blalock, professor of surgery in the Johns Hopkins University, Baltimore, to be foreign associates in succession to the late Prof. A. F. Blakeslee and the late Sir Alexander Fleming, respectively.

## Eighth Science Congress of the Royal Society of New Zealand

The report of the Eighth Science Congress of the Royal Society of New Zealand, held at Auckland during May 17–21, 1954, has now been published as Part 4 of Vol. 82 of the Society's *Transactions* (pp. 150. Wellington: Royal Society of New Zealand, 1955). Besides the presidential address of Dr. W. B. B. Oliver, on "Changes in the Flora and Fauna of New Zealand", it includes the addresses of the chairmen of the various sections, with the exception of Section J (Anthropology), which is given only in abstract. Also published in the report are the two public lectures: that of Prof. M. L. E. Oliphant on "Science and Mankind", and that of Dr. R. N. Robertson on "The Struggle against Equilibrium—a Physico-Chemical Problem in Life". Prof. Oliphant's examination of the foundations of scientific activity, the part it now plays in any developed community and where it is likely to lead, is of very general interest; and his comments on the use and misuse of knowledge, particularly with reference to nuclear physics, are highly pertinent to current discussions on nuclear weapons and nuclear power. A number of chairmen's addresses are also of general interest, notably Prof. E. Beaglehole's discussion of the study of social change in relation to the administration of programmes of technical assistance, that of Dr. M. M. Burns on "Agricultural Science: Contributions and Challenges", and, to a lesser extent, Mr. J. L. King's discussion of the relative problems of the two professions of architecture and engineering. The contributions of Dr. H. O. Askew on biology and the trace elements, of Dr. R. C. Lister on rural settlement, with examples from Canterbury and Southland, and of Mr. N. H. Taylor on the role of soil science in New Zealand problems, are more specialized but still of some general interest, and are presented in a way which will appeal to the general public.

## Announcements

Dr. R. L. Smith-Rose, director of radio research in the Department of Scientific and Industrial Research, has been appointed acting director of the National Physical Laboratory, following the resignation of Sir Edward Bullard and pending the appointment of a new director.

Dr. Detlev Bronk, O.B.E., For.Mem.R.S., president of the Rockefeller Institute and of the U.S. National Academy of Sciences, has been appointed chairman of the Board of the U.S. National Science Foundation.

Mr. K. J. B. Wolfe, formerly deputy director of research for the B.S.A. Company, Ltd., and chief metallurgist, B.S.A. Tools Group of Companies, has been appointed head of fundamental research by the Triplex Safety Glass Co., Ltd., and will take charge of the company's new research department to be built at its Willesden factory in West London.

The Cigar Manufacturers Association of America, in conjunction with the Cigar Institute of America, has made this year's Cigar Industry Annual Research Award to Dr. Walter G. Frankenburg, of Lancaster, Pennsylvania, in recognition of his outstanding contributions to the development of the basic science and technology of tobacco; in particular, for his investigations of the chemical processes that occur in the harvested tobacco leaf, including the conversion of nicotine into a series of other substances, and for the successful application of this new knowledge to problems of the cigar industry. The Award is open to persons engaged in research on the chemistry, biochemistry, biophysics, physiology or agronomy of cigar tobaccos. Consideration for the next Award will be given to all communications submitted to the Chairman, Industry Committee on Awards, Room 2214, 350 Fifth Avenue, New York 1, N.Y.

Erratum.—Referring to the article "Acceleration of Abscission by a Factor produced in Senescent Leaves", by Dr. Daphne J. Osborne (*Nature*, December 17, p. 1161), the author writes that in Table 1, the figure 55 in the second column from the left should be 65. Moreover, a cursory glance at the table might lead the reader to suppose that all the data refer to one experiment rather than to four. To avoid this, the following table should be substituted:

Table 1 Average time in hours for abscission of bean explants when (*a*) agar blocks containing diffusates from young or abscinded pulvini are applied to the pulvinar end; or (*b*) whole pulvini are sealed with agar to the pulvinar end

| | (*a*) | | | | (*b*) | | |
|---|---|---|---|---|---|---|---|
| | Control | Diffusate from young pulvini | Diffusate from abscinded pulvini | | Control | Pulvini from attached leaves | Pulvini from abscinded leaves |
| Expt. 1 | 107 | 105 | 88 | Expt. 3 | >120 | 55 (from senescent leaves) | 45 |
| Expt. 2 | 61 | 65 | 53 | Expt. 4 | 57 | 56 (from young leaves) | 37 |

# WELLCOME MUSEUMS AT THE ROYAL COLLEGE OF SURGEONS

THE Wellcome Museums of the Royal College of Surgeons of England were formally opened on November 30 by Sir Henry Dale, chairman of the Wellcome Trustees. The ceremony took place in the Great Hall of the College, situated immediately beneath the Museums, and the gift was accepted on behalf of the College by the president, Sir Harry Platt.

The erection of the Museums has been made possible by a generous gift of £100,000 to the College by the Wellcome Trustees. The grant was made in recognition of the service which the College has rendered not only to surgery but also to a much wider range of medical and scientific knowledge by the maintenance of its historic and world-famous museums of human and comparative anatomy and pathology. In accordance with the terms of the Trust, the grant was "for the foundation or extension of Museums dealing with medical science or research", a description which was in accordance with the policy of the College Council, which has for long regarded its museums and research laboratories as complementary to each other.

The further condition that the name of Wellcome should be associated with the Museums was one with which the College was happy to comply, for the late Sir Henry Wellcome was an honorary fellow of the College.

The Museums are contained in the south-eastern part of the College, the first part to be rebuilt and enlarged after war damage in 1941. They are situated on the second, third and fourth floors, lying immediately above the Great Hall and coinciding with it in area. The general plan is the same on each floor, the main area (about five-sevenths) forming the exhibition room and the remainder being devoted to research and work-rooms connected with the respective museum functions. Adjacent are the other parts of the College's Departments of Pathology and Anatomy, with their research laboratories and (yet to be built) demonstration rooms. Thus on each floor the Wellcome Museum forms an integral part of the department, the threefold activities of which, dealing with museum, research and teaching, are co-ordinated by the Sir William Collins professor of human and comparative anatomy and conservator of the Anatomical Museum and by the Sir William Collins professor of human and comparative pathology and conservator of the Pathological Museum.

On the second floor the approach is through the research rooms of the Department of Pathology and the offices of the conservator (Prof. G. J. Cunningham). The Wellcome rooms begin with the office of the pathology curator (Dr. L. W. Proger), adjacent to which is a research laboratory and opposite is a museum preparation room and workshop. The exhibition room itself shows the layout intended for all three museums, namely, five bays along either side of the room, each containing specimen shelves on three sides and a table and chairs for study in the centre. The central aisle of the room can be laid out with floor stands or left free for temporary exhibitions. 'Natural' fluorescent lighting has been provided, and this with the neutral grey background displays the colour of the specimens to best advantage.

The present collection is made up of specimens surviving war damage, together with more recent additions. The specimens are arranged in lettered sections according to systems: S, skeletal; A, alimentary; etc. Catalogues with descriptions, clinical and histological notes are provided, and reference to histological slides may be made if required. In suitable cases, photomicrographs, X-rays or clinical photographs are mounted with the specimen to complete the pathological picture. Future progress with this collection involves improving quality, extending the series of exhibits and making good deficiencies.

On the third floor the approach is similarly through the research rooms of the Department of Pathology, though the rooms on this floor are temporarily let to the Imperial Cancer Research Fund as biochemical laboratories. The Wellcome rooms on the third floor start with the photographic studio unit and a large museum store. In the exhibition room the arrangement of the shelves at the near end is similar to that of the room below, while at the farther end a space has been partitioned off, by agreement with the Wellcome Trustees, as a demonstration room for students taking the Basic Medical Sciences course. This is a temporary arrangement, pending completion of the next phase of rebuilding the College, and the whole room will be devoted to the exhibition of specimens within the space of two or three years. The present exhibits include the Teratology Section and selections from the Odontological Collection, the War Collection, and Hunterian Collection. On completion of the next phase of the rebuilding programme, this room will be devoted to a museum illustrating the general principles of pathology. In this collection provision will be made to supplement the specimens with photographs, charts and diagrams.

The fourth floor forms a part of the Department of Anatomy, and here again the approach is through the research rooms and the offices of the conservator (Prof. G. W. Causey). As on the other floors, the Wellcome rooms are reached just before the exhibition room and include a workshop and mounting room, an embalming and preparation room and a prosectors' room. The room at present used for prosectors is destined eventually to become the curator's room.

The exhibition room itself, the Museum of Anatomy and Physiology, is eventually to be laid out with bays on very much the same plan as that of the second floor. Meanwhile, however, the Wellcome Trustees have generously agreed to accommodate the College during its rebuilding by allowing demonstrations to be held in the Museum. Two rooms have therefore been formed by the erection of light partitions, and steel shelving has been put up as a temporary arrangement on all the available wall space.

The first part of the exhibition room contains the Hunterian Physiological and Comparative Anatomical Collection that will be ultimately housed in the rebuilt west end of the College. The far end of the exhibition room contains the human anatomical specimens that will later be arranged in cubicles covering different systems, illustrated by suitable tracings and diagrams of selected physiological and pharmacological reactions.

These new Museums occupy nearly the same site as the rooms which were destroyed by enemy action in 1941, though they are at a higher level and are more economical of space, each occupying one complete story, compared with the nineteenth-century rooms which consisted of a floor and two galleries.

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# THE NATIONAL LEATHERSELLERS COLLEGE

By Dr. J. P. DANBY

Principal

On November 15, the Minister of Education opened extensions at the National Leathersellers College in Bermondsey, London, S.E.1. These consist of a three-story wing housing new research laboratories, a lecture theatre and a senior common room, and drying rooms for heavy and light leather, together with a single-story block consisting of yards for the preliminary and tanning processes for both heavy and light leather manufacture. Moreover, the additional space provided has facilitated the re-equipment and modernization of the original building, which is now almost fifty years old.

The College was founded and built in 1909 by the Worshipful Company of Leathersellers, following the success of the courses in leather manufacture which had been given since 1895 at the Herolds Institute. During these years, rapid developments were taking place in the field of leather chemistry, and it was becoming apparent that the subject merited individual facilities for training and research. The appreciation of fundamental principles underlying the processes of a craft industry by men such as Procter, Stiasny and Knapp was raising leather manufacture from a craft to a science, with the consequence that a rapid expansion took place in the demand for men with a scientific training by tanners all over the world.

Between 1909 and 1951 the Leathersellers Technical College became recognized throughout the world as one of the leading institutions in this sphere of instruction, and under three successive principals gained a wide reputation for the training of technologists in the leather industry. However, although improvements and additions to the College were made from time to time, it was inevitable that sooner or later major developments would be necessary if the College were to maintain its place in the advance of technological education. Consequently, when the Minister of Education, following the recommendations of the Percy Report, decided to found a number of colleges with national status to accommodate the educational needs of the smaller industries, the leather industry approached him with the request that the Leathersellers College should be reconstituted as the National College for the Leather Industry. A trust deed was drawn up, a widely representative board of governors was appointed, and the National College came into being in September 1951. Shortly afterwards, plans were drawn up to extend and re-equip the College, and this has now been done at a cost of more than £90,000, a part of which has been provided by the industry itself. In consequence, there is little doubt that the College is now one of the finest of its kind in the world.

Since the tanner's raw material is animal skins, the technology of leather manufacture is based on protein chemistry. At the same time, because of the variety of other materials used in the manufacturing processes, a trained technologist must possess some knowledge of a wider range of both natural and synthetic products than is called for by almost any other industry, and the subject has therefore some connexion with all the main branches of pure, and many aspects of applied, chemistry. From the practical point of view also, the range of leathers in common use necessitates, in a teaching institution, facilities for their manufacture from the raw skin to the finished product. Further, some familiarity with the ancillary subjects becomes necessary in so far as they impinge on both the theoretical and practical aspects of the principal study.

The scientific and practical approaches have always been the foundations of the College courses; although in the past the training has been more squarely based on processes than on theory, the latter has by no means been neglected. However, the advances which have been made in fundamental knowledge and its systematization, and the development of new techniques, now demand a far more exhaustive course than it has been possible to provide hitherto, and the extensions and modernization have consequently made possible an appropriate and overdue expansion of the content of the syllabus. Moreover, in formulating educational policy, the intentions of the Ministry with respect to academic status have been observed in that plans have been made to bring by stages the level of instruction up to that of a university.

The material facilities the College possesses are unique in so far as that, for practical instruction, they include complete yards for the manufacture of all types of leather, which are made by students working independently, under supervision, as part of their course. The layout has been planned to simulate ideal tannery conditions, and the machinery and other equipment, much of it supplied on permanent loan by the makers, is of the latest design. It will be possible to process twelve hides per week, and in the more flexible conditions of light-leather manufacture, at least twelve dozen skins, by any of the commercial—and many of the experimental—techniques available. A further feature of this department is a complete set of new drying cabinets controlled for humidity, temperature and air-flow, incorporating devices which have been developed over the past decade. All the practical processing work can be now carried out on the ground-floor, which in effect contains a complete tannery appreciably larger than a typical pilot plant.

The additional laboratory space comprises a newly equipped teaching laboratory for senior students, and a microbiological laboratory. Another laboratory has been furnished for physical testing, and it is hoped that in time this will house the most complete set of apparatus for this purpose in Britain. These are, however, extensions of facilities that existed in the original building. An entirely new addition is a research laboratory, which includes a small laboratory-tannery that is to be used mainly for investigations into variations in the processes of the production of sole leather.

The College awards its own diploma on a two-year course, but an extension of this period to one of three years is envisaged to accommodate adequately the increased practical and theoretical instruction made necessary by recent advances in such techniques as leather dyeing, tanning with synthetic materials, drying and so forth. Moreover, in response to the Ministry's expressed intentions with regard to national colleges, the status of the diploma course is to be raised in respect to the level of the training it provides. Although the diploma is a qualification recognized throughout the world in leather-producing circles, it does not possess the standing of a degree, and therefore the outcome of the protracted discussions on higher awards for technology is, as in all similar colleges, awaited with some impatience.

The College offers its own associateship, which may be awarded after a year's research subsequent to the diploma, or to a graduate of a recognized university after a similar period of study. The provision of new research facilities is the most notable innovation under the extension scheme, and it is worth remarking that all the stages of a research programme, from the bench through pilot-plant scale production to what is almost full-scale production, is here housed under one roof. It is therefore proposed to encourage this aspect of the College's activities more vigorously than in the past, and to seek the co-operation of tanners and chemical manufacturers in the matter. Co-operation already exists between the College and the research associations, and the Leather Department in the University of Leeds, so that in this connexion also the Ministry's recommendations are being implemented.

Outside the diploma course, as much flexibility as possible is permitted, notably in the provision of short courses of three or six months duration on specialized aspects of the subject, and, within the confines of space and staff available, every effort is made to accept students individually for courses of even shorter duration. Short refresher courses of from four to six weeks have been a feature since 1951, and these are to be extended, especially in relation to the ancillary sciences. Entirely new courses on works and management study in the leather trade are planned, as part of the normal diploma course, in addition to being offered to the industry as a whole.

The College draws its students from all over the world, and although a quota is placed on entrants from outside the United Kingdom, the fact is evidence of the wide reputation it has gained since its foundation. There is a generous staff–student ratio, and with the space now available, and the promise of adequate support from the trade, it is anticipated that the College will play an increasingly important part in the industry to which it belongs.

# FIRST NATIONAL CROP PROTECTION CONFERENCE

The first National Crop Protection Conference, sponsored by the Pesticides Group of the Society of Chemical Industry and organized in collaboration with the Ministry of Agriculture, Fisheries and Food, the Association of British Insecticide Manufacturers, the British Agricultural Contractors Association, the National Association of Corn and Agricultural Merchants, and the National Farmers Union, was held in the Winter Gardens, Eastbourne, during October 31–November 3. The theme of the Conference was: "Practical Aspects of the Use of Insecticides and Fungicides in Agriculture and Horticulture". The delegates assembled on the evening of October 31 for the chairman's reception at the Grand Hotel, Eastbourne, and later attended a film show, at which were shown "Management for Milk" (Plant Protection), "Fruit Tree Red Spider" (Shell), "Cabbage Root Fly" (Shell) and "The Rival World" (Shell). The last, a dramatic film illustrating man's ceaseless battle not only for food but also for health and very survival against the insect world, underlined the theme of the Conference during the following days. The Conference proper commenced on the following day, when a short account was given by the chairman, Mr. J. M. Leonard, of the Society of Chemical Industry, of the formation of the Pesticides Group and of the events leading up to the holding of the present meeting. Starting with the formation of the Agricultural Group of the Society in 1942, which gave birth to the Pesticides Panel in 1950, he told how the Panel had itself become a group by 1954, capable of sponsoring the Conference by 1955, which was no mean achievement.

The opening address to the Conference was given by Sir Thomas Dugdale, who touched upon the world's loss of produce to pests, both in the field and in storage. These are serious enough in highly developed countries, but in the less-developed ones they must be very much more serious. Since 1940 there have been enormous strides made in the science —and art—of dealing with crop pests; but looking back he saw many landmarks in crop protection and wondered if there might be such a thing as a "fifteen-year rule" in these developments. Before 1940, the start of the present cycle, tar-oil winter wash for fruit trees was introduced about 1925. Derris arrived in 1910. Lime-sulphur and grease banding was brought in about 1895. Still earlier, in 1880, there are records of 'London purple' (an arsenical) being exported to the United States. Before the Second World War, links between the manufacturers and the 'official' research stations were slender and few, and differences many, leading to bewilderment on the part of the farmer; now Sir Thomas sees a much healthier state of interaction from which the farmer is not excluded; the Ministry of Agriculture's Approval Scheme has also marked a great advance. He defined four main groups of pesticides: insecticides and acaricides; fungicides; nematicides; and herbicides. Substances for the control of birds and rodents—mostly the latter—may perhaps be considered as a fifth group. The important points to be remembered are that the use of pesticides must be governed by economics, and that chemicals must not be used as substitutes for good farming. Turning to the future, Sir Thomas asked what scientists have in store for us. Would the fifteen-year rule hold good? Will systematic fungicides really abolish plant disease? Would the only red spiders left be those in museums? Or would Nature fill the vacuum she abhorred? There are already a number of pests which have increased in importance due to the elimination of predators by pesticides; one answer to this is the use of more selective insecticides and methods of application. Flies resistant to the chlorinated hydrocarbon types of insecticide are already a challenge in many places. So long, however, as the problems are attacked bearing in mind these consequences of large-scale interference with Nature, nothing but good can come of the scientists' work.

The first three papers at the Conference were on general subjects. In a general survey of eelworm problems, Dr. B. G. Peters dealt in broad terms with these insidious pests, which are often not detected until extensive damage has been caused. A general survey of soil pests affecting vegetable crops, by Mr. J. W. Wright, was the subject of the following paper, and a general survey on foliage diseases in arable crops, by Dr. H. E. Croxall, rounded off these introductory talks. Later papers dealt with more specialized aspects. In considering the economics of potato blight control, Mr. H. I. Kingston dealt with the search for substitutes to replace the now very expensive copper compounds, and it appears that small quantities of phenyl mercuric chloride can act as synergists and effect reductions in the use of copper up to 40 per cent. In a paper on virus problems in sugar beet, Dr. R. Hull told how loss due to this disease has been reduced in recent years, thanks to careful rogueing on steckling beds and liberal use of insecticides, especially the systemics. The last two papers of the day, control of pests in arable crops, by Mr. J. L. Hunt, and control of pests in *Brassica* seed crops, by Mr. S. G. Jary, drew much discussion on matters ranging from the forecasting of pest incidence to the amount of loss which can be suffered by seed brassicas without reduction of eventual yield.

The morning of November 2 was devoted to a series of papers on application problems and hazards. The application of materials to control pests and diseases of pea crops was dealt with by Mr. R. W. Shorrock and provoked a lively discussion, in which many references were made to the increasing recognition of eelworm as a widespread pest of this crop. The next paper, by Mr. F. W. Morris, on the advantages of high- versus low-volume spraying, was another which led to considerable controversy. Mr. Cameron Gifford, speaking on application aspects of aphis control in sugar beet, brassicas and related crops, emphasized the case for dusting in certain instances. Hazards were dealt with by Dr. E. F. Edson and Dr. J. M. Barnes for application and residue problems, respectively, in a pair of most interesting papers in which emphasis was laid upon the desirability of education for safety rather than 'blanket' legislation. The meeting then passed to consideration of seed dressings. Recent developments in the use and application of dual-purpose seed dressings—that is, of insecticide and fungicide seed dressings—was the subject of a review by Dr. D. Price Jones, and Mr. A. J. Pearson, in a paper on 'Dieldrin' seed dressings, described trials of this comparatively new insecticide against insect pests of the seed and seedling. Taint was discussed by Dr. M. Cohen, who described not only the cases of taint, in which benzene hexachloride is still the principal offender, but also the form of tests used for estimation of off-flavours. Dr. R. de B. Ashworth then gave an account of groups of new chemicals recently included in the crop-protection products approvals scheme.

The last day of the Conference opened with a consideration of glass-house problems. The first paper, by Dr. E. Taylor, dealt with the control of fungi under glass, and was followed by one on control of insects under glass, read by Mr. W. H. Read. The glass-house crops can be more efficiently dealt with by fumigation and aerosol methods than those out of doors, but, on the other hand, their concentration within small spaces raises a number of its own problems. The remainder of the day was occupied with horticultural problems. Mr. J. E. Garnham, speaking on control of red spider on fruit, described the use of chlorbenside against this serious pest, emphasizing the importance of its application early against winter eggs and immature mites, and condemned the use of the term 'ovicide' when applied to such a widely active compound. In considering the control of fruit pests other than red spider, Mr. E. L. Williams directed attention to the increasing use of insecticide sprays for pests against which winter washing used to be the standard treatment. In the ensuing discussion many suggestions were put forward for reducing the number of separate spraying operations by mixed applications of insecticides and fungicides. New techniques for the control of pests on hops were described by Mr. Emery, who showed some very spectacular slides on the effect of the insecticide dimefox applied to the soil beneath the bines. In reply to questions, he mentioned experiments showing first that the quantity of dimefox present in the hops on harvest is negligible, and secondly, that any which is present would certainly be destroyed in the process of brewing. Mr. E. J. Hainsworth then read a paper on recent advances in scab control, from which it appears that the growing use of captan and the organo-mercurials calls for discretion and that there is still a case to be made out for the use of sulphur. The final paper, on other aspects of the control of fungus diseases on fruit, by Mr. R. W. Marsh, stressed the inability of the newer scab-controlling insecticides to keep down the mildews which are at present controlled by means of sulphur sprays. He also spoke of experiments using phenyl mercuric chloride against apple tree canker.

# IONIZING RADIATION AND THE CELL

A SERIES of fourteen papers and an introduction by G. Pollard, which were presented at a conference of the New York Academy of Sciences on "Ionizing Radiation and the Cell", have now been collected as a separate issue of the Academy's *Annals* (59, Art. 3, 467–664; 1955; 4 dollars). For a very good reason the major part of this volume should be of absorbing interest for biologists in a number of different fields. It shows in a precise way, yet intelligible to those outside radiation biology, how varied are the methods now available which use ionizing radiations for analysing ultramicroscopic biological structures and their functions. This is more than can be said of the often ponderous other publications on radiation biology which have multiplied in recent years.

The essentials of the oldest and best-known radiation method are that localized releases of energy within a cell structure may cause it to lose or change one or more of its biological functions. Comparing loss of function caused by irradiation with different types and doses of radiation, one can infer something about the size, shape and molecular stability of the structures examined, and about the relations of these to function. This type of analysis has given useful results, for example, in the case of the structure and function of bacteriophage particles, of chromosomes and genes, and of various other cellular components. The same sort of analysis has been applied successfully to large molecules: a paper by Setlow illustrates it very effectively for the case of certain enzymes and other proteins.

Several of the papers at this conference are based on the use of this inactivation method: one by Fluke and Pollard on bacteriophage; one by Caldecott on barley; one by Bloom *et al.* on the use of microbeams (2·5–7 μ in diameter) on tissue cultures of newt heart; and others. A paper by Giles *et al.*, however, reports the use of radiation both to produce 'loss' mutations and to reverse them.

An elegant new use of ionizing radiations, introduced by Hutchinson, of the Biophysics Department at Yale University, is for probing structure by a sort of radiation sounding procedure. With charged particles such as electrons and protons in beams of controlled energy, it is possible to irradiate the outer layers of a biological system without producing any effect at a depth greater than the particle-range. This range varies in a known way with the kind and energy of the particles. Thus, by using a series of beams of increasing energy, one can probe deeper and deeper into the system. When this is done, discontinuity of structure may become quite clear. For example, inactivation of bacteriophage *T*-1 with slow electrons shows a steep rise between 700 and 1,100 volts, and from this Hutchinson calculates that there is an insensitive outer layer about 125 A. thick. This finding is in perfect agreement with those from the biochemistry and genetics of this phage, which is known to have a protein coating not essential for its multiplication, and an essential core of deoxyribonucleic acid.

All the other papers in this volume are well worth reading by the specialist, though perhaps for the non-specialist they are not as important as those already quoted.

G. PONTECORVO

# THE MELLON INSTITUTE

## REPORT FOR 1954

THE annual report* of the president, Dr. E. R. Weidlein, to the Board of Trustees of the Mellon Institute on the scientific research activities of the Institute for the year ended February 28, 1955, notes the establishment of a new Department of Applied Mathematics to assist in formulating experimental designs and the statistical analysis of data, the installation of an electron microscope in the Department of Research in Chemical Physics, and the equipment of an air-conditioned laboratory for microchemical analysis and research in the Department of Analytical Chemistry. Expenditure on pure and applied research during the year was 4,784,344 dollars, and, of this sum, just over a million dollars was spent on scientific research in the six research departments and on twelve fellowships, in which altogether 147 members of the Institute were engaged. Applied research was conducted under the auspices of sixty-four other fellowships and occupied the time of 390 members. Of these seventy-six fellowships, forty-seven were multiple and twenty-nine individual, and four had been proceeding for forty years and four others for thirty or more years.

Investigations in the Department of Research in Chemical Physics of the selection rules for ethane-like molecules having free internal rotation showed that the selection rules were $D_{3d}$ and not $D_{3h}$ as reported in the literature. The vibrational spectrum alone does not distinguish between the alternatives of free internal rotation or the staggered configuration. Other investigations showed that in the systems hydrogen chloride – diphenyl ether and hydrogen chloride – anisole at 30–90° C., while the frequency of the hydrogen chloride bond remains constant, its intensity diminishes as the temperature increases. Investigations of crystallization in stretched polybutadiene and silicones continued, and an X-ray diffraction study of the crystal structure of antimony pentachloride showed that the unit cell is hexagonal and contains two molecules of antimony pentachloride, the trigonal bipyramidal structure of the gaseous molecule being retained in the solid state.

Equipment for separation by thermal diffusion and chromatography has been extended in the Department of Research in Physical Chemistry, and further studies of the design and operation of packed laboratory apparatus for fractionation by thermal diffusion include the effect of packing density and annular width on separating efficiency. Elution chromatography on alumina with graded eluents has been used extensively in the separation of coal tar by-products, and separate determinations, in which the cuts were examined by ultra-violet spectroscopy, indicated that a naphthalene still residue carcinogenic to mice contained not more than 0·005 per cent of 3 : 4-benzpyrene. An apparatus built for vapour-phase chromatographic investigations has given effective separations and analyses of hydrocarbon mixtures in the range $C_4$ to $C_8$.

The Department of Instrumentation notes a considerable increase in electronic construction and maintenance activities, and has also designed an automatic recording Sward rocker device and an automatic recording instrument for measuring the surface tension of liquids. The preliminary model of a recording balance designed to deflect a recording potentiometer full scale for a 100-mgm. change in weight has been found to be capable of being operated at ten thousand times this sensitivity before drift and short-term instability become appreciable. In devising a set of classical equations for the hydraulics of column and plate distillation, the Department of Applied Mathematics found that, for a critical value of the ratio of thickness of liquid layer to radius of cylinder, the mass vapour transport per unit area attained a maximum before the onset of turbulence, which indicates a flooding condition in distillation columns with diameters less than a critical value depending on the viscosity and density of the liquid and vapour.

In co-operation with the Multiple Fellowship on Petroleum, the Department of Analytical Chemistry has been engaged for nearly two years in a fundamental study of the analytical chemistry of organic sulphur compounds; in the course of this a revised Hastings method for the determination of aliphatic sulphides in the analysis of crude oils, by spectrophotometric measurement of the absorptivity of the iodine-sulphide complex, and a modified polarographic method for the determination of elemental sulphur have been developed, and the reduction of heteropoly acids with thiols have been studied. An investigation of the degradation of cellulosic fibres showed that the deterioration of certain fibres depended on the cellulolytic activity of the micro-organisms brought in on the raw material and which had proliferated during storage. Fundamental studies of the synthetic autotropic bacterium isolated from bituminous coal-mine effluents continued.

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* Scientific Research Activities of the Mellon Institute, 1954–55. (Annual Report Series, No. 42.) Pp. v+53. (Pittsburgh: Mellon Institute, 1955.)

Reviewing the work carried out under the Fellowships in Pure Science, the report refers to the major research programme on air pollution of the American Petroleum Institute, in which two laboratory techniques for tracing the path of stack gases over long distances were ready for field-trial. Attention was also being given to the design of simple field-characteristics of dust removal in various centrifugal and gravity sedimentation devices. The exposure phase of a two-year programme to evaluate the potential response to various inorganic particles of different ranges of size was completed, and histopathological examination of the tissues of exposed animals was in progress. Field-studies included the evaluation of the potential dust exposure to a specific product when used industrially as an oil absorbent. Besides preliminary studies on seventy newly available chemicals that may have economic value, detailed studies were made under the Multiple Fellowship on Chemical Hygiene on fifteen compounds which will reach the public and on eight with which industrial workers only will be in contact.

Using an epoxy resin, fibre-glass cloth and a modified hook, workers under the Multiple Fellowship on Orthopedic Appliances have constructed an appliance which gives the patient essentially the equivalent of a finger and thumb and permits normal wrist motion. Hip, knee and ankle joints have been developed for reliable service where a leg dangles or requires traction, and many experimental appliances have been constructed using nylon or fibre-glass cloth and polyester resins. Under the Fellowship on Mine-Acid Control a report has been presented summarizing the findings of the past eight years and has demonstrated that a seam of coal amenable to recovery by stripping can be removed without acid pollution of adjacent streams. Under the Multiple Fellowship in Glass Science a laboratory has been constructed for nuclear and paramagnetic resonance absorption studies, and attention has been given to the origin of the colour induced in silica glass and quartz by X-rays, γ-rays and neutron irradiation in a nuclear reactor and to the mechanical properties of glassy systems. Under the Allotropy Fellowship a bicyclo-[2 : 2 : 2]-octane has been prepared, this being the simplest molecule with the boat configuration of cyclohexane, both by the Diels–Alder reaction from cyclohexadiene and acrolein and by destructive distillation of magnesium hexahydrohomoterephthalate. A new instrument in which the liquid is continuously sheared between a conical and a flat surface has been developed for determining viscosity over a wide range of rates of shear, and birefringence techniques were being developed as a means of estimating the content of crystallinity in polymers. Durable, colourless synthetic resins have been developed by workers under the Artists' Materials Multiple Fellowship to replace traditionally used natural resins, and a new picture varnish was being evaluated in co-operation with prominent museums. Thermoplastic polymers of the methacrylate class appear to fulfil best the requirements of clarity, solubility, durability and strength. In work on components for digital data-handling systems, special emphasis has been placed on the development of novel methods for making electronic circuits and circuit elements for operating at 200° C. or more.

The greater part of the report is concerned with the research programmes of the Fellowships in Applied Science, and only a few points of more general interest can be mentioned here. Among these are the development of an electromagnetic flowmeter for liquids, which is actuated by the electric potential field generated in the liquid as it moves through a magnetic field, and the considerable progress in studying methods of measurement of consistency of clays for mixing and extruding operations. An improved method has been developed for preparing specimens of castable refractories for use in testing. A co-operative study on grinding wheels showed that compressive stresses up to 100,000 lb./sq. in. can be developed in the surface of quenched and tempered ball-bearing steel by abrasive grinding. The generation of gas on prolonged treatment of silicon carbide with water has been traced to impurities in the grain rather than to silicon carbide itself. Satisfactory methods have been developed for welding manually and automatically the new $T-1$ steel recently developed by the United States Steel Corporation. A concentrated effort to obtain 'Stypol' resins particularly adapted to specific reinforced plastics applications has yielded several new resins of unique properties. A long-term biochemical research project is concerned with the basic mechanism of the natural origin of tastes and odours in public water supplies.

Considerable progress was made in the synthesis and study of pyrrole derivatives in petroleum and related materials, and it has been established that oxides of nitrogen produced in the engine during combustion play an important part in the formation of low-temperature engine varnish. Hydrogenation of nitrobenzene to aniline in the vapour phase proceeds at atmospheric pressure over nickel sulphide catalysts, and a comprehensive investigation of catalysts for this reduction has been planned. A unique class of polysaccharides, resembling tapioca dextrins and natural gums, has been synthesized, which shows promise as envelope and label re-moistening gums, as replacements for gum arabic in mucilage and lithography, and as extenders for polyvinyl alcohol. Progress was also made in developing industrial applications for methylglucoside, now being manufactured from corn sugar. Under the Multiple Fellowship on Felt a study was being made of the requirements of individual industrial fabrics and methods for achieving the optimum characteristics. The search for improved hydraulic fluids has continued, and a study of catalysts for epoxy-type resins has been undertaken. New plasticizers were evaluated for the preparation of plastisols, and the effect of temperature on the flow properties of vinyl resin plastisols was studied, while silicones have been developed for application to leather and to glassware. Efforts to prepare compounds similar to the new antibiotic, azaserine, which may be resistant to the enzyme in mice, and presumably in man, which destroys azaserine, or which may inhibit the action of the enzyme, are being made, and a series of dyestuffs of antiviral activity has been prepared; but although the dyestuffs were active against many viruses *in vitro*, no favourable *in vivo* effects were observed. Development work on the improvement of manufacturing processes for barbituric acid derivatives, aminophylline and certain local anaesthetics and antiseptics continued under the Amine Fellowship, which also led to the development of a promising new compound, 7-(β-hydroxypropy)-theophylline.

# PAST AND FUTURE TRENDS IN WORLD ECONOMIC DEVELOPMENT

SIR GEORGE NELSON assumed office as president of the Institution of Electrical Engineers on October 6 and delivered his inaugural address on the evening of that day. In this address, Sir George outlined the course of development of the application of electricity to the needs of the community from the time of the inception of the Institution in 1871 to the present day, and he related this development to the main changes of social and economic environment which have taken place in that interval. From the present day, he then viewed the future prospect.

For Great Britain in 1905, the installed capacity of generating plant represented 1/20 kW. per head of population, while for the United States the corresponding figure was 1/12 kW. These figures have risen in the intervening fifty years to ¼ kW. and ¾ kW., respectively. It has been forecast in a paper read at the recent Atomic Energy Conference at Geneva that the next fifty years would see a threefold increase in the total energy consumption of the world. Already, it is recognized that the world's demands for power will very quickly exhaust the conventional sources of energy, in particular the natural fuels; but the solution of this problem is in sight in the utilization of nuclear energy. This growing demand for power, which is reflected in both the increase in world population and the universal urge to improve standards of living, is, however, accompanied by correspondingly increased consumptions of the basic constructional materials.

Some 90 per cent of the world's present population has a standard of living below that of the United States and Great Britain, and it has been estimated that, if the living standard of the whole world were raised instantly to that of Great Britain, the resources of such basic materials as iron and copper would last only twenty-five years. Although such a rate of exhaustion is far outside practical possibility, considerations such as these do indicate an urgent need, namely, that of producing synthetically basic metals and similar materials.

The most notable development up to the present time in the field of artificial substitutes is the cellulose products. 'Terylene' fibres, for example, have physical properties comparable with those of steel. It is possible that, in time, means may be found of producing economically a substitute for steel for structural purposes, which would render it possible to conserve iron ore for the manufacture of magnetic or such other special-purpose steels. Synthetic materials have also been produced suitable for the manufacture of pipes for carrying hot, cold or corrosive liquids. Such pipes can serve as a substitute for copper or lead pipes and help to conserve the supplies of these metals.

If a lowering of the standard of living due to the exhaustion of natural resources is to be avoided. intensive effort must be devoted to the production of synthetic substitutes of all kinds, and Sir George pointed out that this effort must be made now. The movement of the whole front of technological advance, whether in the generation of power, the manufacture of synthetic materials, or in the application of automatic methods of production, is dependent upon the supply of scientific workers and technologists. The shortage of scientific man-power is one of the major problems confronting Great Britain and the Commonwealth, and the Institution of Electrical Engineers has its contribution to make towards the solution of the problem.

Sir George reviewed some of the efforts which are being made to increase the intake of suitable young men to the engineering profession. He spoke with appreciation of the film entitled "The Enquiring Mind", which has been produced with the object of attracting the attention of parents and boys to the opportunities for careers in the fields of applied science and technology. It is particularly necessary, he suggested, to attract a great proportion of the young people who at present choose to pursue the Arts. There is also an urgent need for technically qualified men who have natural gifts for management and highest administration. Such qualities are inborn, and the aim should be to develop these natural gifts, when found, in association with a scientific or technical education. Sir George regretted that he could not provide a formula for the early identification of men with this gift, but he suggested that careers masters in schools could make a notable contribution in this connexion.

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# YEAST MITOCHONDRIA

## Subcellular Units involved in the Synthesis of Respiratory-Enzymes in Yeast

IN a series of papers from this laboratory published in 1949[1], it was shown that clones of normal yeast during their growth constantly give rise to respiration-deficient mutants ('vegetative mutants') stable in vegetative reproduction. The respiratory deficiency was shown to be due to lack of several enzymes (including cytochrome oxidase) bound, in normal yeast, to particles which can be sedimented by centrifugation, and to behave as a non-Mendelian character in crosses between normal and mutant yeast. It was suggested[2] that the mutation consists in the loss or irreversible functional inactivation of a particulate cytoplasmic auto-reproducing factor, and the question of the possible identity of this factor with subcellular units defined by various biochemical and cytological criteria was discussed.

Our observations have been reproduced and extended by several authors (cf. ref. 3) and have been the subject of several reviews in which our own views concerning the problems of the nature of the mutation giving rise to the 'vegetative mutants' on one hand, and that of the identity of the cytoplasmic factor on the other, have sometimes been misinterpreted. The purpose of the present communication is to restate our position regarding these two problems.

In discussing these problems, the following units, each defined by independent criteria, must be taken into consideration: (*a*) the extrachromosomal genetic factor; (*b*) the respiratory enzymes missing in the mutants (cytochrome *c* oxidase, succinic, reduced diphosphopyridine nucleotide, α-glycerophosphate, cytochrome *c* reductases, cytochromes *a* and *b* [4]); (*c*) the particles sedimentable from a yeast homogenate at *c.* 25,000 *g*; (*d*) the various particles revealed by microscopic observation of stained and unstained yeast cells.

(1) The occurrence of cells shown by genetic tests to contain the cytoplasmic factor but devoid of the respiratory enzymes in a permanent or transitory way ('segregational mutants'[5] and normal yeast grown anaerobically[4,6], respectively) proves that units (*a*) cannot be identical with units (*b*), the synthesis of which they control.

(2) Units (*a*) cannot be identical with the totality of particles (*c*), nor with the totality of either the microsomes or the macrosomes (frequently referred to as mitochondria in the biochemical literature) constituting the sedimentable fraction. This is demonstrated by the fact that the sedimentable fractions isolated from homogenates of respiratory mutants cannot be distinguished by their gross analytical characteristics from the corresponding fractions of normal yeast (ref. 4 and de Robichon-Szulmajster, H., unpublished observations). It remains possible, however, that (*a*) corresponds to a small fraction of (*c*).

(3) In considering now the possible relationship between the cytoplasmic units (*a*) postulated on genetic grounds and the visible cytoplasmic units (*d*), it must first be emphasized that the latter constitute a heterogeneous group comprising mitochondria, refractive granules and possibly other elements. The term 'mitochondria' will be reserved here for cytoplasmic structures characterized by their reactions to fixatives and their stainability by the Altmann and janus green *B* procedures. It appears to us reasonable to accept the view that these bodies carry cytochrome *c* oxidase, and that the localization in the cell of janus green *B* directly indicates the localization of this enzyme, the presence of which is a prerequisite of the staining reaction. The presence of cytochrome *c* oxidase is similarly required for the oxidation of the Nadi reagent. However, contrary to what is often assumed, the localization of indophenol blue does not necessarily reveal the site of its formation, for indophenol blue produced by *in vitro* oxidation of the reagent stains some granules in the cytoplasm of respiratory mutants devoid of cytochrome oxidase[4].

Since mitochondria are the carriers of cytochrome *c* oxidase, and since the respiratory mutants lack this enzyme, it was suggested that the genetic factor (*a*) might be identical with mitochondria and that the mutation consists in the loss or inactivation of the mitochondria with respect to their function in synthesizing cytochrome oxidase. The following communication by Y. Yotsuyanagi convincingly shows that the respiratory mutants do contain mitochondria. If it is assumed that the mitochondrial population is homogeneous, we are therefore left with the following two possibilities: (i) the genetic factor (*a*) is not identical with the mitochondria; (ii) the genetic factor corresponds to the mitochondria and the latter are not lost but functionally inactivated in the mutant.

However, if the mitochondrial population is assumed to be heterogeneous, a third possibility remains open: (iii) the genetic factor corresponds to a small fraction (carrying cytochrome oxidase) of the mitochondrial population, which may be lost in the mutant.

It can thus be seen that the identification of the genetic factor with the visible cell elements confronts us with essentially the same questions as its identification with the components of the sedimentable fraction (*c*).

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## Mitochondria and Refractive Granules in the Yeast Cell

The present communication is a summary of a re-investigation, by means of cytological techniques, of the controversial problem of yeast mitochondria, prompted by the hypothesis[1] that these bodies might be identical with the cytoplasmic hereditary factor required for the synthesis of respiratory enzymes in yeast. The preceding communication states this problem in the light of the evidence provided by genetic and biochemical data.

By the routine cytological techniques applied to fixed material (Altmann's method, Heidenhain's hæmatoxylin), we have revealed the presence in yeast cells of cytoplasmic bodies exhibiting features characteristic of mitochondria[2]. We have found also that the configuration of these bodies is subject to considerable variations depending on the physiological state of the yeast (growth phase, culture medium, etc.). Lastly, some technical improvements (vigorous aeration during the staining and rigorous control of the concentration of the stain) have permitted us to demonstrate cytoplasmic bodies vitally stainable by janus green *B*.

The configuration of cytoplasmic structures shown by material stained after fixation manifestly coincides with that revealed by janus green *B* in living cells in the same physiological state (Fig. 1). Therefore, in accordance with the usual cytological definition we shall call these bodies 'mitochondria'.

It has been known for a long time that ordinary, as well as phase-contrast, microscopy permits the observation in unstained yeast cells of highly refractive granules. There is nowadays a tendency to consider these refractive granules as mitochondria[3].

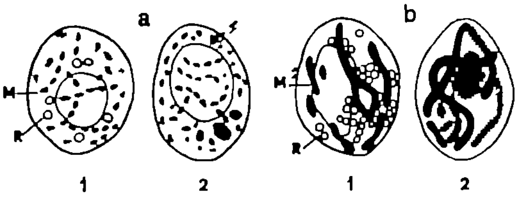

Fig. 1. Pictures of normal yeast cells (strain 'Yeast Foam') obtained by vital staining with janus green *B* (1) and by the application of Altmann's technique (2).
*a* and *b*, cells grown in two different media; *M*, mitochondria; *R*, refractive granules

This tendency is essentially based on the interpretation of images obtained with redox indicators such as indophenol blue and tetrazolium.

However, for the following reasons, the refractive granules seem to constitute quite different entities from the mitochondria as defined above. (*a*) These granules are usually not stained by janus green *B* so long as this reagent is used as a vital stain; (*b*) they differ from mitochondria in their shape, size, number and optical properties; (*c*) double differential staining clearly reveals two different particulate systems present in the cytoplasm; for this purpose yeast is stained vitally in dilute alcoholic solutions of sudan III or in dilute aqueous solutions of tetrazolium and then superstained vitally with janus green *B*. In either case, janus green *B* reveals blue-coloured cytoplasmic bodies, while the refractive granules are stained orange by sudan III or orange to pink by the tetrazolium formazan.

The fact that tetrazolium stains structures differently from those coloured by janus green *B* is of considerable importance. The tetrazolium compounds are frequently considered to be as specific 'mitochondrial stains' as janus green *B*[4]. This interpretation is based more or less implicitly on the following argument: dehydrogenases responsible for the reduction of tetrazolium are bound to particles, and it is assumed that the coloured product of the reduction (formazan) is insoluble in water; it is therefore inferred that the localization of the stain in the cell reveals the localization of particles bearing the dehydrogenases. However, Slonimski has found (unpublished observations) that the formazan of triphenyltetrazolium is soluble in water at very low concentrations (up to 1 p.p.m.) and that the freshly formed formazan is not immediately precipitated. It is clear, therefore, that the diffusion of the product of enzymatic reduction may take place in the cell, and that the localization of the stain may be quite different from the site of its formation. It should be added that both tetrazolium formazan and indophenol blue are soluble in fats, and in many biological materials they stain structures of lipidic nature[5].

In the respiration-deficient strains ('vegetative mutants') of yeast[6], the mitochondrial system is revealed by Altmann's technique. The refractive granules are visible without staining and can be coloured by the reduced tetrazolium. No colour is formed in the presence of janus green *B*, a fact which supports the interpretation[7] that this staining is due to the activity of the cytochrome *c* – cytochrome oxidase system. It is known that the respiration-deficient mutants are devoid of cytochrome *c* oxidase[8]. It appears, therefore, that these mutants contain mitochondria morphologically similar to those of normal yeast, in spite of the fact that they do not contain cytochrome *c* oxidase.

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# ENZYMATIC COAGULATION OF SEMEN

By G. GOTTERER, D. GINSBERG, T. SCHULMAN, JULIA BANKS and
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THE semen of many species coagulates soon after ejaculation. In the rat and the guinea pig, the vaginal plug which forms after copulation is composed of coagulated semen[2]. Camus and Gley[1,2] were the first to recognize that the secretions of the seminal vesicle were coagulated by an enzyme, designated vesiculase, present in the prostatic secretion of rodents. The classical studies of Walker[3,4] established that this coagulating enzyme is manufactured solely in the anterior prostate or so-called coagulating gland. In man, the coagulated semen afterwards liquefies. Huggins and his collaborators[5,6] have shown quite clearly that the liquefaction of human semen is a proteolytic phenomenon, and that human and other semens contain a number of proteolytic enzymes, a finding which has been confirmed and amplified in the laboratory of Lundquist[7]. However, the nature of the reactions responsible for the coagulation of the semen of any species remains unknown.

A stable preparation of proteins of the seminal vesicle coagulable by vesiculase may be obtained as follows. Fresh secretion of the seminal vesicle of the rat or guinea pig is extracted with 0·15 *M* sodium chloride at 2°, insoluble material is removed by centrifugation, and the saline-soluble proteins are precipitated by the addition of cold acetone to a final concentration of 66 per cent. The precipitate is washed with acetone and dried *in vacuo*. The dry powder is stable for at least one month when it is stored in a desiccator at 2°. The coagulable protein(s) is extracted from the acetone powder with 0·15 *M* sodium chloride at 25°, a small insoluble residue being discarded. Such saline extracts can be separated into three major protein components by electrophoresis in 0·1 *M* barbiturate buffer of *p*H 8·6, or by chromatography on ion exchange resins.

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* Scholar in Cancer Research of the American Cancer Society.

The coagulation of these proteins of the seminal vesicle by vesiculase can be determined turbidimetrically at 660 mμ. In solutions buffered at *p*H 7·4, the action of vesiculase is dependent upon the concentration of seminal vesicle proteins added, and especially upon the ionic strength of the reaction mixture. If the final concentration of seminal vesicle proteins is 15 mgm. per ml. or greater, and if the ionic strength is in the vicinity of 0·09, coagulation commences soon after the addition of vesiculase. Increasing the ionic strength to approximately 0·13 by the addition of sodium chloride or sodium bromide or potassium chloride induces a pronounced lag period, which is followed by a rapid rate of formation of insoluble protein. Further elevation of the ionic strength increases the duration of the lag period, but has little influence upon the rate of coagulation once it begins, as can be seen from Fig. 1. At ionic strengths of about 0·09, alteration in the amount of vesiculase added affects both the length of the lag period and the rate of coagulation. At ionic strengths of 0·15 or higher, the lag period, but not the rate of change in turbidity, varies inversely with the quantity of enzyme added. This fact is illustrated in Fig. 2, which also shows that increasing the concentration of seminal vesicle proteins decreases the lag period at a given ionic strength. Vesiculase exhibits a broad optimum over the *p*H range of 6·0–8·0. At *p*H 7·4, coagulation takes place equally well in either tris (hydroxymethyl) aminomethane or phosphate buffers provided that the ionic strengths are kept equal.

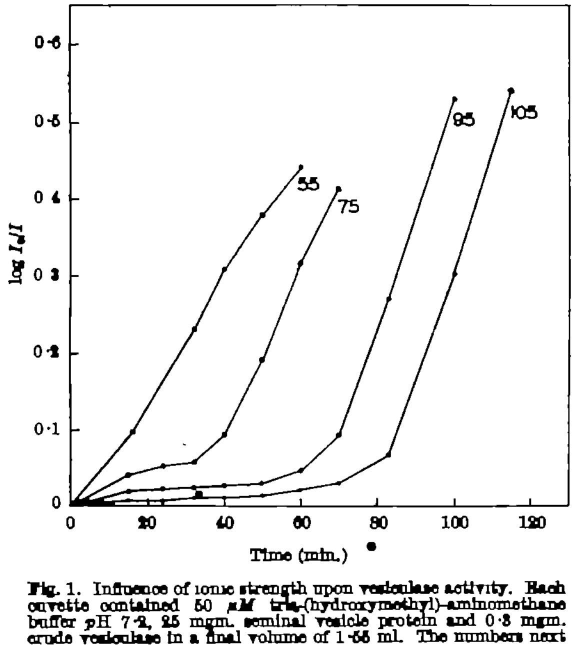

Fig. 1. Influence of ionic strength upon vesiculase activity. Each cuvette contained 50 μ*M* tris-(hydroxymethyl)-aminomethane buffer *p*H 7·2, 25 mgm. seminal vesicle protein and 0·3 mgm. crude vesiculase in a final volume of 1·55 ml. The numbers next to each curve represent the micromoles of sodium chloride per ml. of reaction mixture. Temperature 27°

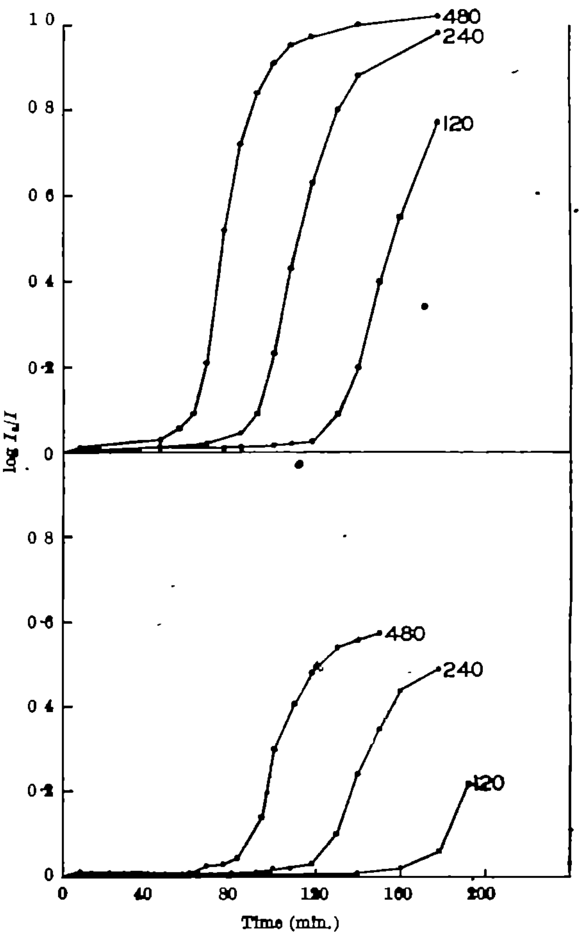

Fig. 2. Influence of the concentration of seminal vesicle protein and of vesiculase upon coagulation. Each cuvette contained 10 μ*M* of sodium phosphate buffer *p*H 7·4 and 165 μ*M* sodium chloride in a final volume of 1 2 ml. The final concentration of seminal vesicle proteins added was 15 and 7·4 mgm. per ml. in the upper and lower series of curves, respectively. The figure next to each curve represents the micrograms of crude vesiculase per ml. of reaction mixture. Temperature 27°

The insoluble material formed by the action of vesiculase upon seminal vesicle proteins is digested by trypsin, but is not soluble in 6·6 *M* urea at *p*H 7 after twenty-four hours at 30°.

The action of either crude or purified vesiculase in tris-(hydroxymethyl)-aminomethane buffer at *p*H 7·4 is unaffected by 2 m*M* concentrations of Ca$^{++}$, Mg$^{++}$ and Mn$^{++}$. It is abolished, however, by low concentrations of ethylenediamine tetra-acetic acid (versene), *o*-phenanthroline and α-α′-dipyridyl. Fifty per cent inhibition by versene is obtained with a final concentration of 2 × $10^{-5}$ *M*. Table 1 shows that the inhibitory effect of versene can be entirely reversed by equimolar or greater concentrations of Mn$^{++}$, and by an excess of Ca$^{++}$. A thirty-fold molar excess of Mg$^{++}$ is required to reverse the versene inhibition. Vesiculase action is depressed by low concentrations of Hg$^{++}$ and Fe$^{++}$, and by iodoacetamide. The inhibition by Hg$^{++}$ is reversed by cysteine, which does not itself affect vesiculase. Heating to 70° for ten minutes destroys this coagulating enzyme.

Table 1

| Versene (m*M*) | $CaCl_2$ (m*M*) | $MnCl_2$ (m*M*) | Change in optical density |
|---|---|---|---|
| | Experiment 1 (Rat) | | |
| 0 | 0 | 0 | 0·238 |
| 0·23 | 0 | 0 | 0·030 |
| 0 | 0·77 | 0 | 0·240 |
| 0 | 0 | 0·77 | 0·228 |
| 0·23 | 0·77 | 0 | 0·310 |
| 0·23 | 0 | 0·77 | 0·288 |
| | Experiment 2 (Guinea Pig) | | |
| 0 | 0 | 0 | 0·760 |
| 0·21 | 0 | 0 | 0·086 |
| 0 | 0 | 0·21 | 0·765 |
| 0 | 0 | 0·42 | 0·755 |
| 0 | 0 | 1·42 | 0·096 |
| 0·21 | 0 | 0·21 | 0·765 |
| 0·21 | 0 | 0·42 | 0·750 |
| 0·21 | 0 | 1·42 | 0·730 |
| 0 | 0·21 | 0 | 0·750 |
| 0 | 0·42 | 0 | 0·770 |
| 0 | 1·42 | 0 | 0·760 |
| 0·21 | 0·21 | 0 | 0·193 |
| 0·21 | 0·42 | 0 | 0·362 |
| 0·21 | 1·42 | 0 | 0·620 |

Experiments carried out at 30° in cuvettes of light path 0·8 cm. All tubes contained 50 *μM* tris-(hydroxymethyl)-aminomethane buffer pH 7·2. The following additions were made in experiments 1 and 2, respectively: seminal vesicle proteins, 25 mgm., 20 mgm.; sodium chloride, 124 *μM*, 93 *μM*; crude vesiculase, 0·61 mgm., 1·5 mgm. Total volumes and duration of experiment: Exp. 1, 1·8 ml., 27 min.; Exp. 2, 1·4 ml., 100 min.

The vesiculase present in saline extracts of guinea pig coagulating gland is precipitated by the addition of ammonium sulphate at 0° between 30 and 50 per cent saturation. If this fraction is dissolved in and dialysed against 0·15 *M* sodium chloride, it may be purified further by the addition of acetone at 0° to a final concentration of 30 per cent. This procedure affords a purification of approximately thirty-fold over the activity of crude extracts. Coagulation can be induced with as little as 10 μgm. per ml. of this purified protein. These treatments also separate vesiculase activity from that of an extremely active enzyme, present in crude coagulating gland extracts, which hydrolyses tosylarginine methyl ester. The latter enzyme, which appears to be similar to the human seminal enzyme hydrolysing benzoylarginine ethyl ester described by Lundquist[7], is precipitated from crude extracts by ammonium sulphate at 0° between 50 and 80 per cent saturation. This fraction will hydrolyse about 1,500 micromoles of tosylarginine methyl ester per mgm. of protein per hour at 37° and *p*H 7·4. A small amount of the tosylarginine methyl ester-hydrolysing enzyme contaminating vesiculase in the 30–50 per cent saturation ammonium sulphate fraction is removed by the subsequent treatment with acetone.

Sherry and Troll[8] have demonstrated that thrombin prepared from a number of species will hydrolyse tosylarginine methyl ester rapidly. Moreover, the action of thrombin upon fibrinogen is inhibited by tosylarginine methyl ester, apparently by a competitive mechanism. The fact that vesiculase can be separated from the tosylarginine methyl ester-hydrolysing enzyme in the coagulating gland, and that the action of vesiculase is not inhibited by tosylarginine methyl ester, suggests that vesiculase and thrombin are not identical. The dissimilarity between semen and blood coagulation is further borne out by the fact that at *p*H 7·4, bovine thrombin (15–36 units per ml.) will not coagulate the proteins of the seminal vesicles of rodents, and that guinea pig vesiculase does not coagulate either bovine or human fibrinogen (1 per cent) in the absence or presence of $Ca^{++}$.

It is a pleasure to acknowledge the advice and assistance of Dr. Dorothy Price in these investigations. This work was supported by grants from the American Cancer Society upon recommendation of the National Research Council Committee on Growth.

[Oct. 14

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# FUNCTION OF CAROTENOIDS IN PHOTOSYNTHESIS

It is a rule without known exceptions that carotenoids accompany chlorophyll in the photosynthetic apparatus of all phototrophs from bacteria to higher plants[1]. Careful measurements of photosynthetic action spectra have shown that the light absorbed by carotenoids can be used for photosynthesis by some, but not by all, the organisms so far examined[2]. It seems, therefore, that direct participation of carotenoids as agents of energy transfer in the chain of primary photochemical events must be regarded as a well-established but by no means universal function of these pigments in photosynthetic organisms.

Some observations that we have recently made with the photosynthetic bacterium *Rhodopseudomonas spheroides* suggest a second, hitherto unsuspected function for carotenoids in photosynthesis, which could well explain the universality of their association with the photosynthetic apparatus: namely, protection of the cell from photodynamic destruction by chlorophyll, its principal light-absorbing pigment.

*Rhodopseudomonas spheroides* is a non-sulphur purple bacterium (family Athiorhodaceae). As shown diagrammatically in Fig. 1, the photosynthetic metabolism of non-sulphur purple bacteria differs from that of green plants. The oxidized moiety arising from the photochemical scission of water, which in green-plant photosynthesis is liberated as oxygen, serves in these bacteria as an oxidant for externally furnished hydrogen donors. Bacterial photosynthesis is thus an anaerobic process, which occurs in the light in the presence of suitable organic hydrogen donors. Many non-sulphur purple bac-

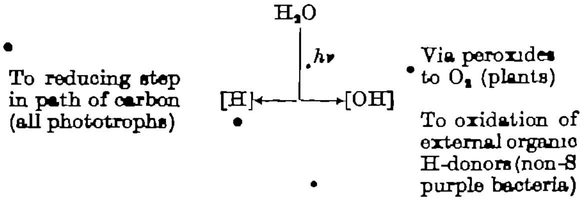
$H_2O$
hν
To reducing step in path of carbon (all phototrophs)
[H]
[OH]
Via peroxides to $O_2$ (plants)
To oxidation of external organic H-donors (non-S purple bacteria)

Fig. 1. Primary reactions in photosynthesis

teria, including *R. spheroides*, can also be grown in the dark. Under such conditions they obtain the energy required for growth by the aerobic oxidation of the organic compounds that serve anaerobically as hydrogen donors for photosynthetic metabolism.

These bacteria also differ from most green plants in the structure of their photosynthetic apparatus. They lack chloroplasts; instead, the photosynthetic pigment system is contained in numerous submicroscopic particles termed chromatophores, each of which is some 50 mμ in diameter[3]. A similar intracellular organization of the pigment system is found in other photosynthetic bacteria[4] and in one plant group, the blue-green algae[5].

The photosynthetic pigments of purple bacteria are bacteriochlorophyll, which is identical throughout the group, and carotenoids, which differ from species to species[6]. *R. spheroides* contains a red and a yellow carotenoid, partly characterized some years ago by van Niel[7]. The colour of the cells varies from brown to red, depending on the conditions of cultivation. We have isolated three classes of mutants which differ from the wild type in their carotenoid constitution. Mutants of the *green* phenotype contain two new yellow carotenoids; those of the *brown* phenotype contain one of these new yellow carotenoids, together with the wild-type yellow and red carotenoids; and those of the *blue-green* phenotype contain no coloured carotenoids. Organisms of the green and brown phenotypes are physiologically normal, whereas those of the blue-green phenotype, although still capable of photosynthesis, display a number of striking biochemical and physiological aberrations, all of which appear to be ultimately referable to the absence of carotenoid pigments.

## Location of the Primary Genetic Block in the Blue-Green Mutant

Fig. 2 shows the spectra of the blue-green mutant and the wild type, both grown anaerobically in the light. The spectra were measured in a special cuvette holder with a pane of opal glass between the suspensions and the photocell, which minimizes the effects of light scattering[8]. The peaks at 375 mμ, at 590 mμ, and beyond 800 mμ indicate absorption by bacteriochlorophyll. In the spectrum of the wild type, the complex system of peaks between 440 and 570 mμ reflects the composite absorption by the two carotenoids. The spectrum of the blue-green mutant shows no peaks in this region; and the absence of coloured carotenoids was confirmed by column chromatography of extracts prepared from the cells. The bacteriochlorophyll in such extracts is spectrally identical with pure bacteriochlorophyll[9], and yields on acid treatment a spectrally typical bacteriophæophytin. When the effluents from columns were examined spectrophotometrically, they were found to contain large quantities of a colourless substance with the characteristic ultra-violet absorption spectrum of phytoene, a $C_{40}$ polyene that has been isolated from a variety of plant sources[10]. From the published values for the specific absorption of phytoene[10] and of the wild-type carotenoids[7], it could be calculated that the amount of phytoene in cells of the blue-green mutant is of the same order of magnitude on a weight basis as the amount of coloured carotenoids in the wild type. Most of the phytoene is localized in the chromatophores. In conformity with earlier observations[11], we were unable to detect phytoene in cells of the wild type.

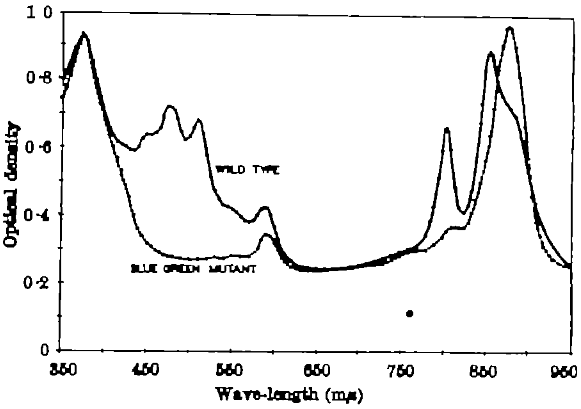

Fig. 2. Spectra of whole cells, adjusted to same densities at 680 mμ

Porter and Lincoln[12] have postulated that phytoene is one of the normal biosynthetic precursors of carotenoids. Although the role of the Porter–Lincoln series (phytoene, phytofluene, ζ-carotene, etc.) in normal carotenogenesis has been questioned[13], the probability that these compounds do have a biosynthetic function has been increased by recent findings with mutants of *Chlorella*[14], in which genetic blockage of normal carotenogenesis leads to an intracellular accumulation of one or more members of the Porter–Lincoln series. It therefore seems reasonable to formulate the primary biochemical lesion in blue-green mutants of *R. spheroides* as follows:

$$\cdots\cdots\rightarrow \text{phytoene} \Big| \xrightarrow{(n \text{ steps})} \text{coloured carotenoids}$$

Reversion of blue-green mutants, which is common in some strains, yields a phenotype indistinguishable from that of the wild type.

## Influence of Cartenoids on the Spectrum of Bacteriochlorophyll *in vivo*

The absence of peaks in the carotenoid region is not the only difference between the absorption spectrum of the blue-green mutant and that of the wild type. Despite the fact that the mutant contains normal bacteriochlorophyll, the infra-red spectrum of its cells shows very marked changes. The peaks at 805, 855 and about 880 mμ characteristic of the wild type (and also of the green and brown mutants) have given place in the blue-green mutant to a perfectly symmetrical main peak at 875 mμ with low shoulders at 760–780 and 800–825 mμ (Fig. 2). As a result of these changes, the general shape of the chlorophyll absorption spectrum in the cells of the blue-green mutant has come to resemble that of pure bacteriochlorophyll in organic solvents (Fig. 3), although the absolute positions of the main peaks still differ widely.

Complex infra-red spectra like that of wild-type *R. spheroides* are shown by most purple bacteria, although the number, position and relative heights of the peaks differ from species to species[15a]. The interpretation of these supernumerary peaks, which have no counterparts in the spectrum of bacteriochlorophyll *in vitro*, has been discussed by several authors[15], and it is generally concluded that they reflect the presence in the cell of several different chlorophyll-protein conjugates. However, the simpli-

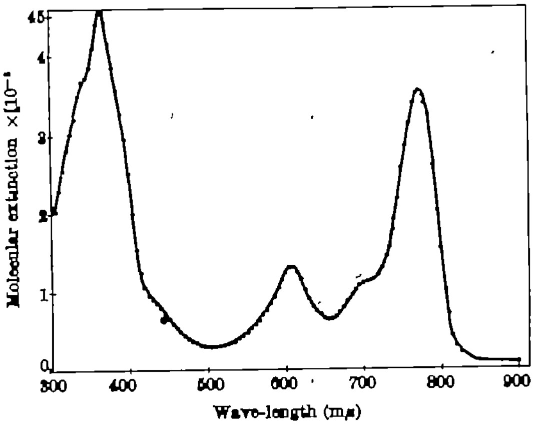

Fig. 3. Extinction curve for bacteriochlorophyll in methanol

fication of the infra-red spectrum that accompanies the disappearance of carotenoid pigments in the blue-green mutants points to a different interpretation. We suggest that the normal multi-peaked spectra are caused by a close and regular spacing of chlorophyll and carotenoid molecules in the photosynthetic unit, which is lost in the blue-green mutant when normal carotenoids are replaced by phytoene, a much more highly saturated compound lacking the molecular rigidity characteristic of the coloured carotenoids.

## Porphyrin Excretion

Media in which the blue-green mutant has been grown under photosynthetic conditions contain green, water-soluble pigments with a composite spectrum characteristic of porphyrins. The wild type can also excrete porphyrins during photosynthetic growth, but they are of a different nature (principally coproporphyrin III, according to Lascelles[16]). By solvent partition and chromatography we have separated the porphyrins excreted by the blue-green mutant into two major and two minor components. One of the minor components is bacteriophæophorbid. The other three substances are phorbids of the *a* series, spectrally very similar to one another and to phæophorbid *a*.

Porphyrin excretion by the blue-green mutant can be differentiated physiologically as well as chemically from porphyrin excretion by the wild type. In wild-type cultures, porphyrins are liberated into the medium only at the end of exponential growth, as the population is entering the stationary phase; in cultures of the blue-green mutant liberation of porphyrin parallels exponential growth, and diminishes with the onset of the stationary phase. The excretion of chlorophyll derivatives by the blue-green mutant is correlated with a subnormal chlorophyll content of the cells (Table 1).

These facts can be interpreted as follows. In the blue-green mutant, the geometry of the chromatophore is drastically changed by the absence of carotenoids, as evidenced by the changes of the infra-red spectrum. Furthermore, the sub-normal chlorophyll content of the cells indicates that less chlorophyll can be accommodated in the chromatophore than is possible for the wild type. However, since the primary genetic block in the blue-green mutant lies in synthesis of carotenoid, the synthesis of chlorophyll by the cell presumably proceeds at the normal rate, and as a consequence the unincorporated surplus must be disposed of in some fashion, the means adopted being excretion of chlorophyll derivatives into the medium. The phorbids which are excreted may be either intermediates in the normal biosynthesis of chlorophyll, or products of its intracellular enzymatic degradation. In any event, it is worthy of note that a photosynthetic bacterium can produce several derivatives of chlorophyll *a*, since the synthesis of this class of substances has been considered up to now the exclusive prerogative of plants[1] and organic chemists[17].

Table 1

| | | Growth conditions* | | | |
|---|---|---|---|---|---|
| | | Anaerobic, at light intensity of<br>270 foot-candles | 670 foot-candles | 1,800 foot-candles | Aerobic, dark |
| Growth-rate† | Blue-green | 0·051 | 0·17 | 0·20 | 0·31 |
| | Wild type | 0·175 | 0·24 | 0·31 | 0·31 |
| Chlorophyll content‡ | Blue-green | 1·1 | 0·86 | 0·47 | — |
| | Wild type | 1·6 | 0·89 | 0·51 | — |

* All experiments conducted at 30° C. in a medium containing: a vitamin–salts mixture; casein hydrolysate; and ammonium malate as principal hydrogen donor. Anaerobic cultures aerated with 95 per cent nitrogen – 5 per cent carbon dioxide; aerobic cultures with 95 per cent air – 5 per cent carbon dioxide.

† Expressed as the reciprocal of the generation time in hours.

‡ Measurements made on cells under steady-state conditions of pigment synthesis, and expressed as mgm. of chlorophyll per 100 ml. of culture with optical density of 1·000 at 680 mμ.

## Physiology of Growth of Bacteria

The relative growth-rates and chlorophyll contents of the blue-green mutant and of the wild type under a variety of environmental conditions are shown in Table 1. Under anaerobic conditions at any given light intensity, the mutant contains less chlorophyll and grows more slowly than the wild type; the divergences are particularly marked at low light

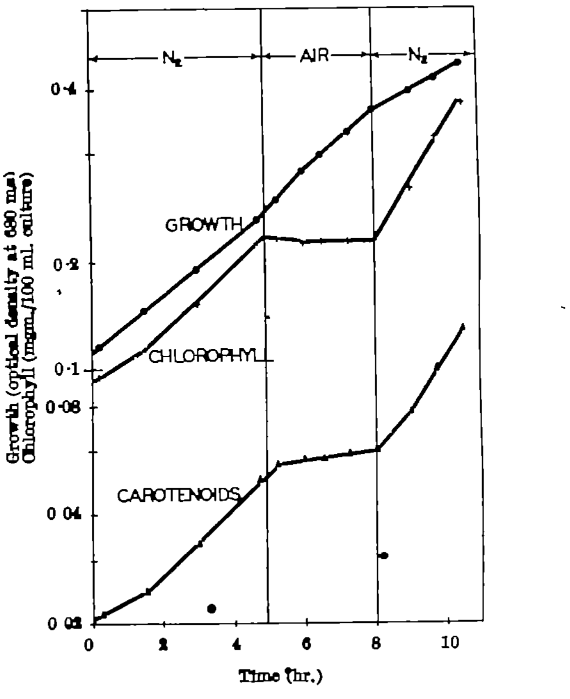

Fig. 4. Effect of air on growth and pigment synthesis by wild type of *R. spheroides*. Continuous illumination

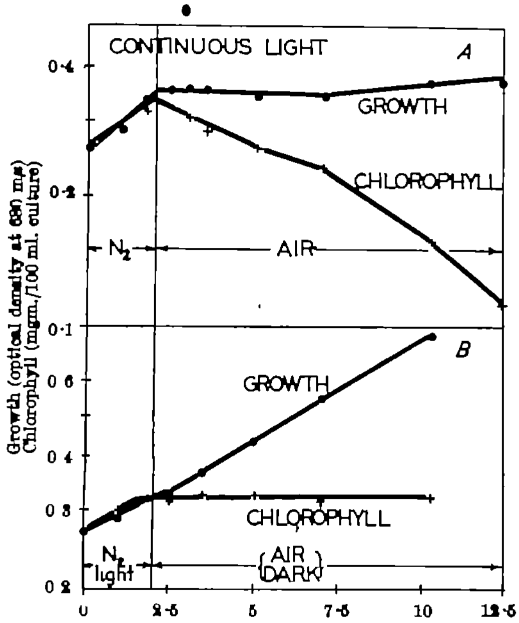

Fig. 5. Effect of air on growth and pigment synthesis by blue-green mutant of *R. spheroides*. *A*, continuous illumination; *B*, culture shielded from illumination just before introduction of air

intensities. Under aerobic conditions in the dark, the growth-rates are identical.

In studies on the kinetics of pigment synthesis by the wild type and the green mutant, we have found that, even in the presence of light, air almost totally inhibits both chlorophyll and carotenoid synthesis by growing cultures, but does not destroy the preformed intracellular pigments. When air is introduced into an illuminated culture previously growing under anaerobic conditions, the growth-rate is either unaffected or slightly increased; presumably photosynthesis continues for a certain period but is increasingly replaced by respiration as the pigment system of the cells is diluted by growth. A typical experiment with the wild type showing the effects of air is shown in Fig. 4. When a similar experiment was conducted with the blue-green mutant, the results were dramatically different (Fig. 5*A*): shortly after the introduction of air, growth ceased abruptly, and the preformed chlorophyll in the cells began to disappear. The arrest of growth indicated massive killing, as shown by viable counts. Death can be prevented by shielding the culture from light just before the introduction of air; under these conditions, growth continues, and the preformed chlorophyll in the cells is not destroyed (Fig. 5*B*). Since neither light nor air alone will kill the mutant, it is evident that death results from photodynamic action[18].

Two possible photosensitizing agents are present: the bacteriochlorophyll in the cells, and the excreted chlorophyll derivatives. Since the principal absorbing region of bacteriochlorophyll *in vivo* lies between 820 and 920 mμ, whereas none of the excreted compounds absorbs light at wave-lengths longer than 800 mμ, a simple experiment to decide between these possibilities suggested itself. The mutant was grown photosynthetically with infra-red light transmitted by a filter (Eastman 87*C*) completely opaque to all wave-lengths shorter than 800 mμ, and the effect of introducing air was determined. Under these conditions, air caused cessation of growth and destruction of chlorophyll in a fashion comparable to its effect on a control culture growing in white light. This experiment shows that the photosensitization of the blue-green mutant is attributable mainly, if not exclusively, to the intracellular bacteriochlorophyll. Since carotenoid-containing strains of the same organism do not show such a photosensitization, the conclusion that they are protected by their carotenoids seems inescapable.

If protection from photosensitization is a general carotenoid function, it follows that the carotenoidless condition should be compatible with photosynthetic growth only in bacteria, since these are the only phototrophs that can be grown in the light in the complete absence of oxygen. A green plant without carotenoids, even if initially placed in anaerobiosis, would presumably produce upon illumination the oxygen necessary for photodynamic death, and hence such a mutation in a plant should prove lethal under all conditions in the light. Claes[14] has recently described carotenoidless mutants of the green alga *Chlorella* that accumulate one or more members of the Porter–Lincoln series. These mutants can be grown only in the dark and are killed by exposure to light, a finding in agreement with the role for carotenoids that we postulate. Since it is well established that carotenoids can absorb light used in photosynthesis, protection from photodynamic death is evidently not their sole function in photosynthetic organisms; but we suggest that it may be the primary and most important one. On this view, the use of carotenoids as ancillary photosynthetic pigments by some organisms might be regarded as a later evolutionary adaptation.

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In the preceding communication, some observations are described on the photosynthetic bacterium *Rhodopseudomonas spheroides* and some of its mutants, which indicate quite clearly that the presence of visibly coloured carotenoid within the cell prevents the killing of the cell when exposed simultaneously to oxygen and light, and that this killing is produced by light absorbed by the bacteriochlorophyll in the absence of coloured carotenoid. It may be associated with a similar phenomenon described for carotenoid-deficient mutants of *Chlorella*[1]. For the latter, however, the requirement of the presence of oxygen for the photokilling of the cell has not yet been demonstrated,[1] although it seems likely that it will be so.

The suggestion is made by Prof. Stanier and his colleagues that this 'protective action' of the carotenoid may represent a significant primary positive biological function of the carotenoid which had survival value and therefore, by implication, was and is a variable upon which evolutionary selection was based. When an attempt is made to formulate the molecular basis for this phenomenon (protection against photo-oxidative destruction), a somewhat different point of view regarding the reasons for its existence presents itself.

If one interprets the phenomenon in terms of an ability or function of the carotenoid to remove the 25–40 kcal. of excitation energy from the chlorophyll in some useful way prior to its use in the activation of some oxidation reaction by molecular oxygen, the protective action arises as an incidental result. Photosensitized oxidations by molecular oxygen and dyestuffs of the type of chlorophyll and of chlorophyll itself, in fact, are very well known. The photosensitized oxidation of thiourea by chlorophyll has indeed been used in actinometry, and the more general photosensitized oxidation of a large variety of unsaturated compounds by molecular oxygen has been studied in some detail.

The mechanism for this sensitized oxidation as formulated by Schenck[2] has been used by others[3] for accounting for a variety of photo-oxidations sensitized by porphyrins; it involves the transition of the first excited singlet state of the porphyrin into a long-lived (longer than $10^{-3}$ sec.) triplet state of the porphyrin[4]. This triplet state is then presumed to combine with the paramagnetic oxygen molecule to form a reactive peroxide[3]. The reactive peroxide can transfer its oxygen to a suitable reductant, leaving the sensitizer to return to its original ground-state. Such reductants have been substances such as ascaridol, etc.[1], and other oxidizable materials such as the thioctic acid disulphide[3a].

There is evidence that precisely such a process of absorption and transition to a long-lived (longer than $10^{-3}$ sec.) state by chlorophyll takes place in the plastids of photosynthetic organisms[5]. If the carotenoid were to play a part in the transport or transformation of the energy from this state, so that in the absence of carotenoids this state would have a greater probability of active peroxide formation in the presence of molecular oxygen, the phenomena above described would be expected to follow. Indeed, evidence for the likelihood of such a function for the carotenoid is also found in another observation described by Prof. Stanier and his colleagues. This is the great reduction, amounting to almost the disappearance, of the absorption bands at 8000 and 8550 A. from the mutant lacking coloured carotenoid, without any concomitant change in the porphyrin composition of the cell to which this might be attributed. As suggested by them, the disappearance of these absorption bands appears to be due to some change in the geometry of the plastids. More specifically, we would suggest that this absorption band is associated with the existence of a pi-complex between the carotenoid and the chlorophyll, models for which are to be found in the several systems which have been described by Scheibe[6] over the past twenty years. Such an interaction would indicate a close coupling between the electronic systems of the two molecules and provide a very effective pathway for energy transport or transformation. That such a transfer may take place in the reverse direction had been demonstrated by the observation of chlorophyll fluorescence induced by carotenoid light absorption[7].

From this point of view, the 'normal' function of the carotenoid would be in one of the following steps: (1) in the conversion of the long-lived electronic chlorophyll excitation into reducing and oxidizing agents (electrons and holes; it is not unlikely that the extra absorption bands mentioned in the previous paragraph are charge-transfer spectra related to this process)[5b,c]; (2) in the succeeding separation of these agents by a process of conduction in the conjugate chain; or (3) as a coenzyme in the conversion of the oxidant initially formed (to oxygen in the green plant or to oxidize the hydrogen donor in the photosynthetic bacteria). In performing any of these energetically useful functions it would, of course, inhibit the photosensitized oxidation of such essential sensitive cell constituents as disulphides and mercaptans. An apparently alternative mechanism for the 'protection' would be for the carotenoid to act as 'most-favoured' oxygen acceptor from the reactive peroxide. This would require a reductive process for the regeneration of carotenoid, and it might even be a process yielding energy, in which case it would correspond to the third possibility mentioned above.

Since all these functions would be considered essential steps in the ability of a cell to use light energy for growth, it is necessary to recognize the requirement for something able to perform these functions, although perhaps less efficiently, in the case of the anaerobic photosynthetic growth of the blue-green mutant. This may be the less conjugated phytoene, or some other as yet unrecognized cell constituent.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Radiation Sensitivity of Ovarian Tissue at −79° C.

Gonadal tissue of rats, soaked *in vitro* in media containing glycerol, can be subjected to very low temperatures without losing its capacity to form an endocrinologically active graft[1]. This observation has made possible the extension to normal tissues of work on the temperature relations of radiation effects which has hitherto been restricted to small ranges of temperatures, or, so far as mammalian material is concerned, to certain tumour cells[2].

Rat ovarian tissue was chosen for the experiments because of the wealth of information about its behaviour *in vitro* and on grafting, and because, in addition to the endocrine cells, the ova offer a highly sensitive indicator of irradiation effects. So far as I am aware, no experiments on X-irradiation *in vitro* have been carried out with ovarian tissue even at normal temperatures, though this method has been used with adrenal grafts[3]. *In vivo*, however, exposure of the rat ovary to 500–3,000 r. causes destruction of the ova[4]. Direct destruction of the endocrine tissue of the ovary must be distinguished from the curtailment of its functional life which may follow destruction of the ova[5].

There are three main indices of the endocrine effectiveness of ovarian grafts in ovariectomized females: the proportion of animals in which the grafts 'take', the latent interval before they become functional and the survival-time of the graft as a functional organ. In rats, the restoration and maintenance of the vaginal cycle in ovariectomized recipients, readily effected by the transplantation of normal ovarian tissue, is a convenient indication of functional activity of the graft. In this communication, 'activity' refers only to endocrine activity thus determined, there being no question of fertility with subcutaneous grafts.

In most of the experiments to be considered here, the two ovaries were removed early in the morning, cut into eight quarters, soaked in 15 per cent glycerol-saline or glycerol-serum for one hour, and sealed in glass ampoules. The ampoules were then immersed in alcohol at room temperature (controls), or frozen in the slow cooler previously described[6] and immersed in alcohol maintained at −79° C. by solid carbon dioxide in a vacuum jar. The jars were dispatched immediately to the Experimental Radiopathology Research Unit at Hammersmith, where the ampoules, still immersed in alcohol, were irradiated under conditions which ensured that a known dose was received by the ovarian tissue contained in the ampoules. The jars were then brought back to Mill Hill, and the tissue transplanted subcutaneously to the donors.

With two sets of operations and slow freezing to be carried out on the same day, the necessity for transporting the material across London for irradiation placed a severe restriction on the design of the experiments. At first, control material was put simultaneously through the same procedure, without irradiation; but with four types of treatment going on simultaneously the number of animals in each category was so reduced that in later experiments the non-irradiated control grafts were made on the previous day. Also, attempts to relieve the logistic difficulties by using material frozen for more than a few hours were complicated by the greater freezing damage thus incurred.

Irradiation was from a Philips 'Metallix' X-ray tube run at 190 kV. and 6 m.amp., giving a dose-rate to the tissue of 68 r. per min. Three levels of dosage were used at room temperature on material in glycerol-saline: 1,000 r., 3,300 r. and 6,600 r. Tissue which had received 1,000 r. established itself as a graft and, over a short period of observation, functioned normally and, at least for a time, contained normal ova. At the other extreme, no functional grafts were obtained from material irradiated with 6,600 r. The intermediate dose did not prevent entirely the establishment of endocrinologically functional grafts; but it greatly decreased their effectiveness and no ova were found in such grafts. Attention was therefore concentrated on irradiation with 3,300 r., and various sighting experiments at room temperature and at −79° C. showed that the effect was influenced by the nature of the medium and by the amount of damage attributable to freezing alone. A four-point experiment based on the results of the preliminary work, in which 15 per cent glycerol-serum was used because of the added protection it gives to ovarian tissue against freezing damage[7], yielded the results summarized in Table 1.

Table 1. Effect of Temperature on Irradiation Damage to Rat Ovarian Tissue

Two replications of a 4-point experiment, 40 rats in all

| *In vitro* treatment of tissue before grafting | | Effectiveness of graft | | |
|---|---|---|---|---|
| | | Proportion of 'takes' | Average latent interval (days) | Proportion active at seven weeks |
| Not irradiated | Soaked only at room temperature | 10/10 | 7·8 | 10/10 |
| | Frozen to − 79° C. | 10/10 | 12·8 | 10/10 |
| Irradiated (3,300 r.) | At room temperature | 2/10 | 21·0 | 0/10 |
| | At − 79° C. | 9/10 | 20·5 | 5/10 |

The following conclusions may be drawn.

(*a*) The grafting of ovarian tissue which had been soaked in glycerol-serum but neither frozen nor irradiated produced effects similar to those previously reported.

(*b*) Freezing alone increased the latent interval, but did not affect the proportion of 'takes' or, within the period of observation, the functional survival-time of the graft.

(*c*) Irradiation with 3,300 r. at room temperature greatly reduced the number of 'takes', increased the latent interval by nearly three times and shortened the functional life of the graft.

(*d*) Irradiation at − 79° C. was less damaging because both the proportion of 'takes' and the survival-time of the graft were much increased as compared with irradiation at room temperature, in spite of some additional damage due to freezing.

Histological examination of the material discussed in the table showed that there was little difference between the two types of non-irradiated grafts; both frozen and fresh tissue gave rise to active-looking grafts with abundant ova, follicles and corpora lutea. Where the tissue had been irradiated at room temperature, only degenerate bits could be recovered at autopsy and these consisted histologically of small nests of old luteal cells. The grafts obtained from tissue irradiated at − 79° C. also consisted mainly of luteal tissue, but much of this was in the form of old but still well-organized corpora lutea. Ova were not seen, and there is no suggestion that under the conditions of this experiment low temperature gave any significant protection to the eggs against the excessive dose of X-rays employed.

The results must be regarded as preliminary, and evidently a host of variables remain to be investigated in connexion with even this one type of tissue. Nevertheless, the experiments justify the conclusion that under certain conditions a temperature of − 79° C. appears to afford some protection to rat ovarian tissue against irradiation effects.

I am much indebted to Dr. G. Popják, who arranged for the irradiations at the Experimental Radiopathology Research Unit, and my especial thanks are due to Dr. M. Ebert, who carried out the irradiations and whose study of dosimetry under unusual conditions was vital to the work recorded. The operative procedures were carried out by Miss M. Moylan.

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# Identification of N$^2$-Methylguanine (2-Methylamino-6-hydroxypurine) as a Normal Constituent of Human Urine

A recently initiated re-investigation[1] of the free purine bases (other than methylxanthines of dietary origin or uric acid) normally occurring in human urine showed that in addition to xanthine, hypoxanthine, adenine and 7-methylguanine, isolated in older work[2], guanine, 1-methylguanine, and a number of as yet unidentified substances of purine-like properties were present. The procedure used segregation of amphoteric components by absorption on 'Dowex 50' resin and elution with ammonia, precipitation of the purines with acid silver nitrate, two-dimensional paper chromatography of this concentrate, elution and ultra-violet spectrophotometry. Improved ultra-violet illumination has revealed the presence of an additional substance the ultra-violet spectrum of which strongly suggests a substituted guanine structure; this appears as a faint spot on the paper chromatograms, between 'spot $U$'[1] and adenine.

A small specimen of this unknown substance was isolated by ion exchange chromatography[3] and further purified by paper chromatography. Its mobilities on paper chromatograms in four solvents (Table 1) and its spectra at five $pH$ values (Fig. 1) were found to be in excellent agreement with those of a synthetic specimen of N$^2$-methylguanine[4].

Table 1. Properties of the Urine Isolate and of N$^2$-Methylguanine, and of the Products formed by Nitrous Acid Treatment

| Property | Urine isolate | N$^2$-methylguanine | Product from action of nitrous acid on urine isolate | Product from action of nitrous acid on N$^2$-methylguanine |
|---|---|---|---|---|
| *Rf* values in | | | | |
| $n$-butanol–0·6 $M$ ammonia | 0·25 | 0·25 | 0·04 | 0·04 |
| $n$-butanol–aq. formic acid | 0·27 | 0·27 | 0·50 | 0·49 |
| $p$H 7 aqueous buffer* | 0·45 | 0·46 | | |
| $p$H 9 aqueous buffer† | 0·45 | 0·45 | | |
| Ultra-violet absorption at | | | | |
| $p$H 2·1, max. (mμ) | 251, 280 | 251, 279 | 245, 292 | 244, 290 |
| $p$H 2·1, min. (mμ) | 228, 270 | 228, 271 | 234, 279 | 236, 278 |
| $p$H 6·2, max. (mμ) | 247, 280 | 247, 280 | 245 | 245 |
| $p$H 6·2, min. (mμ) | 226, 266 | 226, 267 | 228 | 228 |
| $p$H 9·0, max. (mμ) | 247, 280 | 246, 280 | 243 | 243 |
| $p$H 9·0, min. (mμ) | 228, 266 | 229, 266 | 228 | 229 |

* 0·07 $M$ phosphate buffer.
† 0·05 $M$ borate buffer.

Analogous to the case of N$^6$-methyladenine and of 8-methylaminopurine[5] was a small shift to longer wave-length of the absorption maxima of N$^2$-methylguanine relative to those of guanine. To confirm further the identity of the unknown with synthetic N$^2$-methylguanine, both were treated with nitrous acid. (To a suspension of 0·25 mgm. of substance in 0·25 ml. of 2 $M$ acetic acid at 60°, 0·05 ml. of 1 $M$ sodium nitrite was added over a 10-min. interval.) The paper mobilities and ultra-violet absorption of the product from either specimen again coincided within experimental error (Table 1). The structure of the product is at present unknown. The substance produced by action of nitrous acid on N$^6$-methyladenine has been tentatively formulated as an N$^6$-nitroso derivative[6].

The urine of all the normal human subjects examined contained the new compound. The average daily urinary excretion was 0·5 mgm. The urinary excretion of N$^2$-methylguanine, and of the purines earlier described[1], was not significantly changed after three days on a diet restricted to glucose and water,

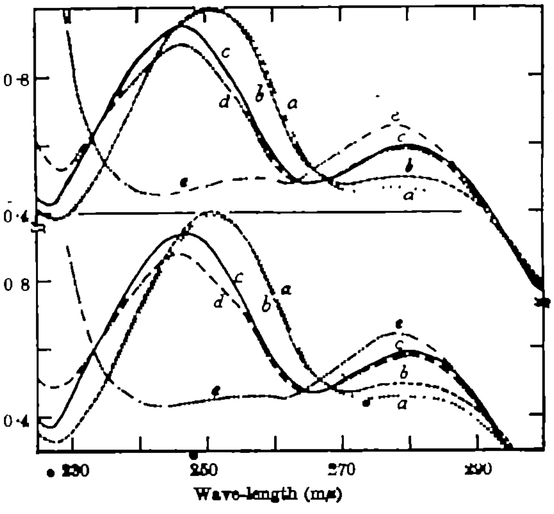

Fig. 1. Ultra-violet spectra of the urine isolate (lower curves) and synthetic N$^2$-methylguanine (upper curves). (a) in 1 $M$ hydrochloric acid · · · · · ·; (b) at $p$H 2·1, – – – –; (c) at $p$H 6·2, ———; (d) at $p$H 9·0, ———; and (e) in 1 $M$ sodium hydroxide, — — · —

or after sterilization of the intestinal tract by ingestion of neomycin and succinylsulphathiazole. This indicates that they are products of endogenous metabolism in man, and not dietary or bacterial in origin.

This identification of N$^2$-methylguanine as a urinary constituent seems to be the first time it has been recorded in a natural product. Of interest in this connexion is the recent demonstration of N$^6$-methyladenine[6] and of N$^6$-dimethyladenine[7] in bacterial and fungal sources. With the earlier identification of 7-methylguanine[2] and 1-methylguanine[1], the identification of N$^2$-methylguanine brings the number of methylated guanines in human urine to three. A possible fourth such derivative is the substance designated[1] 'spot *K*', which is still under investigation. The similarity of the spectra of this substance to those of 8-hydroxyguanine at a number of *p*H values and other evidence suggest that it may be a methylated 8-hydroxyguanine. The possibility that methylated guanine derivatives may play some significant part, as yet unexplored, in human metabolic processes is indicated.

We wish to thank Dr. Gertrude B. Elion, of the Wellcome Research Laboratories, for making available a specimen of synthetic N$^2$-methylguanine. The investigation was supported in part by a grant-in-aid from the National Institute of Arthritis and Metabolic Diseases, National Institutes of Health.

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## Normal Blood Picture of the Guinea Pig

In the course of general research into the effect of various drugs on the hæmopoietic system of the guinea pig, it was necessary to observe and record the normal blood picture, since there is considerable variation in the results given by other workers[1,2]. These records of the normal were primarily obtained to provide a base-line for combined investigations on the reticulo-endothelial system and the blood in relation to the defence mechanism of the body.

The results we have obtained are from 53 intact male guinea pigs which varied in weight from 300 to 570 gm. The blood was removed from a marginal vein of the ear and also from the heart.

*Erythrocytes.* The average total count was found to be 5 million per c.mm. with a variation up to 0·4 million cells. Other workers[3] record a range of 3·7–7·7 million, but the majority are in agreement with a total of about 5 million. In comparison with human blood, there is a slight degree of poikilocytosis, anisocytosis and polychromasia.

*Hæmoglobin.* The hæmoglobin-level was determined by the Sahli method and averaged 81 per cent. Others[3] give values of 75–110 per cent.

*Platelets.* The average number in the present series of animals was 71,000 per c.mm., but varied from 54,000 to 100,000.

*Leucocytes.* The average total count was found to be 9,100 per c.mm. This varied between 5,000 and 15,000; but most of the animals showed a count of between eight and ten thousand.

DIFFERENTIAL COUNT

| | Average (per cent) | Range (per cent) |
|---|---|---|
| Lymphocytes | 64 | 55–81 |
| Pseudoeosinophil granulocytes | 32 | 16–44 |
| Immature granulocytes | 0·1 | 0–1 |
| Eosinophil granulocytes | 0·6 | 0–3 |
| Basophil granulocytes | 0·2 | 0–2 |
| Monocytes | 3·1 | 0–7 |

The normal blood picture is therefore one of 'lymphocytosis'. The pseudoeosinophils are the counterpart of the neutrophils of human blood. Compared with the true eosinophils, they show finer granules in their cytoplasm, do not exhibit certain specific staining (Zollikofer's)[3] and show multiple segmentation of the nucleus, which usually has from four to seven lobes.

The Foa–Kurloff cells[4] in this series of male animals never exceeded 1 per cent of the leucocyte count and were only observed in some of the films examined.

There was no evidence that albino guinea pigs possess more circulating leucocytes than the coloured varieties.

The heart blood compared with that taken from the ear showed a slightly higher percentage of lymphocytes (72 per cent) and a small reduction in pseudoeosinophils (25 per cent), although the total leucocyte count showed no change.

The blood films were stained with Giemsa's stain and the platelet count estimated by comparison with the number of erythrocytes.

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## Cortex and Medulla of Bird-Feathers

In fully developed mammalian fibres, the cortex shows an affinity for 'nitro' dyes, while the medulla retains any acid stain[1], this being clearly seen in Wildman's[2] colour photograph. Histogenetically, the affinity of the fibre medulla for acid dyes may be connected with its re-absorption or adsorption of the earlier segregated droplets of the intensely acidophilic trichohyalin[1], and it may also bear out the chemical specificity of the medulla, as compared with the cortex, pointed out by, for example, Bekker and King[3]. In contrast to its high and general affinity for 'nitro' dyes, the cortex of fully keratinized fibres shows a slight, regional affinity for basic stain[4]. However,

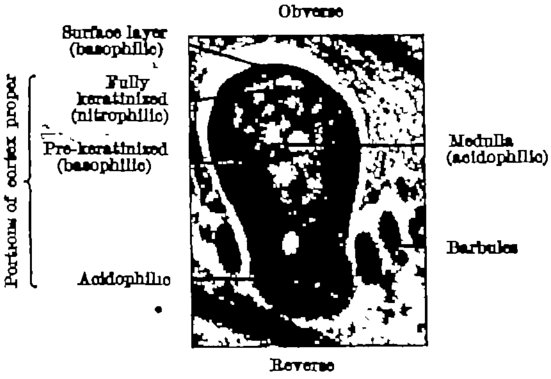
Obverse
Surface layer (basophilic)
Portions of cortex proper
Fully keratinized (nitrophilic)
Pre-keratinized (basophilic)
Acidophilic
Medulla (acidophilic)
Barbules
Reverse

Fig. 1. Part of a transverse section through a feather germ from a guinea fowl, showing a barb, in which the obverse portion of the cortex has attained full keratinization. × 500

before attaining keratinization within the follicle, the cortex shows a 'pre-keratinization' zone in which its previous, acidophilic state abruptly changes into an extremely intense affinity for basic stain[5,1].

Change from an acido- into an intensely basophilic state can be observed during differentiation of cortex also in bird feathers; but Auber's[1] staining procedure reveals that, with full keratinization, the cortex shows a greater and more general tendency to retain basic stain than does fibre cortex; this may be in conjunction with chemical differences between this layer in birds and mammals, found by earlier authors. As in mammalian fibres, the medulla of feathers shows an intensely acidophilic state, which persists after full keratinization; however, no droplets comparable to trichohyalin appear in the medulla at any stage.

Earlier work shows that differentiation and keratinization of the feather takes place in waves passing across the width of the rhachis and the barbs in a direction from the obverse to the reverse. Germs, particularly of large feathers, may show, in a corresponding arrangement, three phases of differentiation of the cortex, namely, full keratinization ('nitro'- or basophilic), pre-keratinization (intensely basophilic), and the early, acidophilic state, in one and the same cross-section of a barb (Fig. 1).

Sections through fully developed feathers may be stained successively with a basic and an acid stain (for example, basic fuchsin and picro-indigocarmine, or toluidine blue and acid fuchsin). After the initially applied basic dye has been extracted from the medulla with 70 per cent alcohol, this layer is stained by a short exposure to the acid dye. In conjunction with the ob–reverse progress of keratinization, reverse portions of the cortex may appear less intensely stained with the basic dye than the rest of the cortex, or they may attain a stain resulting from both dyes; however, they stand out clearly from the intensely acidophilic medulla. Such regional differences within the feather cortex may correspond histogenetically to the regional heterogeneity of the fibre cortex[6,4]. According to the type of bird, the obverse portion of the surface layer[7] may stand out from the cortex proper by an extreme intensity of the basic stain; or this portion may stain less intensely or even, when picro-indigocarmine is used for staining the medulla, it may stain with the 'nitro' dye (picric acid).

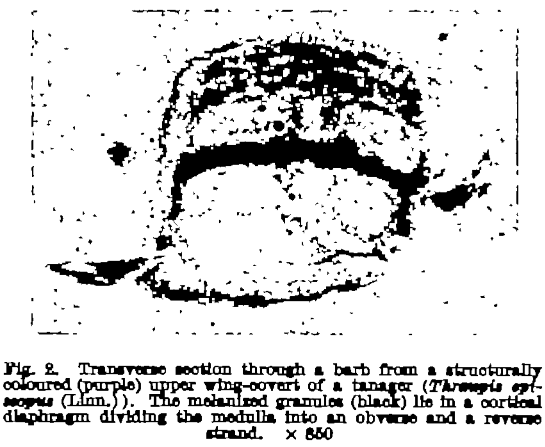

Fig. 2. Transverse section through a barb from a structurally coloured (purple) upper wing-covert of a tanager (*Thraupis episcopus* (Linn.)). The melanized granules (black) lie in a cortical diaphragm dividing the medulla into an obverse and a reverse strand. × 850

By applying such a differential stain, misconceptions by earlier authors[8] about the structure of some feathers can be rectified. Thus it can be shown that in barbs of, for example, some kingfishers and some tanagers, the light-absorbing melanins (necessary for production of Tyndall's blue) are situated, not in the medulla but in a cortical diaphragm which divides the medulla into two strands (Fig. 2). Moreover, in some kingfishers the melanins were found to lie in an isolated axial strand of cortical tissue, completely surrounded by a tube-shaped medulla (Fig. 3). A detailed account of the morphology of such atypically textured feathers is now being prepared.

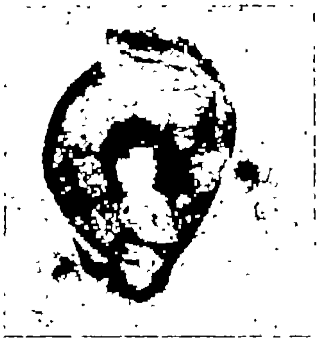

Fig. 3. Transverse section through a barb from a structurally coloured (purple) feather from the rump of a kingfisher (*Halcyon coromanda* (Lath.)). The melanized granules lie in an axial strand of cortical tissue which is completely enclosed by medullary cells. × 900

I am indebted to the Council of the Wool Industries Research Association for permission to publish these observations, and to Mr. H. M. Appleyard, Miss M. E. A. Perkin and Miss D. Davenport for preparing the photomicrographs.

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## Factors Influencing the Motility of a Strain of *Pseudomonas viscosa*

The observation that *Pseudomonas viscosa* is motile only around bubbles of air when examined under a coverslip has led to the investigation of the effect of oxygen and other factors on its motility.

Distilled water suspensions of the organism (approximately 2,500 million viable organisms per ml.) from nutrient agar cultures were gently mixed and then drawn into flat capillary tubes made by a modification of the method of Wright and Colebrook[1]. The tubes were sealed, leaving an air space at one end, and examined microscopically.

Immediately after introduction into the capillary, the organisms were briskly motile throughout the length of the column of suspension; but after several minutes (average 7–10 min.) motility ceased except in a zone approximately 2–4 mm. in length next to the air, and was optimal in a narrow band 1 mm. or more from the air surface. The time required for general motility to cease could be increased to 80 min. by prolonged aeration of the suspension. The organism remained motile for periods up to several days at room temperature in the zone near the air, the duration of motility depending on the size of the air space. If, when all motility had finally ceased, the capillary tube was re-opened, motility re-commenced at the air-suspension interface immediately.

All the phenomena observed with air could be reproduced with oxygen; but motility was not maintained by hydrogen, nitrogen or carbon dioxide.

The use of fresh 50 per cent broth as the suspending medium gave different results. Motility in the centre of the column ceased at approximately the same time as that in the water control; but, after a pause of a second or two, the cells in the presence of broth began to move again, and remained motile for approximately two hours. This finding suggested a second factor promoting motility under relatively anaerobic conditions. Other reagents were tested for ability to give prolonged motility, and the results obtained are summarized in Table 1. They show that arginine was capable of producing all the phenomena noticed with broth, that the duration of motility increased with increasing concentrations of arginine, and that arginine was highly specific.

The temporary brief cessation of motility described above suggested that arginine was not utilized for motility until the available oxygen in the suspending medium had been reduced below a critical level. Experiments designed to test this point were made by comparing the duration of motility of suspensions aerated in the presence and absence of arginine with that of unaerated controls. The results showed that arginine was, in fact, utilized in aerated mixtures, but considerably more slowly than under conditions in which motility dependent upon oxygen had ceased.

To summarize: the motility of this strain may be activated either by a certain minimal concentration of molecular oxygen, or by arginine in the absence of sufficient available oxygen to allow the first mechanism to operate. These observations promise to throw further light on the biochemical processes controlling flagellar activity, and work is continuing in an attempt to determine the role and fate of arginine.

Table 1. Results of Mixing Equal Volumes of Aqueous Suspensions of *Ps. viscosa* and Some Different Reagents

| Reagents | Prolongation of motility beyond that of the water control. (Readings taken at more than 20 mm. from the air space) |
|---|---|
| Nutrient broth. Digest broth. Boiled broth. 0·1 per cent Thioglycollate broth. Brewer's medium. 1 per cent Peptone. L-arginine 1·2 m*M* | > 40 min. |
| Meat extract without added peptone. Supernatant from overnight broth culture. Creatine, L-citrulline and L-ornithine (2·5–25 μ*M*) | 0 min. |
| 18 other amino-acids, singly or in groups (individual concentrations, 4·0–0·5 m*M*) | 0 min. |
| Adenosine triphosphate (2·5 m*M*–0·025 μ*M*), urea (25–0·25 m*M*), glucose (1–0·01 per cent) | 0 min. |
| L-arginine hydrochloride 6 m*M* | 182 min. |
| ,, ,, $2^{-1} \times 6$ m*M* | 86 ,, |
| ,, ,, $2^{-2} \times 6$ m*M* | 43 ,, |
| ,, ,, $2^{-3} \times 6$ m*M* | 22 ,, |
| ,, ,, $2^{-4} \times 6$ m*M* | 12 ,, |
| ,, ,, $2^{-5} \times 6$ m*M* | 7 ,, |
| ,, ,, $2^{-6} \times 6$ m*M* | 2 ,, |
| L-arginine hydrochloride 0·4 m*M* + adenosine triphosphate (0–7·5 m*M*) | 16 ,, approx. |

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## Chloride Ions in the Secretion of the Pitcher Plant

Analogies between the pitchers of insectivorous plants of the genus *Nepenthes* and the mammalian stomach were first given biochemical justification when De Zeeuw[1] demonstrated that the proteolytic activity, long known to occur in the viscous secretion of opened pitchers, was also present in the juice of pitchers opened under sterile conditions and could hence not be of bacterial origin. A recent study of the secretions from opened and unopened pitchers of some fifteen species of *Nepenthes*, made available to me by courtesy of the Director of the Royal Botanic Gardens at Kew, makes it possible to suggest a yet closer analogy between the animal and vegetable organs.

It was found that, whereas the *p*H of the secretion in unopened and sterile pitchers fell within the range 4·2–6·6 (mean 5·5), it was some 2 *p*H units lower (2·3–4·6, mean 3·3) in the juice of freshly opened pitchers which, though not sterile, had not yet acquired a chemically important bacterial population. Chromatography on paper of the secretions of freshly opened pitchers showed no significant amounts of the commonly occurring organic acids. Tests with silver nitrate, however, showed chloride ions to be present in the juices of all pitchers. Whereas chloride was usually present in very low concentration in the immature organs, estimations by an iodometric method on the secretions of newly opened pitchers showed chloride ion concentrations in the range 600–900 mgm. per litre.

Although data are not yet available for the construction of an ion balance sheet, there seems to be a definite qualitative correlation between the hydrogen and chloride ion concentrations in the pitcher secretion of *Nepenthes*. Since, in general agreement with the results of earlier authors[2], the pitcher protease has been consistently found to show an optimum activity on hæmoglobin in the region *p*H 2–3, the provisional conclusion appears to be justified that the proteolytic action in the pitcher is established, as in the mammalian stomach, by concomitant secretions of a protease and of hydrogen ions, the latter being balanced by a simultaneous secretion of chloride.

It is interesting to note that chloride was first detected in the pitcher secretion by Voelker[3] in 1849.

I wish to thank Drs. L. Bentley and D. F. Cheesman for their advice in this investigation.

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## A Crystalline Component of Carp Myogen precipitating at High Ionic Strength

Fractionation of carp myogen with ammonium sulphate reveals the occurrence of a component precipitating at neutral *p*H between 90 and 100 per cent saturation of ammonium sulphate. We have succeeded in isolating this constituent by the following method.

Fresh muscles are minced and extracted with water for 1 hr. at 2° C. The supernatant separated by centrifugation is dialysed in the cold against water. The globulins precipitated are discarded. The solution is brought to 88 per cent saturation by addition of solid ammonium sulphate and the *p*H is adjusted to 6·5. After elimination of the precipitate, solid ammonium sulphate is added to 98 per cent saturation. The solution is gently stirred for 1 hr. in the cold; the precipitate is separated by centrifugation and dissolved in a small amount of water. This solution, which gives rise to an important crystallization within 24 hr. at 2° C. (Fig. 1), has been examined by electrophoresis, ultracentrifugation and spectrophotometry, after dialysis against a phosphate – sodium chloride buffer of $I = 0·15$ and *p*H 7·3 ($I = 0·1$ phosphate + 0·05 sodium chloride).

Two electrophoretic gradients of closely similar mobilities are observed on the ascending side corresponding to the main gradient of carp albumins described by Hamoir[1,2] which migrate at $-3 \times 10^{-5}$ (ascending) and $-2·5 \times 10^{-5}$ (descending) cm.$^2$ volt$^{-1}$ sec.$^{-1}$ (same buffer as above). In the ultracentrifuge, a single peak is obtained with a corrected rate of sedimentation of about 1·5 *S*.

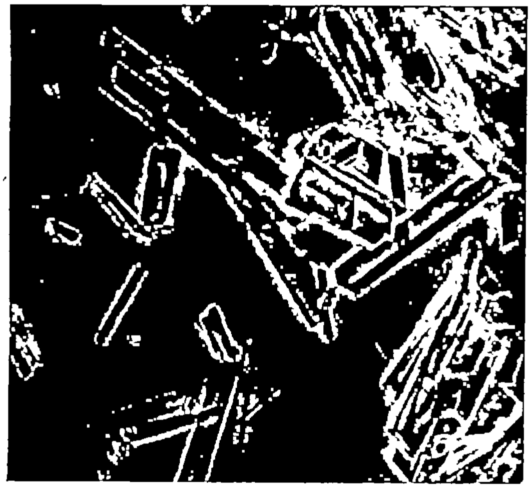

Fig. 1. Photomicrograph with phase-contrast microscope. × 350

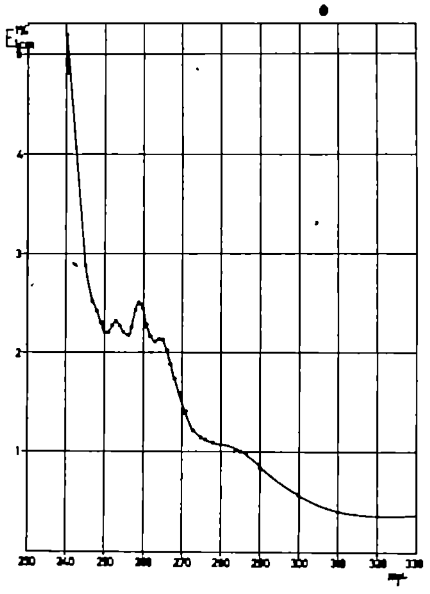

Fig. 2. Ultra-violet spectrum at *p*H 7·3. Ordinate, optical density of a 1 per cent solution; abscissa, wave-length in mμ

The ultra-violet absorption spectrum is shown in Fig. 2. It differs surprisingly from that usually observed with proteins. The absorption at 280 mμ is very low, and three peaks are observed at about 253, 259 and 264 mμ, identical to those described by Fromageot and Schnek[3] in the case of phenylalanine at neutral *p*H. This protein appears, therefore, to contain very little tyrosine and tryptophan, and a much higher proportion of phenylalanine. No protein, except gelatin, seems to have been described so far having such an unbalanced composition in cyclic amino-acids[4].

The occurrence in carp muscle albumins of a protein fraction having such electrophoretic and ultracentrifugal properties has already been inferred from the study of whole extracts[2]; but except myoglobin[6], no component had been isolated and crystallized hitherto from these low-molecular weight proteins, which appear to occur only in muscles of cold-blooded vertebrates[2,5].

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## The 'Blow' of Whales

In a communication in *Nature* of June 25, 1955[1], attention was directed to the occurrence of an extremely stable foam in the lung passages of the rabbit. The foam was formed from a mucus composed of an insoluble protein, the surface tension of which was extremely low.

Foam with comparable qualities has been established as occurring naturally in the sinus system of the middle ear and in the trachea of whales (common rorqual, pilot whale and sperm whale). In these animals the foam is developed from a very finely divided emulsion of fat droplets in mucus, and gas. When it is spread out on a glass plate, the foam persists for several days and eventually dries to a meringue-like consistency.

In the region of the ear, the foam subserves a sound-insulating function[2]; but its occurrence in the respiratory passages suggests that it may also have the role of absorbing the residual nitrogen of the inspired air, both in the lungs and middle-ear sinuses. It is well known that fat has a nitrogen-absorptive capacity six times greater than that of blood[3]. In a foamed emulsoid form, the conditions for absorption are ideal.

This leads to consideration of the constitution of the 'blow' of whales, which has been the subject of much conjecture and not a little controversy. It has variously been thought to be formed of water, of condensed water vapour or of these combined with the exhaled breath. It is obvious that the lungs are not filled with water, and the amount thrown up by the exhaling whale while breaking surface does not seem adequate to account for the conspicuous and, to whaling men particularly, the specifically recognizable fountain which has so often been observed. The fact that the 'blow' is of equal visibility whether seen in the tropics or in colder latitudes would seem to rule out the condensed water-vapour hypothesis. It is suggested, therefore, that it is the nitrogen-charged foam which is expelled on exhalation.

A distinctive colour injection of the oil sinus of the 'melon' of a pilot whale was carried out at the Museum. The result points to a connexion between this supra-maxillary oil sinus and the mucous membrane of the middle ear air sinus. A similar connexion could be anticipated for the similarly situated spermaceti organ of the sperm whale. These liquid oil systems have no capillary vascular system in their interior, and the oil is therefore unlikely to be saturated with nitrogen at atmospheric pressure if the rate of oil synthesis exceeds that of nitrogen saturation. If the oil–nitrogen absorption idea is correct, it would be expected that an animal of the size and deep-diving capacity of the sperm whale would require a very considerable reservoir, such as the spermaceti organ, of liquid oil for emulsification. to replenish that lost at each exhalation.

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## Interlamellar Sorption Complexes of Graphitic Acid with Organic Substances

GRAPHITIC acid has long been known[1] to show reversible interlamellar swelling with water[2], of the same apparent type as that shown by the clay mineral montmorillonite. As in the case of this mineral, reactions with organic substances of polar nature are to be expected; these, although mentioned in an early paper[3], appear not to have been systematically investigated using X-ray diffraction methods. This we are in process of doing.

Table 1. BASAL SPACINGS OF GRAPHITIC ACID COMPLEXES WITH ORGANIC SUBSTANCES

| Substance | Technique | *d*(001) | Δ |
|---|---|---|---|
| Dried over conc. sulphuric acid | *p* | 7·0 | — |
| Water in excess | *f* | 10·9 | 3·9 |
| Ethylene glycol | *p* | 9·6 | 2·6 |
| Glycerol | *p*, *f* | 10·0 | 3·0 |
|  | *o* | 9·2 | 2·2 |
| Acetone | *f* | 9·0 | 2·0 |
| Phenol in aq. sol. | *f* | 10·5 | 3·5 |
| Acrylic nitrile | *p*, *f* | 8·0 | 1·0 |
| Propionic acid | *f* | 9·2 | 2·2 |
| Amyl nitrite | *p* | 7·5 | — |
| Nitrobenzene | *p* | 8·8 | 1·8 |
| *m*-Nitroaniline in aq. sol. | *f* | 11·0 | 4·0 |
| Hexane + pentane | *f* | 7·6 | — |
| Carbon disulphide | *f* | 7·7 | — |
| Benzene | *f* | 7·3 | — |
| Ethylamine | *p* | 8·7 | 1·7 |
| *iso*Butylamine | *p* | 16·8 | 9·8 |
| Aniline | *p* | 18·5 | 11·5 |
| Aniline in aq. suspension | *p* | 23·1 | 16·1 |
| Naphthylamine in aq. sol. | *p* | 14·6 | 7·6 |
| Pyridine | *p* | 11·1 | 4·1 |

For the symbols used to indicate technique, see text. The sign — means no appreciable swelling. For measurements on alcohols, see Fig. 1.

Complexes can be formed simply by moistening the graphitic acid (previously dried) with the organic liquid, or with a suitable solution. Table 1 lists a few of the basal spacings we have observed in this way. In most cases they are derived from X-ray powder photographs, made with the graphitic acid powder in a Lindemann glass tube (indicated by *p* in Table 1); some from similar photographs of small oriented aggregates, as used in studying clay minerals[3] (*o*); others with a special flat-plate semi-focusing camera calibrated with mica (*f*).

The graphitic acid was prepared by treating powdered graphite with a mixture of potassium chloride, nitric and sulphuric acids[4]. It was not an entirely uniform product, the X-ray diagrams showing some unchanged graphite (002) spacing, which, however, caused no confusion. For some of the photographs, the most altered product was separated by sedimentation. The product, after drying over concentrated sulphuric acid, had a basal spacing of 7·0 A. It was perhaps still slightly expanded at this stage, or else some sulphate groups were present in interlamellar positions. The column headed Δ in Table 1 gives the expansion, with reference to an 'unexpanded' spacing of 7·0 A.

The observations referring to the aliphatic alcohols are of particular interest, and are shown graphically in Fig. 1. For the first three members the expansion is small, about 2·5 A., of the same order as that for glycol, glycerol and acetone. The next two alcohols give the same expansion together with a proportion (small for butanol, large for pentanol) of a much larger one. This large expansion increases from butanol to pentanol by an amount equal to the projected length of two C—C bonds, assuming an 'upright' orientation of the molecules as a whole on the graphite layers. Benzyl alcohol fits on the same slope, if it is given its 'effective' number of aliphatic straight-chain carbon atoms. Owing to lack of suitable compounds, we have not been able to follow out this curve further; but it seems to indicate clearly that, between four and five carbon atoms, the orientation of the sorbed molecules changes from being pre-

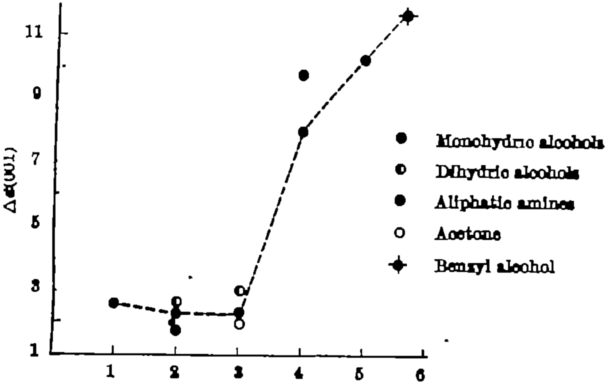

Fig. 1. Butanol and pentanol, in fact, give mixed spacings, only the larger one being plotted

dominantly 'lying down' to predominantly 'standing up'.

The alcohols may be supposed to react with the interlamellar acidic residues to give alkyl compounds: $C_4H_9OH + XOH \rightarrow C_4H_9OX + H_2O$. When the carbon chains are not too long, they can be accommodated in the parallel orientation; but when longer they have to seek another orientation. The observed Δ values for the longer chains correspond to straight-chain two-layer complexes of the type $C_4H_9.OXO.C_4H_9$. The existence of a mixture of spacings for butanol and pentanol may be due to the non-uniform nature of the substrate. It is noteworthy that benzyl alcohol (a much more bulky, though not much longer, molecule than pentanol) gives only the higher spacing.

The nature of the interlamellar acidic groups is not at present known with certainty, though further study of these complexes may throw light on it. According to R. Franklin[5], they would be complex anions of the form $(C_6H_y)_n$, but some acid groups such as $SO_4^{2-}$ are likely also to be present[3].

The amines probably form ionic, instead of homopolar, complexes: for example, ethylamine will give $C_2H_5NH_3^+.OX^-$. When upright, as apparently in the case of *iso*butylamine, they take up more space than the corresponding alcohols, as would be expected from the supposed difference in the nature of the bond. Aniline is an interesting case: it gives a spacing corresponding to an 'upright' orientation; but if sorbed from aqueous suspension it gives a still higher spacing, which appears to result from the introduction of two further layers of water molecules. Amines seem to be readily sorbed from aqueous solution, but not from benzene solution (in which they would not be ionized).

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## Absorption Spectrum of Benzoquinone

The absorption spectrum of benzoquinone in the vapour state between 0° C. and 100° C. in cells 5–100 cm. long has been photographed with a three-prism Steinheil glass spectrograph and a Hilger *E* 492 quartz spectrograph. The molecule exhibits three systems of absorption—two in the ultra-violet and one in the visible region—as does the solution spectrum[1] of the substance.

That the bands in the ultra-violet form two distinct systems with two peaks of maximum intensity at about 2500 A. and 2800 A. is clear from the low-temperature spectrograms. At higher temperatures, however, the two systems overlap. The 2500 A. bands are very diffuse, broad and degraded on both sides, whereas the 2800 A. bands are less diffuse and are degraded to the red. About a hundred bands observed under different experimental conditions in this region were measured. The proposed analysis of the bands bears this out and shows that both systems are due to transitions allowed by symmetry. The 2800 A. band-system, however, has its zero band relatively less intense. Assuming $D_{2h}$ symmetry in the ground- and excited-states, the two systems appear to involve the transitions $B_{1u} \leftarrow A_{1g}$ (2500 A.) and $B_{3u} \leftarrow A_{1g}$ (2800 A.).

The visible bands lie in the region of 4100–5000 A. and consist of eight main groups developed at 100° C. in a 50-cm. cell. About 175 bands were measured in this region, including the twenty-eight bands reported previously[2]. These bands are very sharp, many of them having double and triple heads with separations of 7 cm.$^{-1}$ and 5 cm.$^{-1}$ between them. Some of the bands have a line-like appearance; but most of them are degraded towards the violet. One marked feature to be noticed is the appearance of the companion bands with separations of 36 cm.$^{-1}$ lying on the shorter wave-length side of the first band of each group. Companion bands also develop on the longer wave-length side of the main bands at a slightly higher temperature with frequency differences of 37 cm.$^{-1}$, 64 cm.$^{-1}$ and 92 cm.$^{-1}$. The accuracy is within 2 cm.$^{-1}$ for the sharp bands and 5 cm.$^{-1}$ for the broad bands in this region.

The analysis of this system offers several difficulties and interesting features. Treating the benzoquinone molecule as a *para* di-substituted benzene having $D_{2h}$ symmetry which is preserved on excitation, there is the possibility of the bands being due to a singlet-triplet transition[3] allowed by symmetry but forbidden by spin. The gross structure of the bands is, however, best understood when they are assigned to a symmetry-forbidden transition made possible by a non-totally symmetric vibration (for example, 538 cm.$^{-1}$ in the ground state and 520 cm.$^{-1}$ in the excited state). The forbidden transition appears to be ${}^1A_{1u} \leftarrow {}^1A_{1g}$ with the zero band at 21,512 cm.$^{-1}$.

McMurry[4] has suggested that the long-wave-length absorption in benzoquinone may be similar to the characteristic long-wave-length absorption of carbonyl compounds, which is due to a forbidden transition in which a loosely bound electron occupying a non-bonding orbital lying in the molecular plane and across the CO direction is excited to a higher molecular orbital with a node in the plane. The sharpness of the bands and the present analysis support this view. The analysis also shows that the forbidden character is due to symmetry rather than to spin. Further, if the analogy to the carbonyl compounds is true, it is clear that there is a shift from the aromatic character of the molecule as exhibited in the ultra-violet band systems to the aliphatic ketone character as exhibited in its visible system. There is evidence to show that this shift is gradual in the present case. The companion bands on the shorter wave-length side of the main bands appear to be due to $v,v$ transitions between vibrations of two different types in the two electronic states.

Details of this work will be published elsewhere.

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## A Coal Seam as a Guide for Seismic Energy

A dispersive train of vibrations resembling an internal Love wave has been observed during seismic experiments in the Mangapehi State Coal Mine, New Zealand. The observation is of interest as suggesting that coal mines may offer peculiarly favourable conditions for the study of this type of wave, and also because guided waves may find useful applications in mining.

At Mangapehi a thick seam of sub-bituminous coal about 800 ft. deep is mined to a height of 9 ft. in the first working. The tests were carried out across a panel of solid coal, the shot-point being located in a mine sump. Fig. 1 shows the principal components of motion produced by a series of 2-oz. shots at a distance of 460 ft., as recorded by a portable seismic prospecting apparatus. The dispersive wave-train, which was the largest vibration recorded, appeared on the component parallel to the seam and normal to the direction of the shot-point (Fig. 1a).

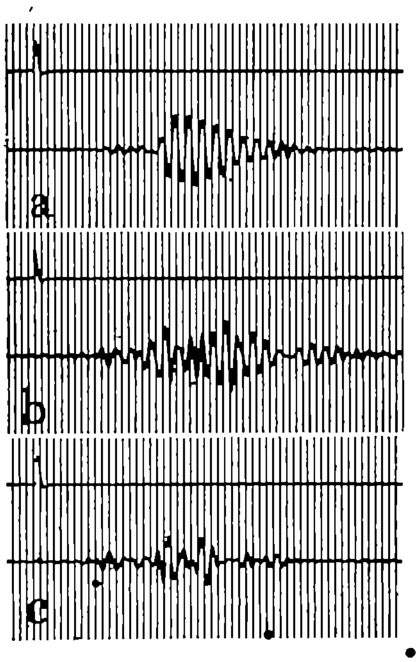

Fig. 1. Vibrations recorded at 460 ft. from source in Mangapehi coal mine. (a) Component parallel to seam and normal to direction of shot; (b) component parallel to seam and in line with direction of shot; (c) component normal to seam. The upper traces record the shot-instant, and timing-lines are at intervals of 10 m.sec. The sensitivity of the receiver for (b) and (c) was twice that for (a)

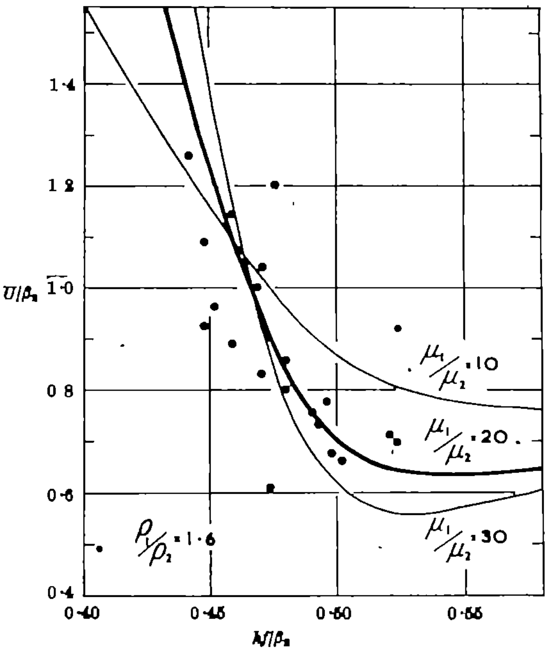

Fig. 2. Dispersion of wave-train in Fig. 1a plotted for comparison with that of theoretical Love waves. $U$ is group velocity and $f$ frequency. Subscripts 1 and 2 applied to the rigidity modulus $\mu$, density $\rho$, and shear velocity $\beta$, refer to the rock and the coal respectively. $h$ is thickness of the seam. Observations are plotted for $h$ = 17·6 ft., and $\beta_2$ = 1,900 ft./sec.

The dispersion of the wave is compared in Fig. 2 with the relevant portions of theoretical Love wave curves, which have been computed for a density ratio (rock/coal) of 1·6 and various rigidity ratios[1]. Apart from scatter (which may be attributed to other types of wave arriving at the same time), satisfactory agreement occurs for a rigidity ratio of 20 if the thickness of the coal is taken as 17·6 ft. and its shear velocity as 1,900 ft./sec. These values appear from other data to be approximately correct: the seam has been proved to be about 20½ ft. thick at a point some 650 ft. from the location of the tests; and in an opencast mine at Kimihia, where the coal is of similar rank, a compressional velocity of 3,000 ft./sec. in the coal has been measured, so that the shear velocity would not be very different from that indicated above. The large rigidity ratio is also corroborated in a general way from the time of travel of the first arrival (Fig. 1,b and c), which implies a compressional velocity of about 9,000 ft./sec. in the rock. A similar velocity was found in the measures under the coal at Kimihia.

Internal Love waves are propagated in a stratum of low shear velocity. Such strata are not uncommon in the Earth's crust, and numerous observations of guided waves have been reported[2]; but detailed studies would clearly be aided if observations could be made inside the guiding stratum. From published observations it seems probable that the shear velocity is commonly less in coal than in the coal-measure rocks[3]. The application of seismic pulse techniques to mining problems, such as that of locating faults, has been hindered by the high rate of attenuation in coal. With dispersive waves, however, times of travel may be determined from relatively low-frequency energy, which suffers less attenuation even apart from the guiding process. The records of Fig. 1 were obtained without electronic amplification.

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## Electric Strength of Irradiated Polythene

The electric strength of irradiated polythene has been measured for material cross-linked by exposure to 4-MeV. electrons from a linear accelerator. Thin (1-mm.) moulded disks of material (average molecular weight, 17,000) recessed to a thickness of about 50 microns were irradiated *in vacuo* with doses of 150–300 Mrad , and the electric strength afterwards measured with direct voltage, using techniques described by Bird and Pelzer[1], and Ball[2]. Control results for normal material coincide with those of other investigations[1,3] to give curve *C* of Fig. 1; results for the irradiated material are shown by lines *A* and *B*. The changes in electric strength due to irradiation unexpectedly resemble those of Young's modulus for similar material measured by Charlesby and Hancock[4]. They are quite unlike those expected from the theory of intrinsic electric strength[5], which predicts for the cross-linked material a fall with temperature more marked than that of curve *C*, and beginning at a lower temperature.

One of us (C. G. G.) has shown that curve *C* above 60° C. and lines *A* and *B* above 80° C. correspond not to the intrinsic strength but to a previously unrecognized form of breakdown due to mechanical deformation. This produces a marked difference in the curves for normal and irradiated polythene because the modulus of elasticity for the former falls to zero at the melting point, whereas the irradiated material has a region of entropy-elasticity covering at least 100 deg.°C. above the normal melting point, in which the modulus rises slightly with temperature.

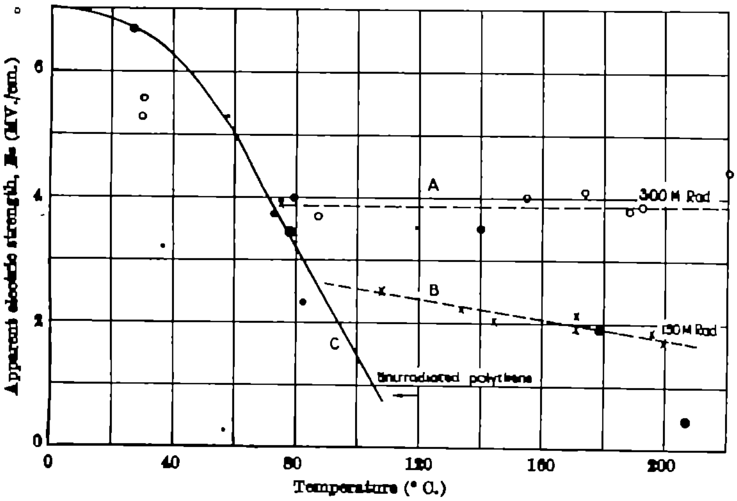

Fig. 1. Electric strength of polythene irradiated with 4-MeV. electrons; values calculated from the initial sample thickness

The mechanical pressure due to the electric breakdown stress is large, of the order of $E^2$ atmospheres ($E$ in MV./cm.). The thickness of the specimen, initially $t_0$, therefore decreases as the voltage ($V$) is raised, until either the intrinsic stress ($E_i$) is reached at a reduced thickness $t$, or until (as shown later) no stable thickness exists. Exact analysis for recessed specimens is impracticable; but the breakdown channel is so much smaller than the thin part of the recess that the case of a plane slab, laterally unconstrained, with electrodes free to follow the material, must be a rough approximation. The equilibrium thickness of the slab is given by:

$$\frac{\epsilon}{8\pi}\left(\frac{V}{t}\right)^2 = Y \log \frac{t_0}{t} \qquad (1)$$

where $Y$ is Young's modulus and $\epsilon$ is dielectric constant; units are C.G.S. and electrostatic. (The logarithmic form of the stress–strain relation is used because the strains are large.) Since $t^2 \log (t_0/t)$ has a maximum value when $t/t_0 = \exp -\frac{1}{2} \approx 0{\cdot}6$, no real value of $V$ can produce a stable value of $t/t_0$ less than 0·6. If the intrinsic strength has not been reached at this value, further increase of $V$ makes the thickness unstable, and it collapses, at a critical electric stress;

$$E_y = (4\pi Y/\epsilon)^{1/2} \text{ E.S.U.} \qquad (2)$$

The highest apparent electric strength which can be observed is therefore:

$$E_a = V/t_0 = (\exp -(\tfrac{1}{2})E_y) \qquad (3)$$

If $E_i$ is greater than $E_y$, the former is unobservable by the present technique; if $E_i$ is less than $E_y$, intrinsic breakdown occurs. $E_i$ can then be deduced from $E_a$ by means of equation (1) and lies in the range $E_a < E_i < (\exp \tfrac{1}{2})E_a$.

This analysis ignores several factors, such as possible earlier instability at microscopic areas of stress concentration, the dependence of $Y$ on time and stress, and plastic flow. These are difficult to calculate; but all tend to a lower value of $Y$. The analysis also applies only to materials sufficiently rubber-like to withstand severe distortion without fracture.

Since the compression involved is only 20 microns, in an object at high temperature and high potential, we have not yet attempted to observe it directly.

Values of $Y$ for irradiated polythene are given in Fig. 4 of ref. 4, one dose unit of this figure corresponding roughly with 100 Mrad. The values are only roughly correct for our specimens, since none of the experimental factors is exactly similar. For normal material, the values of ref. 4 and those of the makers differ by a factor of 4; we have taken the smaller (the makers') as nearer to our conditions of large strain. Breakdown values calculated from these data, using equation (3), are compared with observed values in Table 1, with as good agreement as could be expected from the data. The minimum calculated intrinsic strength for the 300 Mrad. material is 6·3 MV./cm. up to 220° C., and shows no evidence of fall with temperature.

Table 1

| Dose (Mrad.) | Temp. (° C.) | $Y \times 10^{-7}$ (dynes/cm.²) | $E_c$ (MV./cm.) | | $E_i$ (MV./cm.) Calc. from $E_c$ (obs.) |
|---|---|---|---|---|---|
| | | | Calc. | Obs. | |
| 150 | 150 | 2·5 | 2·2 | 2·1 | 3·5 |
| 300 | 150 | 5 | 3·1 | 3·8 | 6·8 |
| Nil | 60 | 18 | 5·8 | 5·0 | 5·9† |
| Nil | 80 | 9 | 4·1 | 3·2 | 5·3 |
| Nil | 100 | 5* | 3·1 | 1·5 | 2·5 |

* Uncertain due to plastic flow

† Value calculated from equat (1), intrinsic breakdown being reached before the critical stress of equat (2).

It may be remarked that tests with fixed electrodes would not eliminate the mechanical pressure, since at these high electric stresses field-emission readily occurs, and the charges which are subject to the electrostatic force are on the surfaces of the dielectric.

Further confirmation of the new mechanism has been obtained from existing data on poly*iso*butylene. The rapid change in electric strength[3] near − 40° C. is accurately predictable from the corresponding change in the modulus of elasticity[4].

For several other thermoplastics previously measured, $E_c$ (from equation (3)) should lie, for room temperatures, between 10 and 100 MV./cm., so that observed values of intrinsic strength between 5 and 10 MV./cm. are presumably genuine, but with no large margin between $E_i$ and $E_c$. It is possible that a material of high dielectric constant, and therefore subject to exceptionally high compressive stress, may fail by fracture even at low temperatures. All existing data on thermoplastics above room temperature must certainly be suspect.

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## An Electronic Computer for the Evaluation of Results of Filter-Paper Electrophoresis

WE have described previously[1] an electronic apparatus for scanning filter-paper electropherograms, whereby curves showing the distribution of separated components are caused to appear on the cathode-ray tube of an oscilloscope. It has been used so far mainly for the analysis of mixtures of proteins.

The purpose of the present communication is to report upon the further development of the apparatus by the incorporation of an electronic integrator, which permits the rapid and accurate evaluation of the area enclosed under the whole or any selected part of such a distribution curve. By this means the quantity of each of the components corresponding to the separate peaks on an electropherogram, expressed as a percentage of the total material, can be read directly from a meter.

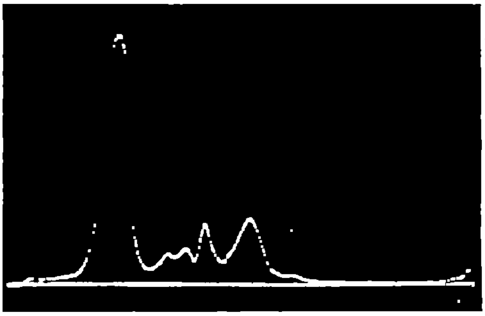
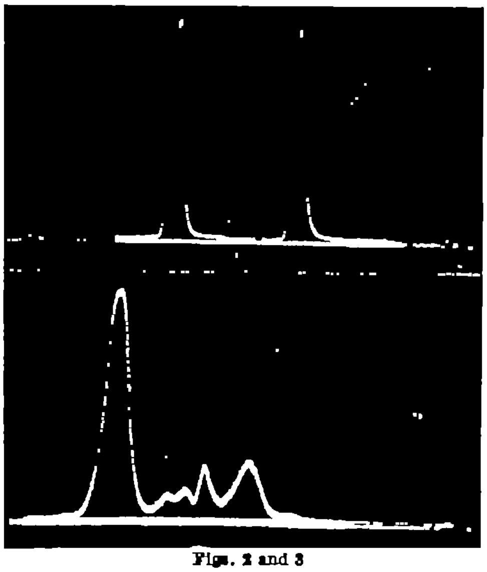


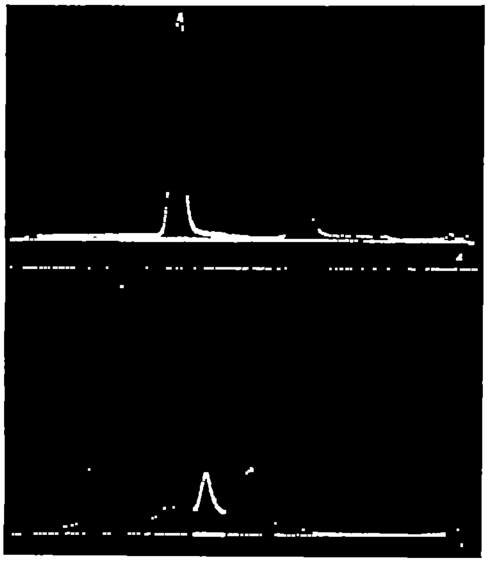
Fig. 1

The basic system includes a well-stabilized power supply, an optical system and a metal drum on which is fastened the filter paper (30 cm. × 4 cm.) with the stained serum proteins. The drum is rotated and the paper illuminated with a narrow beam of light (0·5 mm. × 38 mm.). The reflected light from the filter paper is collimated on to a photomultiplier (*RCA*-931*A*). The current generated by the photomultiplier is passed into a special synchronizing circuit in order to obtain a steady picture of the distribution curve on a cathode-ray tube. The latter is used only as a visual indicator during the operations involved in actual evaluation.

To this basic system has been added a correcting exponential amplifier (cf. Beer–Lambert law), the output of which is fed into an electronic integrator and also into the cathode-ray tube in order to produce the ordinate. Since the Beer–Lambert law has been found to apply, the height of the curve represents directly the dye concentration at any given point along the filter paper without any further corrections. A typical distribution curve (or ordinate) for a normal rabbit serum is represented in Fig. 1. The accompanying photographs illustrate briefly the principles of the computation.



Figs. 2 and 3



Figs. 4 and 5

On a filter-paper strip there were applied two bands each with 0·01 ml. of a 6·5 per cent solution of purified human albumin. The strip was then subjected to electrophoresis for a short time, and the protein was stained with amido-black 10*B*. The curve shown in Fig. 2 is the result of the scanning of this strip by the instrument. The straight base-line under the distribution curve is produced electronically. The level of this line corresponds to the lowest portions of the distribution curves, that is, to those regions of the filter-paper strip where no protein is present. With the aid of a controlling potentiometer, the lowest point of any curve produced can be adjusted to the base-line level. By means of a sensitivity adjustment, the area between the distribution curve and this base line, which in Figs. 2 and 3 is shown by thicker lines, is adjusted to a reading of 100 on the meter. The setting of the sensitivity control necessary to make this adjustment can, by suitable calibration, provide a measure of the total amount of dye bound to the protein, provided that a standard method of staining and decolorization is used.

Two phantastrons enable any portion of the curve to be selected for electronic integration. The reading on the linear scale of the meter then gives directly the percentage of the total stained material represented by this section of the curve. Fig. 4 demonstrates this procedure applied to the results shown in Fig. 2. The part of the curve selected appears as a thicker line. The reading of the meter will then give the percentage of the whole area which is under this part of the curve.

Fig. 5 similarly illustrates the evaluation of the beta globulin of the serum pattern shown in Figs. 1 and 3. These examples demonstrate that, with the aid of the instrument, the separated proteins on the filter-paper strip can be evaluated directly in percentages of the total protein without further treatment of the paper or mathematical operations on the data. About two minutes are necessary to perform a complete evaluation of one strip.

This project was supported by grants awarded by the Department of National Health and Welfare and the National Research Council. We thank the late Dr. D. T. Fraser, Dr. Frieda Fraser and Dr. M. H. Brown for their help and encouragement, and Dr. O. Smithies and Dr. C. S. Hanes for help in the preparation of this communication.

M. D. POULIK
L. PINTERIO
Department of Hygiene and Preventive Medicine,
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Toronto, Ontario. Sept. 9.

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[1] Pinterio, L., and Poulik, M. D., *Can. J. Pub. Health*, p. 163 (April 1954).

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## Detection of Labile Photochemical Free Radicals by Paramagnetic Resonance

PREVIOUS applications of the method of paramagnetic resonance to the detection of labile free radicals have been restricted to those stabilized by permanent trapping in polymers[1] or plastic films[2] at room temperature or those produced by γ-irradiation[3]. Measurements have now been made on radicals formed photochemically by ultra-violet irradiation of solutions frozen at liquid-oxygen or nitrogen temperatures. The radicals can be preserved for some hours at the low temperature, but their high reactivity is demonstrated by the rapid disappearance of the paramagnetic resonance signal on warming. The method of trapping free radicals by photolysis in rigid glasses at liquid-nitrogen temperature has been described by Norman and Porter[4], who used ultraviolet absorption spectroscopy to detect and identify the photochemical products. We have investigated several of the compounds used by Norman and Porter, and in addition we have demonstrated the production of free radicals in systems where they have not been previously observed.

The paramagnetic resonance apparatus was of standard crystal-video detection type operating at 3·2 cm. wave-length. The resonator, working in the $H_{011}$ mode, was specially designed so that the samples could be inserted along the central axis while still cooled to liquid-nitrogen temperature. The signals obtained were displayed on the screen of an oscilloscope. The solutions were frozen in small thin-walled silica tubes and irradiated at the temperature of liquid oxygen or nitrogen with light of wave-length 254 or 366 mμ. All solvents were spectroscopically pure and when irradiated under identical conditions produced no detectable paramagnetic resonance absorption. Using radiation of wave-length 254 mμ and liquid nitrogen, paramagnetic resonance absorption corresponding to free radicals was detected in the following substances: ethyl iodide, toluene, benzylamine, benzyl chloride and benzene in solution in P.HeH[4]; toluene in solution in E.P.A.[4]; hydrogen peroxide in water; oxalato complexes of the ferric, cobaltic and uranyl ions in ether–alcohol–water mixtures. Free radicals were also produced from the oxalato–ferric solutions at both liquid-oxygen and liquid-nitrogen temperature by irradiation with light of wave-length 366 mμ. The presence of air did not appear to affect the formation of free radicals.

Fig. 1*a* shows the absorption line obtained from a mixture of hydrogen peroxide and water. This had a *g* value of 2·01 ± 0·01 with a width of 20 gauss and an intensity corresponding to approximately $10^{16}$ free radicals. Although the vapour-phase photodecomposition of hydrogen peroxide leads to the production of hydroxyl radicals, no direct observation of its trapped photolysis products has previously

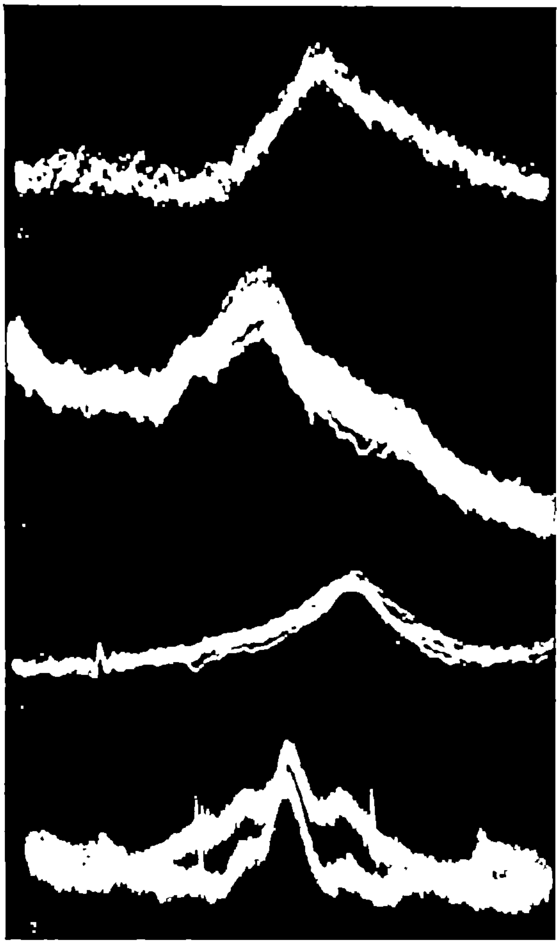

Fig. 1. Paramagnetic resonance absorption observed after ultra-violet irradiation at low temperature. (*a*) 40 per cent hydrogen peroxide in water. (*b*) Ethyl iodide in hydrocarbon mixture. (*c*) Oxalato-ferric chloride in ether-alcohol containing 8 per cent water (low homogeneity of field). (*d*) Oxalato-ferric chloride in ether-alcohol containing 10 per cent water (high homogeneity of field)

been made. The radicals were found to be quite stable at liquid-oxygen temperature but disappeared after storage for a few minutes at the temperature of solid carbon dioxide.

A typical signal obtained from irradiated ethyl iodide solution is shown in Fig. 1*b*. Neither iodine atoms nor ethyl radicals have previously been directly observed in this reaction, although the presence of iodine atoms has been inferred from the fact that the colour of the iodine molecule appears on warming irradiated glasses containing ethyl iodide[4]. The positive results obtained with toluene, benzylamine and benzyl chloride are also of particular interest in view of the spectroscopic evidence[4], which indicates that all three substances give rise to the same labile compound identified by Norman and Porter as the benzyl radical.

An oxalate radical has been postulated as the primary product in the photo-decomposition of ferric–oxalate solutions[5], and in view of the high and nearly constant quantum yield extending to 510 mμ[6], the possibility was investigated of producing and trapping the hypothetical radical by the use of comparatively low-energy radiation. Fig. 1*d* shows the signal obtained (with high homogeneity of field) from a solution of monoxalato-ferric chloride in ether-alcohol containing 10 per cent of water after irradiation in liquid oxygen with light of wave-length 366 mμ. A marked triplet structure is apparent which is attributed to proton interaction. On this basis the radical is tentatively identified as HCO$_2$ or HC$_2$O$_4$. Free-radical absorptions were observed in other oxalato-ferric solutions of varying composition, in all of which the monoxalato complex was the predominating species. Fig. 1*c* shows a typical absorption obtained with field homogeneity comparable with that used in the examination of the other compounds. A prominent feature of the irradiation of frozen ferric–oxalate solutions was the rapid formation of an orange-brown colour which disappeared on warming. The intensity of the colour was not directly related to the concentration of free radicals. It was produced in all the solvent mixtures investigated, including water only, and was particularly intense in solutions containing the trioxalato-ferric complex under conditions when no free radicals could be detected. The brown colour and its relation to the radical are the subject of a separate investigation.

Further work is planned using phase-sensitive detection and better field homogeneity, when the fine structure of the spectra should be more clearly resolved.

This communication is published by permission of the Admiralty.

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[1] Fraenkel, G. K., Hirshon, J. M., and Walling, C., *J. Amer. Chem. Soc.*, **76**, 3606 (1954). Bamford, C. H., Jenkins, A. B., Ingram, D. J. E., and Symons, M. C. R., *Nature*, **175**, 894 (1955).

[2] Bijl, D., and Rose-Innes, A. C., *Nature*, **175**, 82 (1955).

[3] Matheson, M. S., and Smaller, B., *J. Chem. Phys.*, **23**, 521 (1955).

[4] Norman, I., and Porter, G., *Proc. Roy. Soc.*, A, **230**, 399 (1955).

[5] Parker, C. A., *Trans. Farad. Soc.*, **50**, 1213 (1954).

[6] Parker, C. A., *Proc. Roy. Soc.*, A, **220**, 104 (1953), and unpublished work.

# Discrepancy between the Spectro-Isotopic and the Mass-Spectrometric Results for the Natural Abundance Ratio of the Lithium Isotopes

THE determination of the natural abundance ratio of the lithium isotopes lithium-6 and lithium-7 by spectroscopic measurement of the ratio of the line intensities of the isotopic components of the 6708 A. resonance line has given results not in agreement with the mass-spectrometric figure. A summary of the work in both fields up to 1951 has been given by Baldock and Patton[1]. In subsequent work on the spectro-isotopic assay, Stukenbroeker, Smith, Werner and McNally[2] calibrated the optical determination by samples analysed mass-spectrometrically and showed that the method could yield a $2\sigma$ precision of slightly more than 1 per cent using photographic recording.

A very thorough and careful investigation by Brody, Fred and Tomkins[3], in 1954, using both Fabry–Perot étalons and a 30-ft. Paschen–Runge spectrograph and employing direct recording, gave a result of 13·5 ± 0·2 for the natural abundance ratio. Full correction was for the first time made for self-absorption, but no mass-spectrometric results on the sample of lithium sulphate were quoted.

One of us (R. P. T.) has just completed a determination of the natural abundance ratio using Fabry–Perot étalons and photographic recording. The investigation differed only in detail from the American work of the previous year and yielded a similar result, namely, 13·5 ± 0·3. The lithium sulphate sample used had been examined by the mass spectrometer and a ratio of lithium-7 to lithium-6 of 12·2 ± 0·1 was found. No absolute calibration of the mass spectrometer has been yet carried out.

It was then realized that no correction had been made on the peak line intensities measured for the lines of the two isotopes.

According to White[4], the intensity at any point on the intensity frequency contour for the Doppler broadening of a spectral line is given by:

$$I(\nu) = \text{constant} \times \exp \frac{\mu}{2RT} \cdot \frac{c^2}{\nu_0^2} (\nu - \nu_0)^2$$

where $\mu$ is nuclear mass, $\nu_0$ is peak frequency, $c$ is velocity of light, $R$ is gas constant and $T$ is absolute temperature.

From this:

$$I(\nu) \text{ maximum} = \text{'constant'},$$

and the total integrated intensity:

$$\int I(\nu) d\nu = I(\nu) \text{ max. } \sqrt{\pi} \frac{\nu_0}{c} \sqrt{\frac{2RT}{\mu}}$$

$$= I(\nu) \text{ max. } 1 \cdot 772 \frac{\nu_0}{c} \sqrt{\frac{2RT}{\mu}}$$

For two isotopic lines, where the total emitted energy is equal and the two lines correspond to the same pair of initial and terminal term-levels, the values of $I_{\text{max}}$, that is, peak intensity, will be proportional to the square roots of the isotope masses; for example,

$$\frac{I_{\text{max}}\,{}^6\text{Li}}{I_{\text{max}}\,{}^7\text{Li}} = \sqrt{\frac{6}{7}}$$

The abundance ratio (${}^7$Li/${}^6$Li) based on the observed peak intensities of the isotope lines will therefore be $\sqrt{7}/\sqrt{6}$ of the true ratio, and a correction equal to the reciprocal of this, namely, $\sqrt{6}/\sqrt{7}$, should be applied to the observed abundance ratio.

When this correction was applied, the corrected natural abundance ratio was 12·5 ± 0·3, a result in very close agreement with the mass-spectrometric figure, and the mean of which lies within the range of 12·4–12·9 quoted by Cameron[5] for commercially prepared lithium salts.

It might now be said that the discrepancy between the spectroscopic and mass-spectroscopic determinations of the natural abundance ratio of the lithium isotopes has been reduced to the magnitude of the experimental errors of the two methods.

A search of the literature has shown that only in a very complete and precise investigation on boron by Mrozowski[6] has this Doppler correction been applied to the spectroscopic determination of natural abundance ratios.

Although a method has been worked out for the spectroscopic determination of the ratio of deuterium to hydrogen by Broida[7], conditions in the high-frequency discharge used are so complex that it is not possible to apply the large Doppler correction ($1/\sqrt{2}$); but it is of interest that the critical pressure at which the measured ratio equals the mass-spectrometric ratio varies as $\sqrt{D_2/H_2}$.

The isotope shift of the helium-3 and helium-4 isotopes has been measured by Fred *et al.*[8] but no line intensities are quoted.

This correction should apply significantly to the atomic line spectra of carbon ($\sqrt{12/13}$), oxygen ($\sqrt{8/9}$) and neon ($\sqrt{10/11}$), in addition to the elements quoted above.

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R. P. THORNE

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Aug. 8.

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[1] Baldock, R., and Patton, J. R., unclassified document *Y*-758 (1951).

[2] Stukenbroeker, G. L., Smith, D. D., Werner, C. K., and McNally, jun., J. R., *J. Amer. Chem. Soc.*, **42**, 383 (1952).

[3] Brody, J. K., Fred, M., and Tomkins, F. S., *Spectrochimica Acta*, **6**, 383 (1954).

[4] White, H. E., "Introduction to Atomic Spectra", 420 (McGraw-Hill, 1934).

[5] Cameron, A. E., "The Natural Abundance of Lithium Isotopes", unclassified document *K*-1168 (1954).

[6] Mrozowski, S., *Z. Phys.*, **112**, 223 (1939).

[7] Broida, H. P., and Morgan, G. H., unclassified document, *KAPL*-500 (1951).

[8] Fred, M., Tomkins, F. S., and Brody, J. K., *Phys. Rev.*, **76**, 1772 (1949).

## Radioactivity in Quartz Inclusions

THE method used by Ford and Ollier for recording the α-radioactivity of zircons[1] has served also to detect similar radioactivity in quartz inclusions.

The spherical cavities found in some specimens of quartz, of diameters ranging from 10 to 300 microns, are known to contain liquid and carbon dioxide gas[2]; but it is of interest to observe that some contain radioactive elements also.

A quartz microscope slide was covered with a film of Ilford *C2* photographic emulsion 50μ thick, and left for six months. After processing, certain cavities favourably placed with respect to the emulsion revealed tracks of α-particles. Into cavities in the surface, exposed during manufacture of the slide,

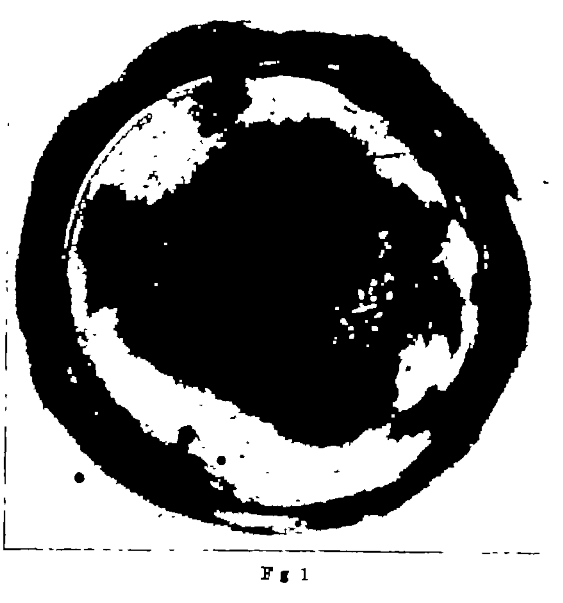

Fig. 1

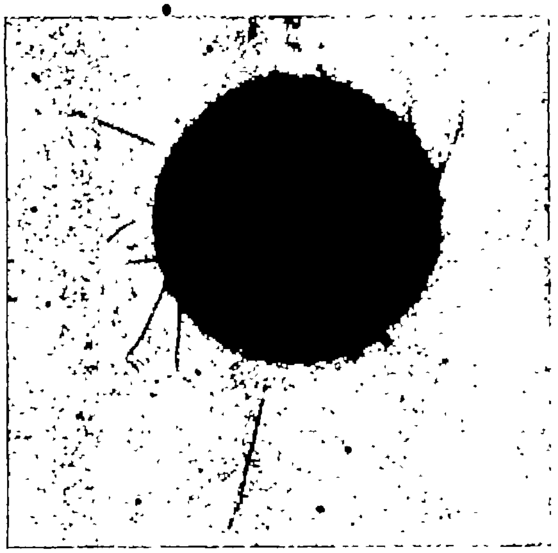

Fig. 2

emulsion had flowed (Fig. 1). Others, remaining intact just below the quartz surface, were near enough to the emulsion to send α-particles into it (Fig. 2). In one of the exposed cavities forty-two tracks of α-particles were counted. The longest, measuring more than 40μ, must have been emitted by a thorium C′ nucleus.

It is of interest to reflect that the interior of a quartz inclusion is apparently one of the rare places in the world where a whole radioactive series is in equilibrium.

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Physics Department,
University College of the Gold Coast,
Achimota, Gold Coast.
Nov. 10.

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[1] Ford and Ollier, *Nature*, 176, 1187 (1955)

[2] Dana, "Text-book of Mineralogy".

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## Definition of the Second of Time

SIR EDWARD BULLARD[1] solicits views on the desirability of abandoning the astronomical second for the most refined physical measurements, in view of the high precision[2] of atomic frequency standards. He suggests instead a 'physical second', to be defined in terms of the natural period of the cæsium atom, the advantage being that the physical second would be more immediately available than the astronomical second in cases where the highest precision is sought. The purpose of this communication is to direct attention to two consequences that should be well understood before the astronomical second is abandoned by physicists. I leave aside the question of desirability, on which views are certain to differ, because the change is desirable from some points of view and undesirable from others.

Many physicists have abandoned the metre as a standard of length and rely instead on the wavelength of a specified line of cadmium or mercury. For convenience, and in order to preserve the distinction between the two standards of length, it has been proposed (and for all I know may have been generally agreed) that the wave-length of the specified line stated in microns should be held fixed, the number of microns in a metre being subject to experimenta determination. To my mind, this convention is a admirable one.

In abandoning the astronomical second for th physical second, physicists would be proceeding in a entirely analogous way; and I think it would b advisable to abandon the word 'second', substitutin a new word that would stand for a unit of time havin an absolutely fixed relation to the natural frequenc of the cæsium atom, being very nearly a small aliquo part of a second, the exact relation being subjec to experimental determination.

The first of the consequences to which I wish t direct attention is that by using the atom at once a a standard of length and of frequency the units o length and of time lose their independence; wavelengths and frequencies have a fixed relation to each other, the product of the two being the velocity o light. Hence it is of the utmost importance that the new units should not be exclusively employed; atomic wave-lengths must be compared with the metre from time to time, and atomic frequencies must be compared with the astronomical second. To fail to do so would be unnecessarily to restrict the science of physics at its very foundations, by assuming what can only be verified by experiment. For this idea I am indebted to Prof. Jan Schilt, of Columbia University.

The second consequence arises from the fact that an atom, while it undoubtedly gives an excellent natural standard of frequency, is not a natural clock. It is probable that two cæsium standards built to the same specifications on opposite sides of the Atlantic would run at the same frequency; but if each were made to control the hands of a clock through a suitable mechanism, the two clocks would not indicate the same time (epoch). Even if they could be brought to the same time with enough precision to satisfy astronomers and geodesists —which is doubtful—if both should stop it would be impossible on starting them again to determine how much time had been lost. For actual timekeeping it will be necessary, as in the past, to rely on better mechanisms than man-made ones. The consequence, then, of adopting the new 'physical second' would be to use one second for measurements of frequency and another for actual timekeeping.

I remark, by the way, that Bullard is unnecessarily pessimistic about the reduction of the errors of astronomical observations by repetition; the systematic errors in star places and the differential refraction are not important limitations when periods of a year or more are considered. My own estimate is that with four dual-rate cameras observing the Moon, an accuracy of 1 in $10^9$ in time and frequency derived from astronomical observations can be attained in a year, and probably 1 in $10^{10}$ in five years. But Bullard's argument is not affected by these estimates.

It is to be hoped that before specifying the new unit of time, physicists will be willing to wait for the end of the International Geophysical Year, by which time a good number of observations of the Moon will have been made, and to compare atomic standards with astronomical ones assiduously in the meantime.

G. M. CLEMENCE

U.S. Naval Observatory,
Washington 25, D.C.
Sept. 21.

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[1] Bullard, E. C., *Nature*, 176, 282 (1955).

[2] Essen, L., and Parry, J. V. L., *Nature*, 176, 280 (1955).

## FORTHCOMING EVENTS

### Wednesday, December 28—Saturday, December 31

Science Masters' Association (at the Royal College of Science, Imperial Institute Road, South Kensington, London, S.W.7)—Annual Meeting.

### Wednesday, December 28

At 8 p.m. (in the Courtauld Hall, Queen Elizabeth College, Campden Hill Road, Kensington, London, W.8)—Sir Edward Salisbury, F.R.S.: "Science and Education" (Presidential Address).

### Friday, December 30

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. W. Marshall: "How Clocks and Watches Work" (Juvenile Lecture).

## APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (with a good honours degree or Associateship of the Royal Institute of Chemistry, and with research and/or industrial experience) in Chemistry, at the Technical College of Monmouthshire, Crumlin—The Director of Education, County Hall, Newport, Mon. (December 30).

Assistant Lecturer (male, single, with a university degree or diploma in horticulture and a sound knowledge of practical horticulture) in Horticulture—The Principal Agricultural Officer, Lancashire County Institute of Agriculture, Hutton, near Preston (December 31).

Scientific Officer (honours graduate, with qualifications and research training or experience in microbiology or biochemistry or both) for work on the nutrition of marine micro-organisms and plankton, with particular reference to the role of vitamin $B_{12}$—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (December 31).

Assistant Experimental Officer (with G.C.E. (advanced) or pass degree, or equivalent qualification) for laboratory and field work in plant pathological research on potato diseases—Officer in Charge, Agricultural Research Council, Potato Storage Investigation, c/o School of Agriculture, Sutton Bonington, Loughborough (January 1).

Electronics Technician (with experience in pulse techniques and in design, construction and general maintenance of equipment used in nuclear research) to take charge of the electronics laboratory, workshop and stores in the Research School of Physical Sciences, Australian National University, Canberra, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (January 6).

Assistant (with a degree in electrical engineering, and preferably with some research or industrial experience) in the Department of Engineering—The Secretary, The University, Edinburgh (January 15).

Chemists or Chemical Engineers (with a good honours degree in chemistry or chemical engineering) for research on the processing of liquid and gaseous by-products obtained during novel methods of coal carbonization—The National Coal Board, Coal Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting Ref. No. 83/138 (January 17).

Assistant Lecturer (graduate in physics, chemistry, metallurgy, biology or engineering) in Dental Materials—The Registrar, The University, Manchester 13 (January 18).

Lecturer or Senior Lecturer in the Department of Electronic Engineering, and a Lecturer in the Department of Electric Power Engineering—The Registrar, The University, Liverpool (January 21).

Scholar (with a good honours degree in physics) in the Geophysical and Meteorological Section of the School of Cosmic Physics—The Senior Clerk, Dublin Institute for Advanced Studies, 64 Merrion Square, Dublin (January 21)

Lecturer (with a first-class honours degree in mathematics, preferably with a special interest in some branch of applied mathematics or statistics) in Mathematics—The Registrar, College of Technology, Manchester 1 (January 23).

Coal Survey Officer, Principal Technical Officer or Senior Technical Officer grade (with a university degree in science, applied science or fuel technology, or equivalent qualifications, with experience in collection of samples and the complete analysis of coal), in the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, Delhi Road, North Ryde, New South Wales, Australia, to organize and supervise the collection, preparation, testing and chemical analyses of coal samples—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/152 (January 28).

Chair of Pathology—The Registrar, The University, Leeds 2 (January 31).

Lecturer (with an honours degree in engineering) in Mechanical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (January 31).

Lecturer (with qualifications in theoretical physics) in Physics—The Secretary, Queen's University, Belfast (January 31).

Physicists (2) (with at least a second-class honours degree in physics and preferably with some research experience) for work on the electrical and optical properties of non-metals—The Professor of Physics, The University, Reading (January 31).

Research Assistant (with a university degree in an engineering or physical science) in Chemical Engineering, and a Lecturer (preferably with a university degree in engineering or in a physical science) in Chemical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (January 31).

Reader in Experimental Physics at Royal Holloway College, Englefield Green, Surrey—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 7).

Lecturer or Assistant Lecturer (with special interests in physico-organic chemistry) in Chemistry—The Secretary, The University, Exeter (February 11).

Chair of Applied Physical Chemistry—The Faculty of Engineering, The University, Alexandria, Egypt (February 15).

Lecturer (with experience in the field of electronics or radio communications) in Electrical Engineering at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 28).

Imperial Chemical Industries Research Fellows in Biochemistry, Chemistry, Chemotherapy, Engineering, Metallurgy, Pharmacology, Physics, and subjects allied to chemistry and physics—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Assistant, Grade A (with B.Sc. or A.R.I.C.), at Coventry Technical College, to teach chemistry mainly for O.N.C. and Inter. B.Sc. courses—The Director of Education, New Council Offices, Coventry.

Assistant Experimental Officers (at least 20 years of age, and with H.S.C. in science subjects, or equivalent qualifications) in the Health Physics Division, to assist in the control of radiation hazards in a variety of laboratories and engineering operations involving a very wide range of radioactive materials—The Establishment Officer, U.K. Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 459.

Assistant Experimental Officers (with at least H.S.C. in science subjects or equivalent qualifications, and preferably with experience of industrial water treatment techniques) in the Engineering Services Division, to carry out the more precise analytical work needed for the chemical service to new water moderated reactors, and to supervise less qualified staff; and (*b*) to operate a chemical service for novel experiments connected with the development of new reactors—The Establishment Officer, United Kingdom Atomic Energy Authority, A.E.R.E., Harwell, Didcot, Berks, quoting Ref. No. 462.

Assistant Trials Officer (with a degree in botany or agriculture or equivalent qualification, with practical experience in crop production) to work at Seale-Hayne Agricultural College, Newton Abbot, Devon, and Leeds University Farm, Headley Hall, Yorks—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Mathematicians (2) (with an honours degree) for research concerned with practical numerical problems capable of solution on computers, and involving work on such problems on machines available to the Corporation—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W.1.

Physicists and Electrical Engineers, Scientific Officer or Experimental Officer grade, at a Ministry of Supply Armament Research and Development Establishment, near Sevenoaks, Kent, for (*a*) experimental design, development and operation of physical measuring apparatus, and (*b*) research and development work on weapon systems, in particular fuse techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.452/5A/MF.

Research Assistant (with a B.Sc. degree, preferably with honours in chemistry) to assist with a research project of an organic/biochemical nature—The Secretary, Biochemistry and Chemistry Department, Guy's Hospital Medical School, London Bridge, London, S.E.1.

Research Officer (with a university degree in forestry, or a university degree in botany and a diploma in forestry) in the Department of Forest Research, Federation of Nigeria, to carry out sylvicultural investigation, chiefly in the highest forest regions of the Federation, but with a possibility of work in the savannah regions also—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.61/14/06.

Technical Librarian (female, with previous experience in technical library work, a science degree or recognized qualification in librarianship, or both) for the Director of Research, 55 Broadway—The Recruitment and Training Officer (F/EV 557), London Transport Executive, 55 Broadway, London, S.W.1.

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# SECURITY REGULATIONS AND THE CIVIL SERVICE

AN outstanding feature of the Geneva Conference last August on the peaceful uses of nuclear energy was the extent to which it restored the old spirit of scientific co-operation. Dr. A. H. Snell, director of the Physics Division of the Oak Ridge National Laboratory, for example, in his "Geneva Diary" in the *American Scientist*, recorded the opinion that the inhibitions of secrecy are no longer a controlling factor but are vestigial, and have been replaced by mutual scientific respect and by a sense that everybody is working on the same big job. Prof. I. I. Rabi, in expressing his own satisfaction with the results of the Conference in re-establishing the world-wide community of scientists, quoted a speech made to Hungary over the Moscow radio by Prof. V. Veksler to much the same effect, and noting the incentive for the mutual exchange of views that the Conference has given.

The significance of this Conference in re-establishing the contact between scientists and the conditions for the exchange of ideas upon which scientific advance depends is thus widely appreciated by scientists in all countries. It would appear, however, from the Prime Minister's very cold and reserved statement in the House of Commons on November 22, that political circles have yet to appreciate the importance of such freer interchange of views and of knowledge, not only from the point of view of scientific and technical advance, but equally from the point of view of preventing waste and duplication of effort. There is, it is true, still much to be done in this respect, and scientists generally could use the success of the Conference to illustrate the importance of freedom of discussion and of exchange of information as providing an essential condition for unimpeded scientific advance and for the most effective use of man-power and materials.

That aspect has been kept well to the fore in much that has been written on the security issue in the past ten years. It is well put, for example, in a symposium of papers on "Internal Security and Civil Rights" published in the *Annals of the American Academy of Political and Social Science* last July, particularly in those of Dr. R. M. Hutchins on the meaning and significance of academic freedom and of Prof. M. S. Livingston on science and security. With Dr. H. Tayler's account of the dismissal of professors who, invoking the Fifth Amendment, refuse to answer political inquiries in public, they help British readers to a clearer understanding of some puzzling incidents in the United States, as well as setting the whole question of science and academic freedom and security in its proper perspective.

This symposium is particularly welcome at a moment when the debates in Parliament on the disappearance of the former Foreign Office officials, Burgess and Maclean, and the subsequent appointment, announced by the Prime Minister on November 23, of a Conference of Privy Councillors to consider security precautions, brought security measures and secrecy again to the front in Great Britain. If, for example, there is to be any relaxation of secrecy in the field of nuclear energy, there must not only be public understanding of the value and importance of such relaxation, but equally public confidence that the precautions against disregard of what secrecy or security measures are retained are adequate and effective. The Conference, which includes the Lord President of the Council and six other members, is to examine the security procedures now applied in the public services of Britain and to consider whether any further precautions are called for and should be taken.

Much of the investigation of this Conference must obviously remain secret, though the Prime Minister said that any recommendations involving changes in the law would be referred to the House of Commons. It was the more unfortunate, accordingly, that neither in the debate in the House of Commons on November 7, nor in that in the House of Lords on November 22, were the wider issues really discussed. While the debates did something to remove public misgivings about the British security system, they were over-occupied with personal and transient aspects of the unhappy episode. The Foreign Secretary, Mr. Harold Macmillan, indeed stated that a regular system of positive vetting has been introduced in all Government departments having access to classified material involving the security of the State, and that in the Foreign Office the practice goes far beyond the recommendation of the committee appointed by the Foreign Secretary, immediately after the disappearance of Maclean and Burgess, to look into all aspects of the security arrangements in the Foreign Office. Not only all members of the senior branches and the senior grades of the junior branches of the Foreign Service are covered, but also many more junior grades who are inevitably employed on highly classified work. The committee, moreover, considered that character as well as political reliability should be assessed, and fresh instructions to that effect had been issued by the Permanent Under-Secretary of the Foreign Office to heads of missions and other senior officials before the committee reported.

Mr. Macmillan was emphatic that there could be no doubt of the skill, perseverance and loyalty of the Security Service, and that we had been able to recruit men of remarkably high character and attainments. He doubted whether any substantial further improvements in our security arrangements could be made within our existing system of law; but recognized that this and other incidents in the world of science have had a serious effect upon our reputation abroad. He said it is of the greatest importance that confidence should be felt that successive Governments have taken all steps within their power to stop any loopholes and to strengthen any legitimate methods of defending the vital secrets of the country.

Mr. Macmillan, in concluding, pointed out the real difficulty in this new situation that confronts us, of reconciling security with the maintenance of a free society in the face of enemies who recognize no restraints. In the effort to preserve tolerance in the face of intolerance, it is all too easy to destroy freedom. As the Prime Minister said, it is probably true that if the Security Service had the powers which are possessed by such services in other countries, Burgess and Maclean would not be where they are to-day. Sir Anthony Eden added that he is not prepared to be Prime Minister of a Government which would ask for such powers of the House. Mr. Alfred Robens, who had reminded the House specifically that the attitude of our allies, and particularly of the United States, to the exchange of atomic secrets is conditioned by the degree of their confidence in our security arrangements and our ability to ensure that secrets entrusted to us will not pass to a foreign Power because of the laxity or inefficiency of our Security Services, agreed that we want security without McCarthyism. None the less, neither the Prime Minister nor the Foreign Secretary really faced the issue over passports, and any legal uncertainty should have made action easier rather than otherwise.

It is on this point that doubts have arisen as to the vigilance of the Foreign Office, on which some rather extreme and ill-judged criticism has been founded. It has been argued that issue of a passport is a privilege, not a right, and that a privilege can be withdrawn at the discretion of the Government. In particular, it has been suggested that those occupying posts involving access to highly secret information should be required to surrender their passports, which would only be available to them on notification of their intention to proceed overseas. During wartime, some procedure of this kind could well be formulated which would not restrict freedom of movement but merely ensure that those engaged in certain categories of work gave prior notification to a responsible officer of their intention to go abroad; but clear thinking on this matter is essential. The general issue is well put by J. A. Fanelli in an article, "Passport—Right or Privilege", contributed to the symposium already mentioned. Mr. Fanelli would make passports a right for every citizen—not sought by legal process; but while he condemns the present practice in the United States, which has been the subject of weighty protests so far as scientists are concerned, he would not object presumably to such a process as that just suggested. Incidentally, in Great Britain, as was pointed out by the Minister of State for Foreign Affairs on November 1, in theory, the Foreign Secretary has the power to withhold or withdraw a passport at his discretion.

The issue is one on which scientists themselves should be thinking constructively. Stray references in the debate in Parliament showed that members were thinking of scientists in relation to security, and that it was recognized as important to take the same care in vetting for employment in secret research work in industry as for employment in the Government service. Such requirements have to be reconciled, moreover, with the maintenance of the conditions under which a scientist, and especially the research worker, can give of his best, and secure stimulating contact with other minds. What matters above all at the moment in regard to this issue of security and secrecy in relation to science is that the right questions should be asked—the questions which scientific advance no less than the national security suggest.

Those questions are well indicated both by Dr. Hutchins and by Prof. Livingston, and their papers are not the less relevant in the discussion of British security measures in that those measures have avoided the grosser errors of which they, and other contributors to the symposium, complain. It is difficult for the non-scientist to keep clearly in mind in this context the way in which progress and leadership in science and national security alike depend on the number and quality of trained minds we can command, or to appreciate that because our intellectual potential provides the greatest security as well as our major resource, to secure the conditions which foster imaginative thinking is as important an element in defence policy as in research policy. Further, to carry restrictive conditions to a point beyond the indispensable minimum not merely hinders such thinking but may also endanger security by discouraging the recruitment of the very type of mind most required.

That we need reliable people in positions of responsibility and especially in secret investigations is obvious; but much keener thinking about the purposes of a security system and the way it functions is desirable than was manifest in either debate in Parliament. Moreover, the references to recruitment never touched on the real issue—the effect of security procedures on the recruitment of men and women of the character and ability most desirable in the service of the State. If we fail to put the proper emphasis on competence, and if independent thought and criticism are at a discount, we may get government servants who are loyal, but we may not get with that loyalty either the enterprise or the competence and vision that to-day are supremely important for the maintenance of national security.

Nor does the report of the Royal Commission on the Civil Service* really discuss this factor. The Commission was, indeed, limited by its terms of reference to the consideration of the principles which should govern pay, but including such matters as hours of work, payment for extra duty, annual leave, etc. It recognizes clearly that these conditions did not permit it to explore or comment upon ways in which recruitment might be improved and the Service made more attractive to possible recruits. None the less, the Commission points out that career prospects bear closely on the recruitment of suitable staff, and it is remarked that a review of recruitment procedures might indicate possibilities of improving the present situation. In the face of the competition, on which some comment was made in evidence to the Commission, it is obvious that the time a candidate sometimes has to wait before he is offered a post loses the Service many desirable candidates, and it may well be that this is one factor contributing to the acute recruitment difficulty of which the Atomic Energy Authority also complained in its first annual report.

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* Report of the Royal Commission on the Civil Service, 1953–55. Pp. viii+238 (Cmd. 9613.) (London: H.M. Stationery Office, 1955.) 6s. 6d. net.

Apart from its bearing on this question of recruitment generally and the effect on the quality of the candidates who present themselves, the report of the Royal Commission on the Civil Service makes little direct contribution to this security issue. The primary principle laid down by the Commission, that Civil Service pay should be based on a "fair comparison with the current remuneration of outside staffs employed on broadly similar work, taking account of differences in other conditions of service", is the only sensible principle. The public service, by its nature, cannot provide its own criteria of what is reasonable remuneration; and the standing advisory committee of distinguished men chosen to reflect a cross-section of informed opinion in the country, recommended by the Commission to advise the Government on the remuneration of the higher Civil Service, should help to avoid the danger of setting standards from within —a practice which the Commission rejects for the scientific class, in spite of the arguments of the Institution of Professional Civil Servants.

The evidence as to the effect of conditions in the Civil Service on recruitment is not altogether clear. The members concerned in the administrative class are too small to be assessed significantly in such a sample inquiry as that recently conducted by Political and Economic Planning, which suggested that the Civil Service is still obtaining, and holding, a reasonable proportion of university graduates, though possibly a lesser proportion of the first-class men than enter the Scientific Civil Service. The Civil Service Commissioners themselves, while considering that the quality of the successful candidates continues in general to be satisfactory, doubted whether the number of really outstanding candidates is quite sufficient for future needs, and would welcome another three or four such candidates a year. This view was generally endorsed by the departmental witnesses; and in the view of the Association of First Division Civil Servants, not enough of the ablest people from the universities are now entering the Service.

The opinion was expressed in evidence that the Civil Service does not require more than about twelve outstanding men a year. These should easily be obtained from the universities if reasonable conditions are offered; but it should also be remembered that, particularly as regards the scientific officer class, it is not in the country's interest that the Civil Service should attract more than a reasonable proportion of the scientific and technical talent of the nation. This was clearly recognized by the Commission, which stressed the importance of preserving as much flexibility as possible for complements in this field. Moreover, it emphasized the importance of adequate opportunities for such staff to transfer to administrative posts, both from the point of view of career, and as a means of ensuring that those responsible for policy are fully competent to appreciate the technical issues involved in its formulation.

That in itself has some bearing on the security issue, if secrecy procedures are to be formulated on a realistic basis, and will also be of increasing importance if the Civil Service is not to lag behind outside employment in the attractiveness of the scientific or professional career it can offer. It is also a prime safeguard in ensuring that there is a reasonable balance in the interchange between the Service and industry, over which the Ministry of Supply in particular is disturbed. Some such interchange is desirable, but the Ministry of Supply thought that superior financial inducements outside had led to excessive loss of senior men. The Commission was, however, strongly impressed by the view of the Barlow Committee that the best scientific men should have equal prospects of pay and promotion with the best men in the administrative class, at least up to the top of the principal grade. The chairman of the Interdepartmental Scientific Panel thought that the present position whereby the average man reached the grade of principal scientific officer by age thirty-six and the really first-class man at thirty to thirty-two was about right, but that the present proportion of posts above that grade was inadequate. He also suggested that while the special-merit promotion scheme was an outstanding success, and catered sufficiently for the exceptionally able research worker whose bent did not lie towards administration, more flexibility was desirable to enable the Service to retain people with administrative initiative and ability.

The Secretary of the Department of Scientific and Industrial Research also expressed the view that the disparity in career values between the administrative and scientific officer class should be reduced, and that some posts now in the deputy chief scientific officer grade would justify chief scientific officer grading. The Commission suggests alternative salaries rather than one figure for the chief scientific officer class, and sees no objection to increasing the number of posts in the scientific officer class with the same salary as the permanent secretary. It believes, however, that the position in the Service at the present time reflects that in outside employment generally, in that the comparatively small number of outstanding scientists are enabled to advance rapidly, while most men of average quality do not get much beyond a level of responsibility corresponding roughly to that of principal scientific officer.

This view finds some support in the recruitment position for, while the number of suitable candidates was below demand, the real vacancies were fewer in 1954 than in 1952 or 1953, varying according to subjects. There were more than sufficient applications from organic chemists and from biologists, but there was a nation-wide shortage of physicists and engineers. The Civil Service Commissioners believe that while the ablest scientists still make their career at the universities, of those just below the highest quality the Government recruits at least a fair share, that the standard of applicants is improving, and that in the next five years the Departments will obtain suitable men for a high proportion of their demands. Such recruitment difficulties as existed are ascribed to the national situation rather than to service conditions.

These views were generally endorsed by witnesses from the main departments employing scientific staff, and in this context the acute difficulty of which the Atomic Energy Authority complained in its first annual report may be a passing phase. The Authority, in fact, has rather more flexibility in regard to salaries than the Civil Service, and it is inconceivable that it is offering less attractive conditions in regard to equipment and the like than other Government establishments. These conditions, in fact, frequently give the Government service a considerable advantage with the research worker over other bodies or industrial firms, particularly if there is any substance in the view frequently expressed that an industrial career does not give the same prestige as an academic career with outstanding research work.

One possible explanation may be the severe screening to which many of the Atomic Energy Authority's staff are subjected. This inevitably reduces the number of eligible candidates, and apart from deterring some who would be eligible, the delay involved may lead to others taking employment elsewhere. The point is worth considering, for it is not only in work on nuclear energy that it is desirable to keep secrecy requirements and screening investigations to the indispensable minimum. The Conference of Privy Counsellors is charged with seeing that security measures in Britain are adequately conceived and effectively operated. It is no less important to see that they are wisely applied, and that they are not allowed to obstruct the nation's economy by being used where no real purpose is served. The restoration of confidence in the security measures operating in Great Britain and abroad is not simply a matter of seeing that they are adequate and are efficiently operated. It is no less a matter of seeing that they are limited to their proper field, and that the lines between military and non-military work on nuclear energy, for example, are drawn as clearly as possible. The philosophy which inspires the whole security system should be one which keeps secrecy in its proper place, and makes it the servant and not the master of policy, placing its reliance not on negatives but on the positive contributions which imaginative, alert and creative thinking make to our economy as well as to our system of defence. The remuneration offered in the Civil Service is still one factor which determines the power to attract recruits of the character as well as of the intellectual ability which that Service demands.

# THE PHILOSOPHY OF NATURAL PRODUCT CHEMISTRY

**The Structural Relations of Natural Products**

Being the First Weizmann Memorial Lectures, December, 1953. By Sir Robert Robinson. Pp. xii+150. (Oxford: Clarendon Press; London: Oxford University Press, 1955.) 25s. net.

THIS is a remarkable little book. Its distinction is twofold. First, it is, so far as I am aware, the first book that has been written by Sir Robert Robinson. Secondly, it represents the first series of Weizmann Memorial Lectures delivered at the Weizmann Institute, Rehovoth, in memory of Israel's late President.

Dr. Chaim Weizmann was widely respected for his scientific work, not only in Israel but also in all countries of the world where the science of organic chemistry is seriously pursued. An introduction to the volume under review by Dr. E. Katchalski, the present director of the Weizmann Institute, indicates something of the character of the man who is to be honoured in perpetuity and gives a glimpse of the respected place that science occupies in the new State of Israel. It need only be said that the first Weizmann Lectures are a worthy token of respect by one great man for another.

The main purpose of the book is to show how the constitutions of natural products can be broken down into smaller units. Once these smaller units have been recognized, they may be reassembled in different ways in order to provide structural formulæ which may, or may not, represent real natural products. The fundamental concept carries with it the implication that there is a relationship between the assembly of the hypothetical structural units and the real, but still largely unknown, processes of biosynthesis. It is somewhat paradoxical that the more complex the natural product the more easy it is, in general, to discern the structural units from which it is composed. It is largely for this reason that 'biogenetic concepts' have now become an important ancillary to more orthodox methods of elucidation of the constitutions of organic molecules.

The first lecture deals with the building up of fatty acids from $C_2$ residues, the modification of this scheme to include isoprene residues and the derived terpenoids and steroids, the development of carbohydrates and their congeners, the introduction of the $C_6$—$C_3$, the $C_6$—$C_3$—$C_6$ and the $C_6$—$C_3$—$C_3$—$C_6$ structural groups and some miscellaneous topics including mould products. The breadth of the field covered is such that no group of substances can be treated in any detail. Nevertheless, the integrating power of the method is so great, and Sir Robert's exposition so able, that the essential points are clearly presented. Any reader who is interested in, say, triterpenoid biogenesis will find the references that he needs to follow the full development of his speciality.

The application of 'biogenetic concepts' probably receives its finest expression in the field of alkaloid chemistry. It is in this branch of knowledge that Sir Robert's classical paper of 1917, describing the synthesis of tropinone, adumbrated clearly all subsequent developments. The second and third lectures present the various groups of alkaloids in order of increasing complexity. Again, it is the more complex compounds which tell us most about biogenetic pathways. For example, once the concept of the fission of the aromatic ring of 3 : 4-dihydroxyphenylalanine (or its equivalent) had been developed by Woodward to explain the biogenesis of strychnine, it was possible to correlate theoretically the strychnine and quinine groups of alkaloids. Furthermore, Sir Robert was even able to deduce the correct constitution for emetine. The achievements of the theory in alkaloid chemistry are indeed impressive.

The use of 'biogenesis' in the elucidation of the constitutions of organic molecules has had its critics, especially from the biological side. Nevertheless, it would seem philosophically improbable that such remarkable order as is presented in the book under review should not have a real basis in Nature. No one pretends that the units written down by the organic chemist, or even used by him in syntheses under 'physiological conditions', are really present in the plant. All that is claimed is that the *equivalents* of these units are available. We are just now beginning to see the fruits of tracer experiments, which should do much to place 'biogenetic concepts' on an even firmer theoretical basis. There is no clash here between the organic chemist and his more biologically minded colleagues. Provided that constitutional arguments by 'biogenesis' are used as a stimulus to critical experimental work—not as a substitute therefor—the method has much to commend it.

This book can be thoroughly recommended to all mature organic chemists and others interested in the subject. It is a little unfortunate that a work which deserves to be read so widely should be so comparatively expensive. D. H. R. BARTON

## CLASSICAL ELECTROMAGNETISM

### Electromagnetic Theory

By Prof. V. C. A. Ferraro. Pp. viii+555. (London: The Athlone Press (University of London), 1954. Distributed by Constable and Co., Ltd.) 42s. net.

PROF. V. C. A. FERRARO'S book "has been written to meet the requirements of students reading for an Honours degree course in Mathematics . . . it should also be of use to physicists and electrical engineers". Four-fifths of the book is devoted to the steady state (including steady currents and their magnetic fields); this part contains chapters devoted to special topics such as systems of conductors, images and inversion, steady-current networks and boundary-value problems in potential theory. After the introduction of electromagnetic induction and the development of Maxwell's equations comes a chapter on alternating-current theory and two chapters on electromagnetic waves. The book closes with a chapter on the motion of charged particles in steady electric and magnetic fields. There are an extensive collection of examples at the end of each chapter and a number of worked examples in the text.

The balance of emphasis between static and varying fields, and the necessarily brief account given of the applications of the theory, suggest that the book should be appraised primarily as an exposition of the fundamental principles of electromagnetic theory. For this exposition the author adopts the traditional method, proceeding from the electromagnetic field in free space to the properties of dielectrics considered as regions of distributed polarization, and then to the magnetic fields of permanent magnets and magnetic materials. The theory of the magnetic fields of steady currents is developed from the properties of the circulation integral, and the connexion between electromagnetic induction and the conservation of energy is explained.

This approach to electromagnetic theory undoubtedly has many advantages. It enables the student to obtain a firm grasp of the physical significance of the electric and magnetic field-strength and induction vectors by studying their simplest manifestations; and this familiarity with the basic concepts facilitates the understanding of their rather complicated interconnexions in Maxwell's equations. On the whole, the author has exploited well the advantages of his choice of method, and the result is a readable and lucid text-book of classical electromagnetic theory. The book is open to criticism, however, on important points of detail. For example: the introduction of the displacement current is based on an apparently arbitrary preference by Maxwell for closed currents; the treatment of the energy density of the magnetic field, on which the deduction of the law of electromagnetic induction depends, proceeds by unjustified generalization, from a formula developed for permanent magnets in free space, to systems containing permeable media and electric currents; the proof of an important formula for the energy of a distributed current system is based on the statement, which is several times repeated in other contexts, that the stream lines in a solenoidal field are closed curves; and even in a theoretical text-book one does not expect to find such statements as that "molecules become electric dipoles only through the action of the inducing electric field", and that in iron the intensity of magnetization is directly proportional to the magnetic field. E. WILD

## BRITISH MOSSES AND LIVERWORTS

### British Mosses and Liverworts

An Introductory Work, with Full Descriptions and Figures of over 200 Species, and Keys for the Identification of all except the Very Rare Species. Written and Illustrated by Dr. E. Vernon Watson. Pp. xvi+419+18 plates. (Cambridge: At the University Press, 1955.) 45s. net.

THE need for a simple flora dealing with the British bryophytes has been felt for a long time. It is true that the identification of the British species is well provided for by the handbooks of Dixon and MacVicar; but the comprehensive detailed treatment which makes these works so valuable is apt to be confusing and even somewhat forbidding to the beginner. Dr. E. Vernon Watson has now produced a clear and attractive introductory flora, which should be a great asset to anyone commencing the study of British mosses and liverworts. It has naturally not been possible to include all the British species in this shortened account; but, by omitting the rarities, identification of the commoner species has been greatly facilitated.

The principal morphological features of mosses and liverworts are simply and clearly described in the introduction and glossary, which should enable the book to be used successfully even by those with little previous knowledge of the bryophytes. Although full descriptions and drawings are given for only 154 species of mosses and 55 species of liverworts, the keys and notes provide in all for the identification of 310 mosses and 136 liverworts. Several practical trials have shown that the keys are easy to follow and are based on readily determined characters. A few numbers have evidently been omitted accidentally from the key on p. 59, but any such errors should give little difficulty and are not easy to avoid in the first edition of a book of this type. The detachable field-key is an innovation of doubtful value. Since only the commonest species are included, its use is sure to lead to disappointment on many occasions.

In a number of respects the book is an improvement on previous bryophyte floras. The drawings of the species selected for detailed treatment are particularly valuable; and include habit drawings as well as figures of details important for identification. The descriptions are straightforward but sufficiently full, and are accompanied by useful ecological notes. Habitat lists at the end of the book indicate the range of species most likely to be encountered in twenty-five different habitats, and should be of great value to those beginning field-studies of the bryophytes. Mention should also be made of the fine photographs, which illustrate the attractive appearance of some of the common mosses and liverworts.

It may be said in conclusion that Dr. Watson has succeeded admirably in his aim of providing a sound introductory flora of the British bryophytes. The British student is now well provided with floristic works; but there is still a great need for an introductory work dealing with the more general aspects of bryology. Anyone acquainted with the classical works of Hofmeister, Leitgeb, Goebel and others, and with the many recent contributions to the morphology, physiology, cytology, genetics and general biology of the bryophytes, will realize that taxonomic studies are only one approach to the many aspects of bryological science. A. Allsopp

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## BLACK FLIES OF GUATEMALA

### The Black Flies (Diptera, Simuliidae) of Guatemala and their Role as Vectors of Onchocerciasis

By Herbert T. Dalmat. (Smithsonian Miscellaneous Collections, Vol. 125, No. 1, Pub. 4173.) Pp. 425 + 44 pl. (Washington, D.C.: Smithsonian Institution, 1955.)

In the New World onchocerciasis is endemic in certain areas in Guatemala, Mexico, elsewhere in Central America, and in Venezuela. In communities within these areas in Guatemala, the degree of infection may vary from 5 to 100 per cent, with an average of about 35 per cent. About half those infected suffer from ocular symptoms, and about 5 per cent suffer the most serious *sequela*, namely, blindness. It has been estimated that some thirty-five thousand persons in Mexico and some twenty-five thousand in Guatemala are infected. As in Africa, the infecting worms are transmitted from man to man by species of Simuliidae. Nuisance caused by the biting flies can also bring to a halt field-operations, particularly the harvesting of coffee, which is the most important crop in the endemic areas of Guatemala. Prior to 1934 only three species of Simuliidae were known from Guatemala; that year Bequaert[1] added three more. To anyone acquainted with the Simuliidae and able to read maps, this was obviously a quite unrealistic picture of the Simuliid fauna in a country like Guatemala. This book by H. T. Dalmat presents the results of nearly six years (1947–53) of intensive work on the Simuliidae in Guatemala, done with the support of various agencies and the Ministry of Health there. Forty-one species are dealt with and, of these, thirteen are ones that Dalmat has described as new in the course of his studies in Guatemala in earlier papers.

The various species are described in detail: both sexes, the pupa with its cocoon, and the mature larva when, as in most cases, diligent field-work or controlled rearing has provided them. No new species are described; but there are descriptions of sexes and stages not previously known. Keys for identification of the species in all stages are provided, and there are excellent series of figures of genitalia, etc., all drawn in the same style from uniformly prepared parts. Uniformity of style and preparation is important because parts such as the male claspers can give very different impressions of their characteristics if snipped off the abdomen at slightly different angles. The keys are restricted to the species known from Guatemala, and one therefore wonders if there is much real value in giving a key to the sub-genera of *Simulium*. All that this key does is to pick out three species which are the only representatives of their different sub-genera in Guatemala and then lead on to other keys to the remaining species of the other four sub-genera represented in the Guatemalan fauna. Only the more important and more recent references for each species are given, and the reader is referred to Vargas's[2] catalogue of "New World Simuliidae" for the complete literature up to the date of that catalogue (1945). The status of genera and sub-genera is not discussed.

Valuable and important as these systematic descriptions are, the parts of the book that will interest Old World readers most are probably those dealing with epidemiology (pp. 6–57) and ecology (pp. 313–372). Anyone proposing to carry out a survey of Simuliidae would do well to study Dalmat's approach and methods. The various tables, graphs, etc., obviously represent but a creaming of a vast amount of data collected.

In certain regions the rainy season is inimical to Simuliidae because the exceptional amounts of water scour large numbers of larvæ and pupæ from their substrates and wash them down-stream to conditions under which, even if they could gain a foothold, they would not survive. The coffee crop is usually concentrated in small patches cleared in the forest. At harvest large numbers of workers go to these coffee fields, and men especially will expose the upper parts of the body and roll up their trouser legs when picking the berries. Furthermore, while picking berries, the workers stand relatively still in one place and so present excellent targets for the flies. If the harvest coincides with a good emergence of adult Simuliidae, then conditions are ideal for spreading the infection of onchocerciasis, for the adult flies will travel considerable distances to obtain a blood-meal.

Only three species of *Simulium* appear to be of importance as vectors of onchocerciasis in Guatemala: *ochraceum* Walker, *metallicum* Bellardi and *callidum* Dyar and Shannon. These three are markedly anthropophilic in habit compared with the remaining species. Itinerant peddlers are a feature of Guatemalan village life, and they may possibly be a source of infection. The exact factors that control endemicity are not yet apparent: the principal vector seems to be *S. ochraceum* Walker; but the areas of endemicity do not extend to the margins of the distribution of this species.

The Smithsonian Institution is to be congratulated on the general format and production of this book, in which it has been assisted financially by the Pan-American Sanitary Bureau. John Smart

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[1] Bequaert, J. C., in Strong, R. P., Sandground, J. D., Bequaert, J. C. and Ochoa, M. M., "Onchocerciasis, with special Reference to the Central American Form of the Disease" (Dept. Trop. Med. and Inst. Trop. Biol. Med., Harvard Univ., Contr. No. 6, 234; 1934).

[2] Vargas, L., *Inst. Salubr. Enferm. Trop., Mexico*, No. 1 (1945).

# COMBUSTION IN THEORY AND PRACTICE

By T. F. HURLEY, O.B.E.

Chief Research Engineer, Fuel Research Station, Department of Scientific and Industrial Research

A CONFERENCE on the subject of combustion was held in June of this year in the United States at Boston under the auspices of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers and repeated in London in October. At each meeting the same forty papers were presented and discussed, seventeen being of British or European origin and twenty-three American.

The main idea of the conference was first to link theory and practice in the sphere of combustion by presenting the results of theoretical work to practical engineers, and secondly to provide an opportunity for practical engineers to discuss the application of theory in the field of boilers, furnaces, internal combustion engines and gas turbines. On the whole, this theme was followed and was not lost to view in the mass of useful information of a practical nature which was also presented in the papers and discussed in both Boston and London.

For convenience of discussion, the conference was divided into six sessions, the first of which dealt with the chemistry and physics of combustion from the fundamental aspect and included an American paper on the appraisal of combustion research. This paper reviewed the history of the development of the art of combustion in a comprehensive manner, and the authors' reflexions in relation to the theme of the conference obviously had a marked influence upon the views which were expressed during the discussion.

The second, third, fourth and fifth sessions were concerned with papers on boilers, industrial furnaces, internal combustion engines and gas turbines, respectively. They were mainly, though not entirely, of a practical nature and dealt with such subjects as fuels of all types, the design of equipment, operating difficulties and experiences, and instrumentation.

The sixth and final session was used to summarize the previous five and was the only one in which the conference was divided into sections for the simultaneous discussion of different groups of papers. The fundamental papers were discussed in London, but not in Boston.

It was suggested in the general papers and generally agreed in the discussion that, in the field of combustion, basic theory and practice are far apart: the practical engineer has developed his full-scale equipment and methods empirically, as a result of experience rather than by the application of scientific data. When in difficulties he may call in the chemist or the physicist to explain new phenomena which he has encountered; but the function of the scientist should be to predict as well as to explain.

Various explanations were put forward: one being that through over-specialization the engineer and the scientist not only see the same thing from different angles but also speak different languages. The engineer should therefore learn to state his problem in a manner which would be understood by the scientist, while the latter should present his results in such a way that the engineer can readily see how to apply them in practice. Some authors and speakers advocated the use of middlemen or interpreters who could speak both languages, while others thought that, whenever possible, both large- and small-scale research and development should be carried out jointly by teams comprising, in the ideal case, engineers, chemists, physicists and mathematicians.

From a different aspect a minority pointed out that the chemistry of combustion is extremely complex, and the engineer is always under pressure to adapt plant quickly to suit new conditions. He may have only a limited knowledge of the details of the combustion mechanism but, nevertheless, especially in the older fields of application, he has ample knowledge of the conditions necessary to obtain, and maintain, a very high standard of thermal efficiency, and he has amply proved his ability to apply his knowledge.

Many of the papers, taken from all sections of the conference, amply demonstrate that in most practical applications combustion, in itself, does not present a major problem. In some cases the type of fuel used and the design of the combustion equipment are decided by the size of the plant, in some by maintenance problems or ease of control, and, in nearly all, by economic considerations. In each session emphasis was placed on the effects of impurities in the fuel, which are so important that combustion problems usually become apparent only when some such effect as temperature accentuates the difficulties caused by the presence of harmful elements such as sodium, sulphur or vanadium. In boilers the process of combustion is subordinate to considerations of heat transfer and the avoidance of bonded and other external deposits; in furnaces the life of the roof is all-important; in internal combustion engines the use of residual oils has brought up problems of abrasion and corrosion, which were discussed in detail; and in industrial gas turbines, although combustion problems are more important than in some other fields, the effect of impurities such as vanadium in residual oil is receiving much attention.

Although in the past the art of combustion may have developed more as a result of experience than by the application of fundamental data, the high rates of reaction and of heat-release which are demanded when burning fuel in the newer types of equipment, such as gas turbines and ram jets, bring much nearer the time when performance will be limited by the basic mechanism of the combustion process. Possibly for this reason great interest was shown in an American paper describing experiments to determine the maximum heat-release to be obtained by burning liquid hydrocarbons and to observe the conditions which limit reaction-rates. In these experiments it was found that, under certain specified conditions, the maximum heat-release was $8{\cdot}0 \times 10^{8}$ B.Th.U. per cu. ft. per hr. per $(\text{atm.})^{1{\cdot}8}$, and that in the final stages of combustion the oxidation of carbon monoxide was the slow controlling step.

For various practical reasons the maximum heat-release obtained in these experiments is more than ten thousand times that employed in most modern water-tube boilers; but it was pointed out that heat-releases of the same order occur intermittently in internal combustion engines and a figure of several million B.Th.U. per cu. ft. per hr. was quoted for continuous combustion in gas turbines. The conclusion that the oxidation of carbon monoxide limits the maximum heat-release is consistent with British experiments showing that the combustion of carbon monoxide is inhibited by the presence of methane. It may also be in line with a statement that in the gas turbine most of the heat-release takes place in about one-third of the space used for combustion, the remainder being used for the combustion of hydrogen and carbon monoxide.

It must not be thought that, even with the older methods of combustion, progress has been made without the use of extensive research or without employing scientific methods of investigation. Thus some scientists would not regard work carried out on combustion under the rapidly changing conditions within the cylinder of an internal combustion engine as fundamental; but one paper described experiments in which the scientific method is used *inter alia* to examine the flame stability in an internal combustion engine by means of new electronic measuring devices. Similarly, much use is made of models to examine the influence of aerodynamic flow upon the combustion process in plant as divergent in construction as the open-hearth furnace and the gas turbine.

Mention may also be made of some of the other examples of applied research on combustion which were discussed at the conference. The high temperatures encountered in modern small-sized combustion chambers and the extended use of automatic control in the larger sizes have resulted in the development of many new measuring instruments. The radiation from the flames of solid, liquid and gaseous fuels is being studied by an international committee and, with each type of fuel, attempts are being made to correlate radiation with the progress of combustion. The chemical and physical properties of the ashes in various types of fuel are being studied intensely, not only with the object of reducing deposits on metal surfaces but also because of their limiting effect upon combustion conditions at high rates of heat-release. Experimental work is proceeding on the use of additives to influence the actual combustion process, as well as to reduce the effect of impurities upon deposits and upon wear and tear. Completeness of combustion is also being controlled to prevent deposits. As a final example, studies of aerodynamic flow in various types of combustion chamber are of outstanding interest on account of the influence of the flow pattern upon the conditions controlling combustion at any particular point and at any particular time.

Considering the complete conference in relation to its central theme, it would seem that the practical engineer has developed combustion techniques which have served their immediate purpose and which, in the past, have been good enough to make the actual process of combustion a minor problem. More recently, he has found it necessary to carry out intensive experimental work on closely associated phenomena; but he has not, so far, made much use of the fundamental chemistry and physics of the combustion mechanism. The conference clearly deplored this fact and supported the view that the time has arrived to take positive action to close the gap between theory and practice.

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# THE SCIENTIFIC STUDY OF PLANTS*

By Prof. H. E. STREET
University College of Swansea

THE Department of Biology of University College, Swansea, was founded in 1921 under the direction of Dr. Florence A. Mockeridge; in 1936 she was elected its first professor of botany. Now the College is establishing separate Departments of Botany and Zoology and building new biological laboratories. The pioneer biologists at Swansea have faced, in some measure, that resistance which their subject has encountered at many points during its history; a resistance which arises because its impact on our dogmas and ways of life is more direct and profound than that of any other branch of science. There exists a widespread lack of understanding of the nature and importance of contemporary botany. It is therefore appropriate that I should endeavour to trace, in very broad outline, some of the main currents of its historical development.

## Systematic Botany and the Concept of Evolution

Knowledge of the usefulness of plants is as old as man himself. It was not, however, until the rise of the Greek and Roman civilizations, and then primarily in connexion with the identification of medicinal plants, that systematic and detailed descriptions of plants were written down. From work of this kind originated the "Herbal" of Dioscorides, produced in the first century A.D.

The Dark Ages intervened between the fall of Rome and the Renaissance. Then came a renewal of interest in the form of living things as exemplified by the paintings of Botticelli and the drawings of Leonardo da Vinci, by the reproductions of the texts of the Ancients, by the publication of the sixteenth-century herbals, by the anatomical studies of Harvey, and by the founding of learned societies like the Royal Society. It was at this time that botanic (physic) gardens were established in the ancient universities of Europe, and that explorers first brought to Europe many of the food plants we know to-day.

Stimulated by Bacon's dictum that the essential first step for scientific progress is the accumulation of facts, and aided by Boyle's introduction (1663) of alcohol as a preservative, there arose during the eighteenth century a group of naturalists which included Tournefort in France and John Ray in Cambridgeshire. They not only collected and described plants, but also sought to classify them into species, genera and families. They recognized not only distinct species (a unit introduced by Aristotle) but also resemblances and affinities between them. This work formed the basis for the "Systema Naturae" of Linnaeus, first published in 1735; a work which exercised a very powerful influence. Botanists assiduously sought new genera and species. They came to be esteemed within their own circle in proportion to the number of flowering plants the characters of which they knew by heart.

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* Substance of an inaugural lecture delivered on October 27 at the University College of Swansea.

This static eighteenth-century botany, by stimulating the search for new species, brought about its own eclipse. Botanists travelled in the ships of Cook and Flinders and in the nineteenth-century voyages of scientific exploration. Knowledge of the living world grew rapidly and excited great interest. Geology developed the concepts of palæontology, making possible the study of fossil plants initiated by Robert Brown (1851). The concept of species as immutable units each dating back to an act of special creation became suspect. The similarities between species, particularly the basic similarity of structure among the warm-blooded animals, suggested a common ancestry. Fossil organisms were clearly related to, but quite distinct from, living species. Domestic animals and cultivated plants were known to have arisen by human selection of the progeny of their wild ancestors. In the writings of Buffon, Erasmus Darwin and Lamarck, species were regarded as undergoing continuous change, the bewildering variety of living organisms as having arisen from a smaller number of ancestral types and as now undergoing change into the organisms of the future. The situation awaited the synthesis achieved by A. R. Wallace and by Charles Darwin, whose "Origin of Species by Means of Natural Selection" was published in 1859.

Darwin had set forth the immense weight of evidence for the hypothesis that the diverse forms of life are of common descent. Strongly influenced by Malthus, he explained the process of change by postulating that natural variations were inherited and selected in a "struggle for existence". Darwinism and the evolutionary contention of Spencer that the direction of change had been such as to produce higher from lower forms of life became synonymous in men's minds and found wide acceptance and able protagonists.

This concept of organic evolution played an important part in the ferment of scientific ideas which characterized the second half of the nineteenth century. The challenge of Darwinism was, however, not fully understood by contemporary biologists. The systematists saw in it a justification for their work; they embroidered and extended the systems of classification, which now seemed to reveal the evolutionary sequences of the past; there arose a veritable forest of geneological trees. The spirit of the Darwinian period from 1860 until 1900 directed attention away from a really critical examination of the nature and extent of natural variation, and of the mechanism of evolutionary change.

## The Study of Cells and of Heredity

To understand how the scientific study of plants was to move forward, it is necessary to go back to the publication in 1665 of the "Micrographia" of Robert Hooke, to his "new invisible world" of the minute structure of plants revealed by the microscope, to the discovery of "cells". This was quickly followed by the work of other seventeenth-century microscopists like Malpighi and Grew, who showed that the stems, roots, leaves and flowers of plants are compounded of many different kinds of cells arranged in patterns of tissues. Further progress, however, had to await the development during the nineteenth century of more powerful microscopes. 1831 saw Robert Brown's description of the nucleus, and 1838 Schleiden's description of the cell substance (cytoplasm) in which the nucleus was always embedded. These together constitute protoplasm, the living substance of the cell. The enclosing cell wall which alone had been observed by the seventeenth-century microscopists was not the cell as we now visualize it, but simply the envelope of structural material secreted around it by protoplasmic activity.

By 1878 Abbe microscopes, with achromatic lenses, were being manufactured and distributed by Zeiss of Jena; they foreshadowed in all essentials the microscopes of to-day. By 1843 certain one-celled plants had been observed undergoing fission into two daughter cells. In 1875 Eduard Strasburger, using an improved microscope and basic aniline dyes as nuclear stains, was able to give the first detailed description of this process of cell division, showing it to be a process led and controlled by division of the nucleus. Preparatory to nuclear division, there appeared in the nucleus minute, deeply staining (chromatin-rich) threads, the chromosomes, constant in number and form in the nuclei of each plant species. During nuclear division these chromosomes underwent a precise longitudinal division so that each daughter nucleus received its proper chromosome complement; the formation of daughter nuclei was followed by division of the cell. Evidence accumulated that the chromosomes were permanent structures the staining properties of which varied with the state of the nucleus.

The new microscopes also made possible study of the process of sexual reproduction at the cellular level. In 1855 Pringsheim introduced his observations thus: "with regard to the manner in which the (sexual) organs participate *materially* in the act of impregnation and even as regards the necessity for their co-operation, there are but vague surmises". Then he proceeded to describe accurately the act of fertilization in the alga *Vaucheria*, thereby demonstrating for the first time that the subsequent development of the female cell into a new plant was not initiated by some mysterious male essence—the "*aura seminalis*" of Aristotle—but by a fusion of the sex cells. This was followed, in 1887, by Beneden's demonstration that in *Ascaris* the essential feature of fertilization is a fusion of the sex nuclei, each with the haploid chromosome number, to give a fusion nucleus containing one set of chromosomes of paternal and one of maternal origin. Preparatory to the formation of sex cells the haploid number was restored by a special reduction division, first observed in plants, again by Strasburger (1894). In this, corresponding chromosomes paired off and then separated to give haploid nuclei each containing some paternal and some maternal chromosomes. These researches pointed to the chromosomes as the physical agents of heredity. Full recognition of their significance came, however, only after botanists and zoologists, labouring to interpret the results of controlled breeding experiments, had formulated hypothetical concepts which described, at first unwittingly, and then with increasing consciousness, the nature and behaviour of the chromosomes; they had established the science of cytogenetics.

The breeding experiments of Mendel were begun in 1857, published in 1865, and then completely neglected until confirmed and acknowledged in 1900. First Mendel had studied the inheritance of single recognizable characters, for example, average height, when 'dwarf' and 'tall' varieties of peas were crossed and the hybrids selfed. To explain his results, he had to postulate that the expression of the character was controlled by a pair of determinants (in 1909 termed 'genes' by Johannsen), one derived from each parent, that in the zygote the expression of one of these factors was dominant over the other (the 'tall' gene was dominant), and that the maternal and paternal members of the gene pair suffered random distribution to the sex cells formed in preparation for the next generation. Mendel had then extended his work to study simultaneously the inheritance of two characters and concluded that the genes for separate characters were inherited quite independently.

Subsequent work, particularly with the fruit-fly, *Drosophila*, initiated in 1909 by Morgan in Columbia University, extended and modified Mendel's findings. Characters were not inherited independently but in 'linkage groups'; only characters from different groups behaved in a typical Mendelian manner. The number of linkage groups corresponded with the haploid number of chromosomes. Linkage of genes was, however, not absolute; if the genes of the linkage group were on the same chromosome, then there occurred an interchange or 'crossing-over' of genes between paired chromosomes during the reduction division—this was the genetic significance of the 'chiasmata' observed in reduction division. 'Crossing-over' frequencies between genes could only be explained by postulating that the genes are arranged in a linear series along the chromosomes; just as are the chromatin granules of the chromosome threads. The visible structural units of the chromosomes were either genes or were the loci of genes, themselves still smaller material entities. Thus arose the 'theory of the gene', from which has stemmed a deeper understanding of the twin problems of the variability within species and of their change into new species during evolution.

Darwin had postulated that evolution was a process of gradual change, the cumulative effect of successive small variations over many generations. Hugo de Vries, like others before him, was, however, convinced that series of individuals grading from one species into another, such as would be expected from Darwin's hypothesis, are in Nature conspicuous by their absence. In 1886, examining a colony of the American evening primrose, he found variants which on selfing gave rise to quite new and true-breeding forms. Here it seemed was a species disintegrating, suddenly not gradually, to use de Vries's term, by 'mutation'. Similarly, Johannsen (1913), although quite unable to alter gradually the mean seed-weight of beans by always selecting and replanting the heaviest or the lightest seed, encountered two cases of mutation in which the mean seed-weights suddenly changed to new and persistent values. These mutations were apparently quite unrelated in direction or extent to environmental influences. Their discovery, combined with the recognition that heredity operates through special sex cells set aside early in development, formed the starting point for the now generally accepted view that evolution has proceeded by naturally occurring mutation. These sudden changes are quite unrelated to characters 'acquired' during the development of the organism. They are subjected to natural selection or rejection, and, since many are unfavourable, there is a preponderance of rejection.

The rapid accumulation of genetic data which followed the rediscovery of Mendel's work not only exposed the phenomena of 'linkage' and 'crossing-over', but also that of gene interaction. Gene interaction, together with the independent inheritance of 'linkage groups' and their fragmentation by 'crossing-over', showed that inherited variation could arise by a reshuffling, during reduction division, of a fixed gene population. Mutations, the changes important in evolution, were, by contrast, shown to involve either quantitative or qualitative change in the gene population. One kind of mutation arose from breakdowns in chromosome behaviour; their frequency could be speeded up by agents like colchicine and mustard gas. Such chromosome mutations involved deletions or duplications of chromosomes or of chromosome segments; sometimes duplications of whole sets of chromosomes (polyploidy). The second kind, gene mutations, involved radical changes in individual genes. These also occurred naturally with a very low frequency; many mutations of this kind have been induced by X-rays, gamma-rays and other radiations.

It thus became possible to explain at the chromosome-level the concept of species, the nature of natural variation within species and the mechanism of evolutionary change.

## Plant Physiology and Biochemistry

It is necessary now to consider the development of a further, and again quite different, level of approach to biological problems.

The seventeenth-century microscopists, observing the development in organic fluids of innumerable moving microscopic organisms, concluded that they had demonstrated the 'spontaneous generation' of life as postulated by Aristotle. Pasteur and Tyndall showed that, in all cases of this kind, the organisms had reached the suitable source of food and moisture by being carried via the air. Their researches also proved that natural fermentations were always associated with living organisms and were not chemical processes in the sense visualized by Liebig. The foundations were laid for the demonstration that infectious diseases were caused by micro-organisms capable of surviving a period of separation from their stricken hosts. Infective fluids could be sterilized either by heat or by removal of the micro-organisms by passage through bacteria-proof filters.

However, in 1892 and again in 1896, it was shown that the juice of tobacco plants infected with 'mosaic' could not be freed from its infectivity by filtration. This observation was a landmark in the discovery of viruses. Further, the infective agent causing the 'mosaic' disease, the tobacco mosaic virus, when isolated by chemical procedures, consisted entirely of ribonucleoprotein. Here was a chemical entity capable of causing an infectious plant disease, requiring suitable living host cells for its duplication, something non-living when isolated, living when introduced into the cytoplasm of the host, in some of its properties an organism, in others a large molecule.

Here we have raised in an acute form the transition from a chemical to a biological level of organization.

In studying life as a material system, as a unique state of matter, we attempt to utilize the techniques of experimental science, particularly those of chemistry and physics, and to extend the concepts of the physical sciences to aid in the interpretation of a higher level of organization. Such studies have revealed life as a dynamic system, a system of happenings, of physical and chemical processes proceeding—have established the science of physiology.

While eighteenth-century botany was preoccupied with systematics, physiology was mainly a speculative occupation of physicians. Outstanding, however, was Stephan Hales, who, working in his vicarage garden at Teddington, sought by experiments to explain the action of living plants on the basis of known physical forces. In 1727 he published "Vegetable Staticks", the foundation work of plant physiology.

By the second half of the eighteenth century, men of many persuasions were studying the nature of air and the effects of plant and animal life on its composition. Priestley, Ingen-Housz and de Saussure were conducting experiments which in aggregate demonstrated that at all times plants and animals are absorbing oxygen and exhaling carbon dioxide (performing respiration); and that in addition green plants have the unique power, in sunlight, to effect photosynthesis. Photosynthesis involved the uptake of carbon dioxide, the evolution of oxygen and the synthesis of organic matter.

These and many other pioneer researches in plant physiology were set forth with great clarity in 1865 by Julius Sachs in his "Physiology of Plants". Here we find respiration described as the process which effects a continuous liberation of energy by the oxidation of the organic food reserves of the cell and the concept that this constant energy supply is essential for the maintenance and growth of protoplasm. Here, in an account illuminated by his own researches, Sachs sets out the general nature of photosynthesis, identifies chlorophyll as the essential catalyst, describes starch as the first visible product and recognizes this as a complex compound capable of yielding respiratory energy or acting as the starting point for the synthesis of other protoplasmic constituents.

The forceful writings of Liebig, particularly the publication in 1840 of his "Chemistry in its Application to Agriculture and Physiology", had led to a wide acceptance of the inorganic theory of plant nutrition, that the essential nutrients required by plants are obtained either from the soil or from the air in inorganic form. Liebig had shown ammonium salts to act as effective sources of nitrogen for plant growth. Boussingault in 1838 had similarly demonstrated the manurial properties of Chilean nitrate, first introduced into Europe in 1820. Boussingault's use of washed sand as a growth medium and the development of water-culture techniques by Sachs and Knop made it possible to identify the elements essential for plant growth, work which ultimately led to the recognition and effective treatment of the important deficiency diseases of crops.

The plant physiologist is, however, not only concerned to define what nutrients are essential but also seeks to trace the chemical changes which they undergo in the chemical reactions of the cell; to trace their role in metabolism. At first, studies of this kind were approached by indirect means, and knowledge of cellular mechanisms was purely circumstantial. However, in 1897, Buchner performed an experiment initiating the science of biochemistry. He obtained from disintegrated yeast cells a clear aqueous solution capable of effecting the alcoholic fermentation of sugar. The biological and chemical theories of fermentation so keenly argued by Pasteur and Liebig had both been vindicated.

The yeast juice of Buchner was afterwards shown to contain a mixture of soluble ferments or enzymes, each responsible for catalysing one of the sequence of linked reactions involved in sugar fermentation. With the progress of biochemical studies it became apparent that enzymes are extremely active, specific and relatively unstable catalysts, and that all, or almost all, the chemical reactions of cells are under enzyme control. When these enzymes were separated and purified, they were found to be either proteins or proteins associated with units of smaller molecular weight, the co-enzymes (some of the latter are now known to be identical with the vitamins). Protoplasm clearly contained several kinds of proteins, reserve proteins, structural proteins responsible for its molecular framework and colloidal properties, and, in small amounts, several hundred specific enzyme proteins controlling cell metabolism.

The discovery of a further kind of protein and a brief discussion of its special role in living cells will serve to illustrate one important way in which plant physiology has deepened our understanding of the major botanical problems the development of which we have followed. Miescher in 1868 isolated the nuclei from pus cells and demonstrated that they contained an unusual phosphorus compound, a new kind of protein, a nucleoprotein. This we now describe as deoxyribonucleoprotein, a compound formed by combination between basic proteins and deoxyribonucleic acid (DNA).

Using modern techniques, it has been possible to study quantitatively the distribution of nucleic acids within cells and to show the universal presence not only of DNA, but also of a second kind of nucleic acid, ribonucleic acid (RNA), also associated with basic protein. From such studies we know that DNA-protein is concentrated in the chromosomes, coinciding in distribution with the chromatin of the cytologists. Nuclei also contain RNA-protein, concentrated in separate nuclear regions and apparently implemented in the synthesis of the DNA-protein.

Nucleic acids were at first considered to be strictly nuclear constituents. The cytoplasm has now been shown to contain cytoplasmic particles, reproducing by fission, rich in RNA-protein, and uniquely rich in enzymes.

Cytoplasm cannot persist in the absence of the nucleus, nor are isolated nuclei self-perpetuating. The two are interdependent. This suggests that the nucleus is dependent upon cytoplasm for organic and inorganic nutrients, and that the nucleus controls cytoplasmic activity by sending out into it 'messengers', some of which it seems from recent genetical work are involved in the origin of persistent and self-duplicating plasmagenes. Viruses may represent plasmagenes which have gained access to and proved capable of multiplying in a foreign cytoplasm and thereby caused a pathological disturbance of metabolism inducing disease symptoms.

The chromatin granules of the chromosomes, carriers of the nuclear genes, cytoplasmic particles, apparently carriers of plasmagenes and other less stable 'gene products', and the viruses are all units capable of self-duplication with retention of their specific properties. They are all nucleoproteins or are rich in nucleoprotein. Nuclear genes and viruses show mutation. Nucleoproteins confer upon these genetic units their specific properties ; nucleoprotein molecules in the environment of the living cell can exactly replicate themselves. We are led to conclude that the massive molecules of nucleoprotein can exist in, at least, as many specific configurations as there are genetic units, that mutations arise from sudden and stabilized changes in their molecular configuration, and that evolution depends upon the structural variations achieved in these special molecules.

The evidence that the RNA-proteins of the nucleus are concerned with the synthesis of chromosome proteins suggests that the RNA-proteins of the cytoplasmic particles may be responsible for the synthesis of enzymes ; that genes may control metabolism by controlling, through the medium of their 'messengers', the establishment and activity, in the cytoplasm, of the nucleoprotein centres of enzyme synthesis. Many mutations would then be expected to result in derangements of the delicately adjusted and interlocked reaction chains of cell metabolism. This is the thesis behind the studies in biochemical genetics initiated in 1940 by Beadle and Tatum at Stanford University and afterwards developed in many laboratories. Mutants of fungi and bacteria induced by X-rays have been isolated which have more elaborate and definable nutritive requirements than the parent 'wild' strains. Using appropriate X-ray dosages, many of the mutants have an induced requirement for a single essential metabolite. The induced requirement arises from the breakdown of a single identifiable reaction in cell metabolism. In a number of cases the enzyme controlling the critical step is known and the mutant has been shown to differ from the 'wild' strain in lacking the operative enzyme. Where the micro-organism reproduces sexually, breeding experiments have revealed that the mutants lacking a single enzyme are single-gene mutations. The nuclear genes act, in such cases, by controlling the synthesis of single enzymes. Such gene control could be responsible for the physiological and morphological characters which are the concern of the plant-breeder.

Study of the physiology and biochemistry of nucleoproteins has therefore contributed to our knowledge of the chemical nature of genes and of their mechanism of action, and thereby deepened our understanding of heredity and natural variation.

Contemporary botany has made great contributions not only to the material welfare of mankind, but also to our understanding of life. It is now raising questions enlivening and taxing not only the biological but also the physical sciences. It is in the borderlands between these sciences that, in the immediate future, we may expect the most important discoveries. This poses important problems in the training of biologists and in the development of research.

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# IS THE GENE A PRIME MOVER?

By Prof. CARL C. LINDEGREN

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RECENT advances in understanding the chemical structure of deoxyribonucleic acid[1] together with evidence[2] of its capacity to mediate the transfer of genes from cell to cell has led to the belief that the secret of life lies in this nucleic acid. Such optimism has its basis in the idea that the gene is the fundamental, 'self-perpetuating', *primary*, living particle[3].

The possibility that the gene is a terminal or recent addition to the cell has not been sufficiently considered. There can be no question that the chromosomes and their genes are essential components of living matter as we know it to-day ; but this does not prove that they are *primary* components of living material. Electrical devices are essential components of the organism which we call Chicago, and there is little doubt that, without electrical devices, Chicago would perish and yield its place to some competing metropolis not similarly handicapped. It is equally clear that such devices are not primary components and that Chicago existed as an organism for a long time without them, although they now play a vital part in the city's life.

Numerous critical experiments have shown that extra-chromosomal autonomous structures are present in the cell. (1) Michaelis[4] proved (by back-crossing interspecific hybrids of *Epilobia* to the male parent) that replacing all the chromosomes of one species by those of another did not completely convert the recipient species. (2) Renner[5] has shown that the chloroplasts (which are free of deoxyribonucleic acid) are autonomous structures. (3) Harder[6] showed that the removal of one nucleus from a dikaryon of a hymenomycete (which contains the cytoplasm from both gametes) produces a surviving cell (with nucleus *A* in a mixture of both *A* and *B* cytoplasms) that is permanently different from the parent containing nucleus *A* in *A* cytoplasm—thus establishing the autonomy of *B* cytoplasm.

Now that the gene is allegedly a pure chemical compound, it seems difficult, if not impossible, to ascribe the mysterious capacity for 'self-reproduction' to it. It seems obvious that no chemical possesses an autonomous capacity for reproducing itself, for it must depend upon the environment for its components and the synthesis must be mediated by an enzyme. Self-duplication reduces to a mechanism whereby the enzymes controlling the synthesis and the structure which is synthesized are intimately associated. Many components of the cell other than the chromosomes appear to possess an autonomy which operates at this level. It is as inconceivable that a cell could survive without a plasma membrane as that it could survive without genes. The secret of life is not to be found in the structure of any given chemical, but in the organization and association which make the whole cell capable of producing all the components necessary to the synthesis of all the cellular organelles when placed in an adequate milieu[7]. This statement does not solve the secret ; but it denies that the solution lies in the gene alone. Life may have originated by the association of a synthesizing enzyme with a protein in some circumstances (depending upon structural interrelationships) by which the protein and the enzyme were reconstituted together. The next step could be the development of a differentiated envelope for the protein mass associated with its own synthesizing enzyme. Many synergistic components may have followed, each of which facilitated the synthesis of the complex, and each of which halted all syntheses when the particular components necessary for its construction were in short supply.

The demonstration of the essential nature of the gene depends upon the fact that deletion of a gene produces a lethal result. It is clear from the previous discussion that this fact does not prove that the gene is a primary component of the cell. Actually, one would expect co-ordinating and regulating functions to be superimposed late in the evolution of the cell. Many synthetic steps might involve minute amounts of regulatory materials which were required to act upon a specific substrate for a specific purpose. The critical value of the gene may depend on such a device. The control of adaptive enzymes by genes suggests that such trivial but occasionally valuable activities are controlled by genes. During the early phases of the development of gene theory it was proposed that genes differentiated specific or varietal characters while cytoplasm differentiated characteristics distinguishing genera or phyla. One ordinarily thinks of controlling, supervising and co-ordinating functions as relatively recent rather than primary activities of organizations whether they be cities or countries or cultures; genes may be recent agents in the origin of life carrying on functions similar to those of the electrical devices in a city such as Chicago.

There is a specific characteristic which is not consistent with the view that genes are composed of deoxyribonucleic acid. Evidence[8] concerning the gene controlling galactose-fermentation in *Saccharomyces* has been interpreted to indicate that genes may be plastic, since the substrate for a gene controlling the production of an adaptive enzyme is itself a mutagen controlling the mutation of the gene from a non-functional to a functional state. Similar instances have been encountered in studying the genes controlling carbohydrate fermentation in *Saccharomyces*. Rather than a rigid structure such as deoxyribonucleic acid, the genes themselves may be plastic materials attached to deoxyribonucleic acid. Lindegren[9] suggested that the rigidity of the chromosome made it an ideal site for assembly-line synthesis of gene-products, and the brilliant researches of Demerec (personal communication) have revealed that such assembly-line syntheses actually do occur. There is evidence[10] that gene products may not always be synthesized at the locus of the gene, and this suggestion leads one to suppose that the fibrous nature of the chromosome is exploited as a means of communication and co-ordination, and that the basic functions of deoxyribonucleic acid are to hold the plastic material of the gene in place and to transmit information from it to a functioning cell centre.

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# OBITUARIES

## Sir Arthur Tansley, F.R.S.

Sir Arthur Tansley, who died on November 25, must be ranked as one of the makers of British botany. During his long and active life he exerted a profound influence on the development of the science, and on the attitude of botanists towards the study of the plant world.

Tansley was born in 1871, educated at Highgate School, University College London, and Trinity College, Cambridge. At University College he came under that inspiring personality F. W. Oliver, and at Cambridge he was influenced by Francis Darwin, Seward, and F. F. Blackman, who for many years was one of his closest friends. After taking a first class in Part II of the Natural Sciences Tripos at Cambridge, he returned to London as Quain Student at University College, later becoming demonstrator and assistant professor there. At this period he was much interested in evolutionary problems, then so much in the minds of botanists; he worked on the anatomy of ferns and on seedling structure. In 1902 he embarked on the bold venture of founding a new botanical periodical, *The New Phytologist*, which was to be "a medium of easy communication between British Botanists". He realized that this was a hazardous experiment, and at first he acted both as editor and publisher. The experiment proved completely successful, and in the thirty years during which he was editor the journal became one of the principal botanical publications in the world. It frequently contained important contributions by the editor, such as his "Lectures on the Evolution of the Filicinean Vascular System". It was important, too, in promoting an integration of the various branches of botany hitherto regarded as distinct.

In 1903 he married Edith Chick, his successor in the Quain studentship, and three years later he returned to Cambridge as University lecturer. He settled in a beautiful home at Grantchester which became a centre for botanists young and old. His lectures presented fresh points of view, especially those on ecology, at that time a new subject in Britain. Tansley had begun this study in London with Oliver, and he became an active member of the Committee for the Study of British Vegetation. The work of this Committee, and the articles in *The New Phytologist* on "Vegetation at Home and Abroad", did much to spread an interest in plant ecology which brought together taxonomists, physiologists and anatomists. In 1911 he organized the first International Phytogeographical Excursion to the British Isles. For this he produced a noteworthy book, "Types of British Vegetation". Two years later he took a leading part in the formation of the British Ecological Society, of which he was the first president; during 1916–37 he edited the Society's *Journal of Ecology*.

During the First World War Tansley undertook work in the Ministry of Munitions, and afterwards he spent a period in Vienna with Prof. Freud. This resulted in his well-known book "The New Psychology", which spread a knowledge of Freud's theories widely in Britain. Afterwards his mind became much occupied with the teaching of botany in schools, and in 1922 he produced an admirable text-book, "Elements of Plant Biology", which had a far-reaching influence. In 1923 he was president of Section K (Botany) of the British Association, and delivered a very stimulating address on the position of botany at that time, in which he called for a new outlook in the study of plants. In the same year he resigned his university post at Cambridge and for a few years occupied himself with research and writing. His important work with T. F. Chipp on "Aims and Methods in the Study of Vegetation", and his "Practical Plant Ecology" date from this period.

A new phase in his career came in 1927 with his election as Sherardian professor of botany and fellow of Magdalen College at Oxford. Here he did much to stimulate and reorganize the study of botany. He collected around him a group of able young men and restored the old prestige of the department. He did much to prepare the way for the provision of a new building, though this was not constructed until after the Second World War.

On his retirement from Oxford in 1937 he devoted himself mainly to the completion of his monumental work, "The British Islands and their Vegetation", in which his own wide knowledge and the labours of British ecologists over some thirty years were epitomized. This fine volume, written in the lucid style which characterized all his works, will long remain as a memorial to his influence and enthusiasm; and it gained for him the Gold Medal of the Linnean Society of London. But his energies were still by no means exhausted, and in 1943 he became chairman of a committee to consider nature conservation and nature reserves in post-war Britain. His book, "Our Heritage of Wild Nature", and his addresses on various occasions did much to arouse a consciousness of the value to the nation of the preservation of areas inhabited by interesting plants and animals. He took an active part in the plan for helping teachers and students of all kinds to study plants and animals in their natural habitats, becoming president of the Council for the Promotion of Field Studies; he also provided students with "An Introduction to Plant Ecology", and was joint author of "Plant Ecology and the School". His appointment as first chairman of the Nature Conservancy in 1949 was a fitting climax to his efforts for so many years.

Tansley's work was recognized by his election to the Royal Society in 1915, to an honorary fellowship at Trinity College, Cambridge, in 1944, and by the conferment of a knighthood in 1950.

He will be widely mourned as a leader and a friend.

H. HAMSHAW THOMAS

## Sir Richard Paget, Bart.

SIR RICHARD ARTHUR SURTEES PAGET died on October 23 at the age of eighty-six. He was educated at Eton and Magdalen College, Oxford. After qualifying as a barrister and becoming a member of the Inner Temple, he gave valuable services on a number of industrial panels and commissions, where his genial personal qualities fitted him well as a negotiator. The bulk of his life, however, was spent in the cause of science. He loved science and brought the scientific attitude of mind to bear upon problems in many diverse fields—thus he achieved important work and gained distinction in physics, anthropology, architecture, town planning, acoustics, linguistics, speech and several artistic crafts. He was, moreover, of an inventive turn of mind, delighting in novel and unorthodox ways of viewing things, so that it is not surprising that he anticipated by half a century some present-day developments such as the streamline motor-car.

When in 1915 Britain was faced with calamity, he was one of the first to realize the urgency of well-directed scientific research on a national scale; he acted as assistant secretary of Section II of the Admiralty Board of Invention and Research during 1915–18. Not a few of the practical investigations undertaken by the Board during the First World War were the direct result of his foresight, to which tribute was paid on more than one occasion by the late Sir William Bragg, who was in charge of experimental work for the Navy.

Mention must be made of Sir Richard's keen interest in the arts. He was an accomplished musician, being particularly adept at keyboard improvization and composition. Folk music had a great fascination for him and provided an interest which he was ultimately able to link with his later studies on speech and language. Coupled with his inventiveness was a rare manual dexterity leading to skill in scientific experimentation and many forms of practical art; for example, he excelled in the manufacture of pottery. As recently as June 1954, prior to a Friday Evening Discourse at the Royal Institution, he created intense interest by demonstrating his early models of the action of the vocal apparatus by which he could reproduce consonants and vowels, thereby simulating human speech. Though these models were connected with work done more than forty years ago, they struck the observer most forcibly at once by the elegance of their simplicity and their appropriateness for the purpose in hand. It is good to know that Sir Lawrence Bragg has now received the models for the Royal Institution Museum and will use them in his lectures from time to time.

Perhaps the most outstanding work of Sir Richard Paget was that upon speech and language. His extreme humanitarianism led him to exert himself to the full in the cause of the deaf and dumb. He put much effort into the development of a sign language for their use.

Several glowing appreciations of Sir Richard's scientific work have already appeared in the Press, both at home and overseas. All of them stress his amazing versatility, his originality of outlook, his zest for life and, above all, his great personal charm and humanity. Perhaps, in concluding, I may be permitted to introduce a personal note. When in 1938 I was faced with the task of opening the large new South-West Essex Technical College and School of Art, the extremely diverse problems involved in equipping departments of science, engineering, architecture and building, commerce, women's subjects, and not least a school of art, were just such as to appeal to Sir Richard's 'universal' mind. He gave me much practical advice and designed not a few special pieces of equipment for me. He afterwards addressed the students with great success. The building of the College organ also interested him, and at the opening recital he sketched the instrument and the organist. There must be many like myself who cherish memories of his ready, generous and expert counsel and assistance. H. Lowery

# NEWS and VIEWS

## Dr. Karl Jordan, F.R.S.: Ninety-fourth Birthday Presentation

Dr. Karl Jordan, the distinguished entomologist, was honoured on his ninety-fourth birthday by the presentation of a jubilee volume at a meeting of the Royal Entomological Society held at the Society's house in Queen's Gate, London, on December 7. The volume contains a series of essays and scientific papers by entomologists of many countries reflecting the numerous facets of Dr. Jordan's work. The essays include a biography, and reviews of Jordan's work in organizing the International Congresses of Entomology, his work for the organization of zoological nomenclature, his work on fleas, his influence on current concepts of systematics and evolution, his contributions to the systematics of Anthribid beetles and his work on the Lepidoptera. There follow a bibliography listing some 460 items written by Dr. Jordan over a period of seventy years, and twenty scientific papers. Few men can have contributed more to the science of entomology than Dr. Jordan, and it was fitting, and a sign of the high regard in which he is held throughout the world, that the jubilee volume was initiated in the United States. It was Mr. H. K. Clench, of the Carnegie Museum, Pittsburgh, who fired the enthusiasm of friends of Dr. Jordan in the United States, Canada and in Britain, and who was responsible for a large part of the work of assembling the contributions. The Royal Entomological Society of London, of which Dr. Jordan is an Honorary Fellow, undertook the publication of the volume.

## Peaceful Uses of Atomic Energy: India and the United Kingdom

The United Kingdom Atomic Energy Authority states that discussions between the United Kingdom Atomic Energy Authority and the Indian Department of Atomic Energy have led to the conclusion of an agreement which ensures that there shall be close co-operation and mutual assistance between the Authority and the Department in the promotion and development of the peaceful uses of atomic energy. The agreement provides for the Authority and the Department to arrange for members of their staffs to consult and work together on mutually agreed topics. In furtherance of this agreement, the United Kingdom Atomic Energy Authority will provide the Indian Department of Atomic Energy with enriched uranium fuel elements for a 'swimming pool' reactor now under construction at Bombay. The agreement also includes arrangements for the Authority to assist in the design and construction of a high-flux research reactor which may be built at a later date.

## Technical Education in Great Britain

Replying to questions on technical education in the House of Commons on December 13, the Prime Minister re-affirmed the Government's determination to make a big advance in technical education and said that the Minister of Education would make a further statement shortly on technical colleges. Sir Anthony Eden did not think that appointment of a committee to inquire into all aspects of scientific, technological and technical training or of a Minister for Technical Education would help. He gave no direct reply to questions regarding the position relative to the U.S.S.R., but said that last year about £4·5 million was spent on improvements in various spheres of technical education. This year £7 million is being spent and next year £9 million. No contracts for technical colleges in Britain were placed during 1946–47, but during subsequent years the figures are: 1948–49, £222,000; 1950–51, £874,000; 1952–53, £3,307,000; and last year just under £7 million.

## Sea-going Facilities for Naval Scientific Workers

Increasing facilities are being granted by the Royal Navy so that scientists, designers and others concerned with the development of new equipment for the Navy can serve afloat and study the problems of those who use their equipment. For some time naval officers have been specially appointed to naval research and development establishments in an endeavour to ensure that civilian officers fully appreciate naval problems, but it is being more and more realized that knowledge and appreciation cannot be fully acquired through the experience of others. Long periods at sea are possible only for a small proportion of those in the Royal Naval Scientific Service engaged on research, design and the production of naval equipment, but many, including draughtsmen, do visit ships for trials and inspections, even if they do not always proceed to sea. During fleet exercises a number of civil officers are embarked in various units of the fleets as observers to study the general problems of operation and weapon efficiency, and there are, of course, members of the Royal Naval Scientific Service attached to the staffs of the Commanders-in-Chief, Home Fleet and Mediterranean Fleet, as fleet scientific advisers. During recent years the amount and complexity of electronic equipment now fitted in ships have increased to such an extent that special efforts are made to enable the designers and producers of this equipment to study at sea the problems of the user and the maintenance staff. During the past eighteen months the fleets have been able to accommodate in various ships, for periods varying between a few days and four or five weeks, about one hundred civil scientific officers engaged in this sort of work; included in this number are staff representatives from Ministry of Supply Establishments, which are responsible for most of the airborne electronic equipment for the Navy, and also designers and engineers of industrial firms engaged on Admiralty work.

## Vacation Courses in Synoptic Meteorology

For the sixth year in succession, the Royal Meteorological Society, in conjunction with the Council for the Promotion of Field Studies, held in the early autumn a vacation course in elementary synoptic meteorology at the Council's field-centre at Malham Tarn. This year, however, in view of the increasing number of applications, a parallel course for sixth-form pupils was also held at the Juniper Hall Field-Centre. The course at Malham Tarn was attended by thirty-five students, mainly undergraduates, reading for degrees in mathematics, physics and geography, and the Juniper Hall course had an attendance of thirty-two. The instructors at Malham were Mr. C. D. Ovey, lecturer in geography at the University of Cambridge, and Dr. R. S. Scorer, lecturer in meteorology, Imperial College; Mr. E. J. W. Spence dealt with the construction and use of meteorological instruments. At Juniper Hall the instructors were Mr. W. D. S. McCaffery and Mr. C. E. Wallington, both of the Meteorological Office. The visiting lecturers at Malham included Prof. P. R. Crowe, University of Manchester, who discussed "Some Problems of Tropical Weather"; Dr. D. Walker, University of Cambridge, who gave a talk on palæo-ecology; and Prof. G. Manley, Bedford College, London, whose subject was "The Study of Climatic Variations". At Juniper Hall, Mr. R. E. Lacy, Building Research Station, dealt with meteorological problems in the building industry; Mr. H. Charnock, National Institute of Oceanography, explained the inter-relationship between oceanography and meteorology; Mr. R. A. McCormick, at present visiting Great Britain on an exchange basis between the U.S. Weather Bureau and the Meteorological Office, described the work of the former; Mr. D. H. Lucas, Central Electricity Authority Research Laboratories, spoke on smoke pollution; and Dr. R. M. Goody described research on the upper stratosphere. At Juniper Hall an excursion to the Meteorological Office Radiosonde Station at Crawley was arranged, and a visit was also paid to the Research Laboratories of the Central Electricity Authority at Leatherhead. An important part of the course consisted of observation work and the plotting of synoptic meteorological data. A novel feature at the Malham Tarn course was the use of a specially equipped meteorological van, kindly lent by the Department of Meteorology of the Imperial College of Science and Technology. Simultaneous observations of pilot balloons by two theodolites were made by radio-communication. As in previous years, various education authorities and the Education Department of the R.A.F. made it possible for some of the students to attend the courses, which are approved for grants in suitable cases. Similar courses will be held in 1956 at the Malham Tarn Field-Centre for undergraduates during August 22–29 and at Flatford Mill Field-Centre for sixth-form pupils during September 5–12. Early application is advisable.

## An Abnormal Smoke Belt over London

About 1 p.m. on Sunday, January 16, 1955, a belt of extreme darkness crossed the London area from north-west to south-east, causing widespread public interest and attention in the press. The belt of smoke and low cloud was about 1½ miles wide and moved at 6–18 m.p.h., taking 6–10 minutes to cross a given place. The daylight illumination as recorded at Kew Observatory (normally about 7 kilolux at this time on overcast days in January) dropped at 1.14 p.m. from 7 kilolux to a value barely distinguishable from zero. In the November issue of the *Meteorological Magazine* (p. 342), N. G. Helliwell and M. J. Blackwell describe the physical causes. The essential features were a low inversion of temperature (increase of temperature with height instead of the usual fall) beneath which smoke was trapped, and a change of wind direction associated with the eastward movement of the centre of a depression across London. The smoke was carried north-westwards, first of all by the south wind ahead of the centre to the Chilterns, and concentrated there against a front with north-easterly winds on its northern side. As the depression moved, the wind changed to north-west and brought the smoke belt back across the London area. Trajectories of the smoke are given in the paper. It was possible from observations to trace its further movement south-east to the Sussex coast. The amount of smoke pollution at the Fuel Research Station, Greenwich, increased from 0·36 mgm. m.$^{-3}$ between 1 and 1.15 p.m. to 0·7 mgm. m.$^{-3}$ during 1.45–2.45 p.m., when the extreme darkness occurred there. At Grosvenor Road the maximum pollution of 1·3 occurred earlier, and the value at the time of darkness was 0·3. During the infamous smoke fog of December 5, 1952, the pollution reached 4·5 mgm. m.$^{-3}$ at Greenwich.

## University of London

The following appointments have been made in the University of London: Dr. B. C. King, senior lecturer in the University of Glasgow, to the University chair of geology tenable at Bedford College; and Dr. K. W. Sykes, senior lecturer in the University College of Swansea, to the University chair of physical chemistry tenable at Queen Mary College. The title of reader in biochemistry in the University of London has been conferred on Dr. A. L. Greenbaum in respect of his post at University College.

## Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: D. C. P. Evans (agricultural officer, Gold Coast), senior agricultural officer, Gold Coast; J. S. Addison, J. S. Smith and M. L. Webber (conservators of forests, Federation of Malaya), conservators of forests, grade A, Federation of Malaya; A. Foggie (conservator of forests, Gold Coast), deputy chief conservator of forests, Gold Coast; F. G. Harper (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; F. H. Landon (conservator of forests, Federation of Malaya), chief research officer, Federation of Malaya; D. McIntosh (conservator of forests, Northern Region, Nigeria), deputy chief conservator of forests, Northern Region, Nigeria; B. E. Webb (forest engineer, Federation of Malaya), conservator, development and utilization, Federation of Malaya; M. S. Garson (geologist, Nyasaland), geologist, Cyprus; Dr. E. R. N. Cooke (pathologist, Kenya), specialist (pathologist), Kenya; P. B. Cornwall (scientific officer, West African Cocoa Research Institute, Gold Coast), senior scientific officer, West African Cocoa Research Institute, Gold Coast; A. E. Dorman, J. F. Hart and R. W. E. Lewis (veterinary officers, Kenya), provincial veterinary officers, Kenya; K. D. S. MacOwan (deputy director of veterinary services, Kenya), director of veterinary services, Kenya; K. D. S. Baldwin, economist, Agriculture Department, Northern Region, Nigeria; J. A. Bullock, scientific officer, entomologist, Kenya; J. C. Davies, entomologist, Department of Agriculture, Uganda; F. Isherwood, scientific officer, entomologist, East Africa High Commission; W. P. Mowat, scientific officer, plant pathologist, Sarawak; N. C. Loveday, assistant conservator of forests, Tanganyika; D. R. McQueen, silviculturist, Nyasaland; M. T. Ashcroft, medical research officer, grade 2, East Africa High Commission; M. N. Henry, pathologist, grade B, Trinidad; P. D. Meers, pathologist, Nigeria; A. W. Ireland, deputy director of meteorological services, Nigeria; C. P. MacKenzie, veterinary education officer, Nigeria; S. M. Rimmer, veterinary officer, Tanganyika; D. J. Garrod, scientific officer, East African Fisheries Research Organization, East Africa High Commission; D. J. C. Orr, game ranger, Tanganyika; Dr. E. W. Russell, director, East African Agriculture and Forestry Research Organization, East Africa High Commission; E. A. Salzen, scientific officer, marine biologist, West African Fisheries Research Institute, Sierra Leone; P. D. Turner, mycologist, West African Cocoa Research Institute, Gold Coast.

## The Night Sky in January

New moon occurs on Jan. 13d. 03h. 01m., u.t., and full moon on Jan. 27d. 14h. 4m. The following conjunctions with the Moon take place: Jan. 1d. 23h., Jupiter 7° N.; Jan. 8d. 11h., Mars 2° N.; Jan. 8d. 18h., Saturn 4° N.; Jan. 14d. 22h., Mercury 4° S.; Jan. 16d. 09h., Venus 7° S.; Jan. 29d. 06h., Jupiter 6° N. In addition to these conjunctions with the Moon, Mars is in conjunction with Saturn on Jan. 14d. 21h., Mars 1·6° S., and with Antares on Jan. 26d. 21h., Mars 5° N.; also, Jupiter is in conjunction with Regulus on Jan. 27d. 19h., Jupiter 0·7° N. Mercury sets at 17h., 17h. 55m. and 16h. 10m. on January 1, 15 and 31, respectively. Its stellar magnitude varies from −0·7 to 2·1, and the visible portion of its illuminated disk from 0·864 to 0·046 during the month; it will not be so conspicuous towards the end of the month in spite of the fact that it attains a greater altitude. Venus sets at 18h. 25m., 19h. 10m. and 20h. on January 1, 15 and 31, respectively. Its stellar magnitude varies from −3·4 to −3·5 and the visible portion of its illuminated disk from 0·868 to 0·796, its distance from the Earth varying between 129 to 113 million miles. Mars rises shortly after 4h. during January and has an eastward motion through Libra and Scorpius. Its stellar magnitude varies from 1·7 to 1·5, and its distance from the Earth from 195 to 171 million miles. Jupiter rises at 20h. 40m., 19h. 35m. and 18h. 20m. at the beginning, middle and end of the month, respectively, its stellar magnitude varying between −1·9 and −2·0, owing to its distance from the Earth decreasing from 437 to 411 million miles; its westward motion in Leo can be observed by comparing its positions with reference to Regulus during the month. Saturn rises at 4h. 50m., 4h. and 3h. on January 1, 15 and 31, respectively, and has an easterly motion in Scorpius; but it lies rather low for good observation in the British Isles. It is fairly close to β Scorpii during the month, and its stellar magnitude remains 0·8. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Jan. 1d. 02h. 07·4m., ω Leo. *m* (*R*); Jan. 16d. 18h. 32·5m., 51 Aqr. *m* (*D*); Jan. 31d. 06h. 39·0m., 13 *B* Vir. (*R*), *R* and *D* referring to reappearance and disappearance, respectively. The Earth is in perihelion on Jan. 2d. 13h. The Quadrantid meteors are active on the first few days of January, but moonlight will interfere with their observation.

## Announcements

Mr. J. P. Doncaster, at present in charge of the collections of aphids and allied groups of insects in the Department of Entomology of the British Museum (Natural History), has been appointed a deputy keeper of the Department.

Dr. R. L. Mitchell, head of the Department of Spectrochemistry, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen, has been appointed deputy director of the Institute, and Dr. E. G. Williams head of the Department of Soil Fertility.

Mr. W. T. O'Dea, keeper of the Department of Aeronautics and Sailing Ships in the Science Museum, London, has been released for three months to undertake an exploratory mission for Unesco as technical assistance expert in Ceylon under the Colombo plan. He will advise the Government of Ceylon on the establishment of a science museum at Colombo and will call at New Delhi on his return journey to discuss with representatives of the Government of India their proposals for science museums in four widely separated localities.

The Scientific Instrument Manufacturers' Association is arranging to hold a permanent exhibition of instruments made by member firms at its headquarters at 20 Queen Anne Street, London, W.1. The exhibition, which will be opened on February 9, is not intended to be public, but it will be open to anyone interested in using scientific instruments.

A David Anderson-Berry Silver-Gilt Medal and a sum of about £100 will be awarded in 1956 by the Royal Society of Edinburgh for work on the therapeutical effect of X-rays on human diseases. Both published and unpublished work may be submitted. Applications and copies of relevant papers must be sent to the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, not later than March 31.

Applications are invited for a Drummond senior fellowship and not more than two Drummond junior fellowships for research in nutrition, both tenable for two years. The senior fellowship will be worth £900 a year with research expenses not exceeding £50, and up to £90 a year for superannuation, and the junior fellowship will be worth £500 a year, with research expenses not exceeding £75 a year. Application forms, to be returned by January 27, and further information can be obtained from the Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1.

The authors of the article entitled "Laboratory Design", published in *Nature* of November 26, p. 999, write: "This investigation was assisted by a grant made by the Agricultural Research Council to the Nuffield Foundation. Acknowledgments also are due to Sir William Ogg, director of the Rothamsted Experimental Station at Harpenden, and to Prof. H. D. Kay, director of the National Institute for Research in Dairying, Shinfield, Reading, and their staffs for giving facilities for the survey described. and to the Trustees and Director of the Nuffield Foundation for permission to publish the work".

# ENGLISH STYLE IN SCIENTIFIC PAPERS

SINCE the publication in *Nature* of November 5 of Dr. J. R. Baker's article on the use of English in scientific papers and the accompanying editorial article, we have received a number of letters commenting on the situation. We print below a selection covering the main points raised.

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DR. J. R. BAKER asks, "How can the standard of English in scientific journals be improved ?" It is true that I have sometimes been conscious of an uncharitable desire to be able to write book reviews in the style of Macaulay, a desire which I should presumably not have experienced if I had not read Macaulay ; but I do not believe that any substantial improvement will be brought about, at the level which matters most, by relying on the too comfortable doctrine that 'good reading makes good writing'. If standards are to be raised, those concerned with the education and training of scientists, from the early forms of the grammar schools onward, must believe that the writing of good English is important; and must make the weight of their belief felt by means of appropriate sanctions—by making pupils rewrite slovenly essays, by refusing to approve badly written Ph.D. theses, and so on.

But surely the short answer to Dr. Baker's question is "by the refusal of editors to print bad English". When I started to write scientific papers, most of them were edited by the late Dr. Clarence Smith, to whom I owe a great debt of gratitude for what I was at first inclined to regard as tyrannical restriction ; on many occasions he showed me how economy of words and clarity of expression went hand in hand, and even when I could not agree with his alterations, I benefited by being forced to think hard about my writing. I am sure that editors still help young authors in this way ; but I believe that the more ruthless use of the editorial pen could do much to raise the standard of English in our scientific journals.

On points of detail may I remark first that, although the principles involved in their correct use may be simple enough, in my experience the best advice to give about gerunds and present participles is to avoid them ; thus the phrase "on opening the body-cavity" used by Dr. Baker could easily be incorrect in a slightly different context, so that it is much safer, and on the whole more direct, to write "when the body-cavity is (was) opened". Secondly, much clumsy periphrasis is caused by our avoidance of the first person ; could we not agree that clarity is more to be prized than false modesty ?

E. G. COX

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University of Leeds.

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IN his excellent article, Dr. J. R. Baker justly says that understanding is impeded by the misuse of words and by perverse or slovenly syntax. I would like to direct attention to a related problem : the growing inadequacy of the language itself as a means of expression. There are already too few words available to writers and the situation is growing worse.

Since the industrial revolution, the rate of appearance of new things, new activities, and new qualities has been faster than ever before in the world's history. At the same time, universal education, the spread of literacy, and a willing subjection to the tyranny of the dictionary have restricted the introduction of new words.

Sea-going folk are adequately supplied with words ; words which were originated by seamen were afterwards authorized by the dictionary-makers. But the language of aviation is sterile. We have a few cumbersome terms : bomber, fighter, airliner, seaplane, monoplane, biplane, and so forth, some of which have courageously been invented to meet an obvious need. But the rate of invention is not high enough. This is especially noticeable when something new appears. The Rolls-Royce jet-lifted vehicle is a good example of this. Clearly this is a member of the class of aerodynes ; but it is neither an aeroplane nor a helicopter. What are vehicles of this kind to be called ? Need we descend to the facetious and use such terms as 'flying bedstead' to describe a most advanced piece of engineering.

What are we to do about guided missiles ? Many different kinds are being developed now, and the only way of describing them seems to be with the aid of abbreviations, SSM, ASM (surface-to-surface missile ; air-to-surface missile) and so on. Many of them use rocket propulsion. But what is a rocket ? It used to be the complete vehicle, comprising propulsive means, stabilizing means, container and payload ; but as the vehicles grow bigger and we approach space-ships, the word is becoming limited to the motor itself.

Since there is, in fact, no shortage of letter combinations (nor of sound combinations) there seems no reason why new words should not be made concurrently with new things. It is in fact true that there have been considerable successes in this way ('radar' is a good example), but we need many more. The main requirements are common sense and courage. There will be many who will resist any attempt to introduce a word that is not already in the dictionary. Such people may be quite prepared to avail themselves of a modern product such as a cathode-ray tube, but they will not have the grace to allow it a word of its own.

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DR. J. R. BAKER's description of some symptoms of a linguistic disease will have delighted all concerned with problems of information. May I point out two more of its deplorable effects : (*a*) the many Continental authors who now write directly for British or American publication may be led to take it as a model, neglecting the study of the very real virtues of American (not to mention English, which some of us in our old-fashioned way think equal to any task, even if it does not make up into such comfortably broad-bottomed volumes) ; and (*b*) now that printing is costed almost to the last 'en', one not only has to suffer this pompous verbosity, but also to pay extra for it.

P. J. EDMONDS

Cleaver-Hume Press, Ltd.,
Publishing Division,
31 Wright's Lane, London, W.8.

Dr. John R. Baker and the Editors of *Nature* have indicated some of the unhealthy symptoms in contemporary scientific writing and have made constructive suggestions regarding diagnosis and treatment. One fundamental factor which they have still overlooked is the almost universal evasion of the word "I", which evasion, in my opinion, is responsible for much of the circumlocution, artificiality and apparent 'genteelism' and 'grandiloquence' of scientists and bureaucrats alike.

There is one standard objection to the use of the personal pronoun: that it is immodest in a research worker because it imparts a personal flavour when science should be impersonal as well as unbiased. The psychologist McDougall[1] has trenchantly refuted this argument: "There is a common form of egotism which consists in ostentatiously avoiding the appearance of egotism. In conversation one avoids the words 'I' and 'me' as though they were among the most disgraceful in the language; one finds oneself most at ease with persons who do not offend one's susceptibilities with blatant egotism and who can appreciate one's freedom from that gross fault, a fault one cannot tolerate. In writing, and especially in early efforts, one refers not infrequently to 'the present writer' or 'the author of these pages', and uses other ponderous circumlocutions in the effort to avoid the solecism of appearing in the first person".

I doubt very much whether ignorance of basic grammar constitutes a major difficulty for the average scientist of research calibre, or whether he really needs more than the occasional second opinion of a friend or the occasional consultation of "Fowler". It is rather that the scientific author, like the official or the honorary official, somehow feels that everyday language is not quite important enough for his purpose. One junior worker among many who have commenced a paper on the lines: "Working out a collection of animals from Katmandu, three new species were found", listened politely as I asked if he realized that he had perpetrated, not only a grammatical monstrosity but an idea-picture which, taken literally, would need a Lewis Carroll or an Edward Lear to do it justice. Would he speak in that way? Would he describe his work in just those words in a letter to a friend? "Well, no," he answered, "but looking through other people's papers I thought that was how you were supposed to write."

I believe that the kernel of the whole problem lies in the individual's choice of reading. Laymen and scientists alike who have delighted in the lucid and majestic language of one of the greatest living masters of English prose, may well ponder Sir Winston Churchill's account[2] of the days when he took his own education in hand and set out to read Gibbon's "Decline and Fall of the Roman Empire" because "Someone had told me that my father . . . knew whole pages of it by heart, and that it had greatly affected his style of speech and writing". Let every young biologist, for example, take Aldous Huxley's essay[3] as guide and soak himself in the writing of T. H. Huxley. Let him read (in translation) the communications of old Antony van Leeuenhoek[4], as fresh now as when they were written more than two hundred years ago, as precise as the most puritanical of pure scientists could desire, as concise as the most frugal editor could demand and, incidentally, bristling with I's and none the worse for them.

There will be those who, once the elementary requirements of accuracy and brevity have been met, will belittle the importance of literary style in scientific writing and will apply the adjective 'literary' out of criticism, pity or simulated contempt. I think they will be profoundly wrong to do so. Until a few decades ago scientists and technicians combined with statesmen, public officials, lawyers, clergymen and popular novelists to form an influential community adequate to maintain the purity of our language. To-day the balance of power has changed for the worse. The age of Newspeak may be even closer than Orwell[5] prophesied.

Denys W. Tucker

British Museum (Natural History),
London, S.W.7.

[1] McDougall, W., "Character and the Conduct of Life" (Methuen, London, 1927).

[2] Churchill, W. S., "My Early Life" (Macmillan, London, 1930).

[3] Huxley, A., "T. H. Huxley as a Literary Man" (Huxley Memorial Lecture: Macmillan, London, 1932. Reprinted in "The Olive Tree" (Chatto and Windus, London, 1936)).

[4] Dobell, C., "Antony van Leeuenhoek and his 'Little Animals'" (John Bale, Sons and Danielsson, London, 1932).

[5] Orwell, G., "Nineteen Eighty-four" (Secker and Warburg, London, 1949).

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It is stated in *Nature* of November 5 that "The time does not seem far away when high school pupils will have to learn a new table of symbols apart from those atomic". It would, however, appear that such a sad state already exists, the symbols and abbreviations being too numerous for a mere twenty-six letter alphabet.

Another difficulty is that the pupil has to know several glossaries of symbols, to be in line with different authorities.

David Want
(Sixth-form pupil)

South-West Essex Technical School.

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# USE AND ABUSE OF PROTECTIVE EQUIPMENT

The fifth conference of the British Occupational Hygiene Society was held in London on November 4, the theme of the conference being "The Use and Abuse of Protective Equipment". It was divided into four sections dealing with the protection of the lungs, skin, eyes and feet. The proceedings will be published in the March issue of the ***British Journal of Industrial Safety***, and reprints will be obtainable from the honorary scientific secretary of the Society, D. Turner, Environmental Hygiene Research Unit, M.R.C. Laboratories, Holly Hill, London, N.W.3.

The morning session was opened by S. H. Wilkes (senior chemical inspector of factories), who warned against using the canister respirator inside tanks, stills or other closed spaces where there may be high concentrations of toxic gases or where shortage of air is possible. Papers on the protection of the lungs were presented by A. C. Peacock, of the Chemical Defence Experimental Establishment, Porton, and by J. Whittaker, of the Central Safety Department, Imperial Chemical Industries, Ltd. After stating that the only fully satisfactory method of protection of the lungs is by suppression of the risk at source, Mr. Peacock described the different respirators available for use when the ideal cannot be realized.

Characteristics necessary in types suitable for continuous wearing have necessitated a compromise in design between degree of protection and acceptability to the wearer. A review of the standard of protection demanded will sometimes result in a very much more wearable device.

Mr. Whittaker emphasized the importance of a good fit of face-pieces, which is easier to secure with full-sized face masks, going under the chin, than with the small kind covering only the mouth and nose. The larger the protective appliance, however, the greater is the aversion to wearing it and the risk of its being surreptitiously discarded. Discipline in the atomic energy field in this respect is better than in older industries because the workers are well aware of the danger and are accustomed to imperceptible risks.

The second section of the conference consisted of papers on the protection of the skin by Prof. J. R. Squire, of the Department of Experimental Pathology, University of Birmingham, and by Dr. A. Lloyd Potter, of the General Chemicals Division, Imperial Chemical Industries, Ltd. Prof. Squire described how the outer layer of the skin is chemically inert but swells in alkalis and, being a protein, can react with or absorb substances containing $-NH_2$ or $-SH$ groups. It can be destroyed by reducing agents and cracked if dried excessively. Loss of water is normally impeded by a surface film of fatty material which is replenished naturally after removal with solvents in about two hours. Mechanical abrasion, leading to wear of the horny surface faster than the germinal layer can replace it, is occasionally encountered in industry. Chemical irritants produce their effect rapidly when they act as sensitizers, in which case an intense reaction may follow a second exposure, even to very small quantities, after an interval of ten to fourteen days. Carcinogens require years to produce even precancerous effects, and the peak incidence of skin cancer is twenty to thirty years after exposure. Repeated exposure is necessary, and the action decreases when less of the carcinogen reaches the skin.

Dr. Lloyd Potter said that in order to affect the skin a substance must wet it, either by being itself liquid or by solution in perspiration or other liquid. Water, alcohol and weak acids do not greatly affect the skin; but alkalis and fat solvents penetrate to the sebaceous layer. Liability to dermatitis is not detectable at pre-employment medical examinations. Protection of a process by complete enclosure may be nullified if the final product is packed by hand. Protective clothing should not add to the risk of contracting dermatitis by causing sweating and chafing. Proper washing facilities should be provided for and used by workers, and, in this connexion, barrier creams are good because they encourage washing.

Speakers in the afternoon session were introduced by Sir Harold Roberts (chief inspector of mines), who stated that mining is the most dangerous of industries, being closely followed by shipping in respect of fatalities. The death-rate in coal mining is nine times as high as the death-rate in factories, major catastrophies being responsible for only a very small proportion of the casualties in mines; the major toll is taken by falls of ground and by transport operations. Owing to improved standards of lighting, the incidence of nystagmus has been greatly reduced.

Dr. D. R. Campbell, director of research, Birmingham and Midland Eye Hospital, in a paper on ocular injuries and hazards, said that eye injuries constitute 4·26 per cent of all industrial accidents and are mostly preventable, being due to flying particles. Goggles are liable to steam up; they restrict vision and are uncomfortable to wear. They are better received if the worker is given a number of kinds to choose from. Ocular injuries are often repairable, now that the complication of infection is largely absent, but even a small scar on the centre of the cornea can cause dazzle in artificial light. Eye protection, she said, should be compulsory when striking and chipping with metal tools. Burns from molten metals and chemicals, especially caustic soda, are dangerous, though immediate irrigation with water may save an eye.

The legal obligation to provide eye protection against certain hazards was then explained by G. V. Thom, safety officer, Plastics Division, Imperial Chemical Industries, Ltd. Protection built in to a machine is more desirable than protecting the operator, and he showed typical examples. Various devices for personal eye protection were described. In the particular case of welding, protection against infra-red rays is needed, and against ultra-violet as well in electric-arc welding.

H. Bradley, director of the British Boot and Shoe and Allied Trades Research Association, was the first speaker in the session on the protection of the feet, and outlined the steps which have led to the drafting of British Standards for safety footwear. These contain a steel toe-cap which has to resist an impact test. He was followed by H. E. Thomas, head of the Safety Department of the Ford Motor Company, who said that, in his experience, the standard safety boot did, in some cases, give protection but that many toe fractures while wearing them continue to arise. He thought these could be avoided by extending the toe-cap backwards. It is true that it would then be unable to pass the impact test, but it is evident that considerable deflexion of the toe-cap is possible without injury to the wearer's foot.

C. N. Davies

# THE FUNCTION OF LIBRARIES

At the annual conference of the Library Association, held in Southport during September 20–23, two speakers concerned themselves particularly with the university library. Sir Philip Morris, in his presidential address on September 20, drew on his experience in visits to universities overseas since the Second World War, when he found that there was no university which was not either replanning or developing its library, designing a new library and library service, or had just completed some new library undertaking. In Canada and the United States last year he saw, and discussed with those responsible for, five large new libraries completed within the past two or three years. All were different, and while there appeared to be no single answer to the problem of library design, the physical environment, arrangement and facilities of a library profoundly affected its service, and there appeared to be a growing need for much more co-operation and interdependence between libraries. Sir Philip believes that the efficiency of a university might be said to be a function of the adequacy and efficiency of its libraries, and, apart from this factor of co-operation, he emphasized the importance of books being available in suitable circumstances for the reader, and especially the importance of high standards of education and professional ability on the part of the library staff.

These points were elaborated more fully later at the conference by Dr. L. W. Sharp in a paper entitled "What do we look for in a University Library?" Dr. Sharp said little of library co-operation, believing it to be in a very healthy state so far as university libraries are concerned. He referred, however, to some of the difficulties occasioned by departmental libraries and made some suggestions for co-operation here in regard to book selection, exhibits and the like. Like Sir Philip Morris, he stressed the supreme importance of the quality of the library staff, referring to the importance of a university librarian having other academic interests and of encouraging his assistants to widen their interests, for example, through exchanges of staff with other libraries at home and abroad and by the provision of more research scholarships for special library projects. On the subject of library design, he emphasized, like Sir Philip, the importance of having regard to individual circumstances, as well as to the needs of the reader, and commended specially the provision of some rooms for special collections. He stressed particularly the principle that the university library is equally for masters and scholars, and that students should have as free access as any other readers. He does not think that the division into a scholars' library and a masters' library, from which scholars are excluded, is sound; the aim should be to let the student feel that he is a member of a scholarly community and that he is welcome and his place is honourable.

Among the other papers presented to the conference, three were of particular interest to the scientist. They dealt with the general theme, "The Library in the Community", that of Mr. W. S. Haugh (city librarian, Bristol) reviewing the public library service in general. Mr. Haugh said that only fifteen English municipal authorities serving populations in excess of a hundred thousand exceeded 1*s*. 6*d*. per head of population in their expenditure on books during 1952–53, whereas nine spent less than 10*d*. per head as against the 2*s*. suggested as standard in the centenary assessment brochure. For the counties later figures are available, and seven English county authorities are estimated to exceed 2*s*. per head in 1955–56 and seven others to be spending less than 1*s*. 3*d*. Of more specific interest to the scientific worker and technologist, however, were Mr. Haugh's observations on the importance of adequate expenditure on books in the schools and its bearing on educational efficiency, and what is being done by county libraries and other public library services to improve the facilities for educational reading for children as well as for students of technology and of other subjects. He referred particularly to some recent developments in the provision of technical information services by the public libraries, such as the scheme at Liverpool that provides for an immediate temporary technical library and a permanent technical library at a cost of £270,000; the establishment of technical library facilities at the Speke Branch Library serving the trading estate there, as well as branch technical libraries elsewhere; the extension of the Leeds commercial and technical library; the establishment of a separate technical department at Rugby; and the formation at Luton, where the central library maintains a large file of information on the requirements of the export trade, of the Luton and District Technical Information Service. He also mentioned the installation earlier this year in the Manchester Central Library of a teleprinter apparatus giving a direct link to more than a hundred users in the Manchester area, two thousand in the United Kingdom and twenty-five thousand in twenty-one centres abroad, and to the formation of co-operative industrial and commercial reference and information services among public libraries and business firms both in the West London and the North London areas.

Of the other two papers, Mr. H. Thompson (technical librarian, Lancashire County Library), dealing with technical library services in the county, described more particularly the nature of this service, emphasizing its bearing on technical education, and the importance both of mobility and of taking full account of the various requirements of the groups served. Mr. D. J. Foskett (librarian and information officer of the Metal Box Co., Ltd.), dealing with special libraries, also referred to co-operation in the technical field, and his paper was particularly valuable for emphasizing the necessity in all such schemes of remembering that the special library owes its first responsibility to the group by which it is maintained. If this is ignored, the special library can scarcely make its contribution either in co-operation or in the development of new techniques and improved services.

# ROTHAMSTED EXPERIMENTAL STATION

## REPORT FOR 1954

WITH the advent of any new agricultural problem that is amenable to scientific treatment, it has become almost a matter of course for the interested parties to ask: "What is Rothamsted doing about it?" Clearly it is impossible for any research station to follow up too many of the problems of the moment without dangerous dispersal of effort and neglect of fundamental aspects. It is therefore heartening to see that the annual report of the Rothamsted Experimental Station (Pp. 242. 7*s*. 6*d*., from Rothamsted Experimental Station, Harpenden) again reflects a most satisfactory balance between pure and applied research and in the choice of the problems being studied. It is also clear from the very large number of visitors from all parts of the world that the Station continues to play a vital part in the exchange of information.

In the Physics Department there have been further advances in the techniques for measuring micro-climates, and these methods are being used to study the conditions affecting the spread of virus diseases and of blight in potatoes. A new sodium-saturation test has been used to assess the increase in crumb cohesion caused by certain high polymers. It is interesting to note that some of these are more effective on acid than on calcareous soils. Work continues on the crystal structure of kaolinite.

Notable among a wide range of studies in the Chemistry Department are experiments on the placing of fertilizers. It has been demonstrated that some crops, including potatoes, benefit from the placing of nitrogen and potassium as well as phosphorus. Important progress has been made in the estimation of ammoniacal and nitrate nitrogen in soils, and fundamental studies are being made of mineral phosphates and of organic nitrogen and phosphorus compounds in soils.

The Pedology Department is closely linked with the Soil Survey and, in collaboration with the latter, a study has been made of the mineralogy of sand and clay fractions from a wide range of soils from Great Britain and the Colonial Territories. This work is providing important data on soil formation and classification. Progress is being made with the survey of trace-element distribution in British soils, and work continues on the effects of leaf leachates in soil-forming processes.

Investigations on the possibility of controlling disease fungi by antagonistic micro-organisms are in progress in the Soil Microbiology Department. It has now been shown that the action of Actinomycetes in suppressing the root fungus *Helminthosporum* is antibiotic and not merely competitive. Work continues on the strains of clover nodule bacteria which fail to produce effective nodules, and attempts are being made to select genetically stable strains for seed inoculation.

Studies in the Botany Department include the mutual interaction of iron and other micro-nutrients, the uptake of nutrients by plants through the leaves and by excised roots, and the physiological effects of virus infections. Work on kale has shown that there is an optimum leaf area, per unit area of land, for dry-matter production. If this is exceeded, efficiency falls off due to the mutual interference of leaves. Studies on weeds continue, with special attention being paid to wild oats.

The Biochemistry Department is mainly concerned with the study of representative enzyme systems, special attention being paid to the enzymes of bracken in the hope that measures of control may ultimately result. Various oxidation systems are also being studied, and progress has been made in designing a press for the large-scale extraction of protein from fresh leaves.

Work in the Plant Pathology Department seems to indicate that, in newly inoculated leaves, virus particles are continually synthesized and broken down and that the ratio of breakdown to synthesis increases with temperature. Among much other interesting work on virus diseases, it has been shown that the incidence of yellows in sugar beet is much reduced by systemic insecticides. Mycological studies have been carried out in relation to a number of crops, and the value of soaking sugar-beet seed in ethyl mercury phosphate has again been emphasized.

In the Nematology Department intensive study is being made of eelworms, their relationships to host plants and the conditions under which populations build up. Surveys at Rothamsted show that increases of eelworm cysts on plots under continuous mangolds and sugar beet have been very slight during the past eight years, but that the highest densities are associated with manurial treatments giving the highest yields.

Research has continued in the Insecticides Department on the mode of action of organo-phosphorus insecticides and, in particular, on their interaction with the esterase systems of various insects. Useful work is reported on practical methods for controlling black aphis on beans and the wheat bulb fly, and progress has been made in rearing the latter in the laboratory.

The biology of the wheat bulb fly is also being studied in the Entomology Department. Work continues on the dispersal of aphids and on the biology of their natural enemies. Interesting studies of gall midges of various plants are reported, in particular the Hessian fly and the midges of white clover, the latter being especially important in relation to the production of clover seed.

The Bee Department once again presents a fascinating research report on foraging habits and social organization. It has been shown that the foraging of bees may be induced by the release in the hive of a scent which they have learnt to associate with food, and this may have great importance in problems of directing bees to particular crops. The sharing of sugary substances collected by one bee with the other members of a colony (using syrup containing carbon-14), the nature and functions of 'queen substance' and trials of acaricides are among other studies reported.

An electronic computer has now been installed in the Statistics Department, and an intensive study is being made of its potentialities. The survey of hill and livestock-rearing farms is complete and will indicate what scope exists for further expenditure on upland farms. Surveys of fertilizer practice and rabbit damage continue.

The report closes with two useful review articles on "Clay Minerals" and on "The Uptake of Nutrients from Leaf Sprays by Agricultural Crops".

# EAST MALLING RESEARCH STATION

## REPORT FOR 1954

THE forty-second annual report, for 1954, of the East Malling Research Station, near Maidstone, Kent (170 pp., 12*s*. 6*d*. post paid from the Station), includes two general papers of particular interest. The first is the text of the seventh Amos Memorial Lecture, by Prof. T. A. Bennet-Clark, who reviews various concepts of the mechanism by which water ascends large trees, showing that this is not yet fully understood, and makes a plea for more research on the matter. The second is by S. C. Pearce and D. W. P. Greenham, and is a history of the Station's land in the parish of East Malling. It has been possible to trace certain land uses as far back as A.D. 1411, and such historical investigations might achieve useful correlation with modern soil survey.

Malling types of apple rootstocks are now famous, and H. M. Tydeman gives a most useful summary of the twenty-four types, and also crab *C*. His text is very short, but five tables and thirty-five excellent half-tone illustrations give very detailed information about winter and summer characters. D. W. Way, E. S. J. Hatcher and R. J. Garner have investigated the propagation of rootstocks by means of root cuttings. Position on the original root system, length, moisture relations, depth of planting, and various methods of coating the cut ends, have all been assessed, and detailed results are presented. The two last-mentioned workers have also experimented with propagation of Malling crab *C*, by sphæroblast cuttings. Sphæroblasts are rounded swellings on woody stems which are able to produce shoot buds—sufficient to yield some twenty-five hardwood cuttings per maiden tree. The peach variety Hale's Early is compatible with a Brompton rootstock, though not

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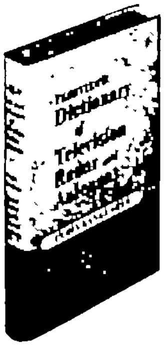

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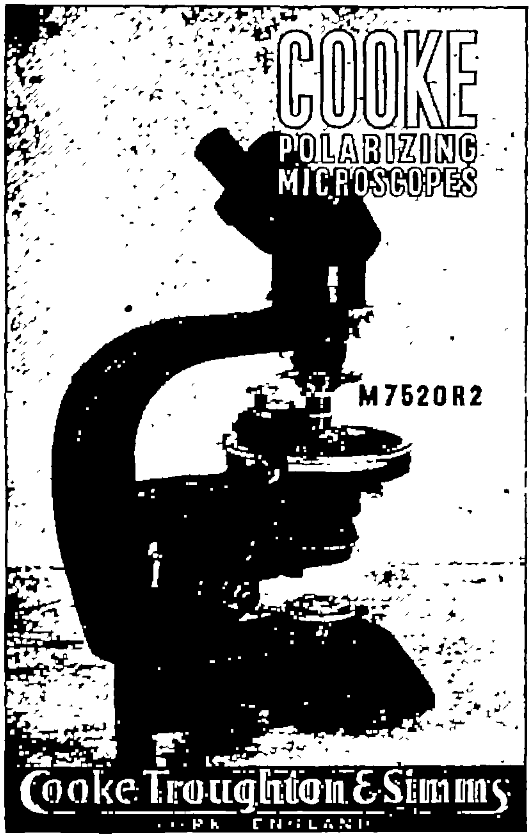

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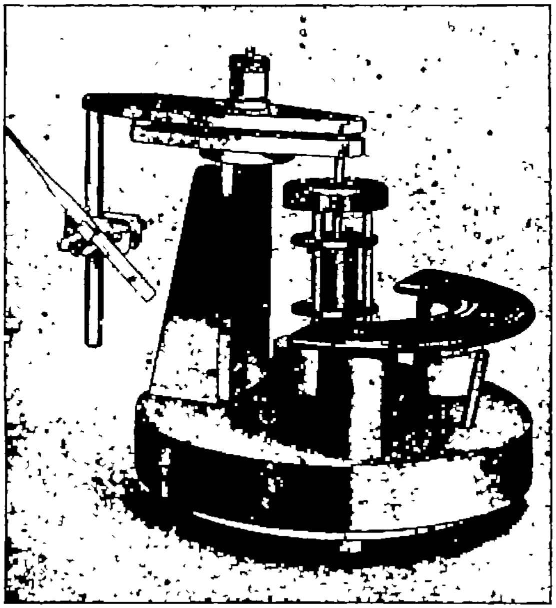

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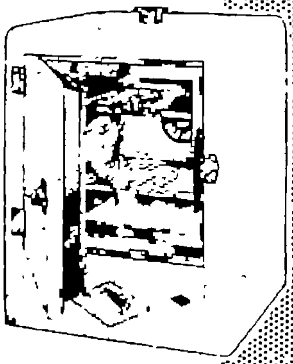

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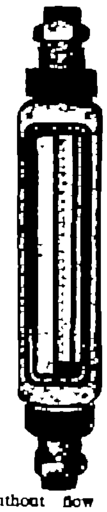

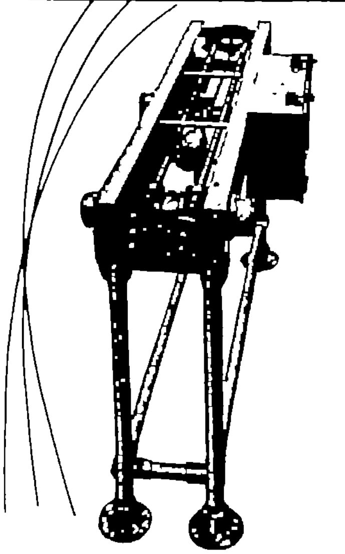

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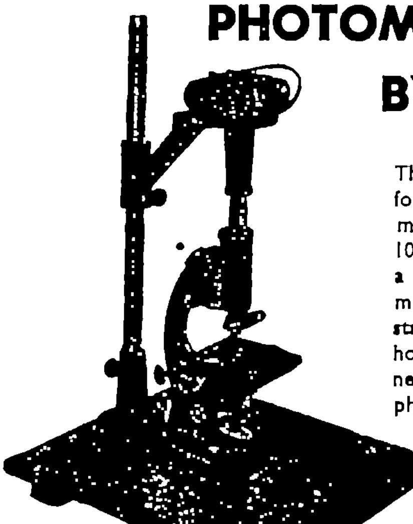

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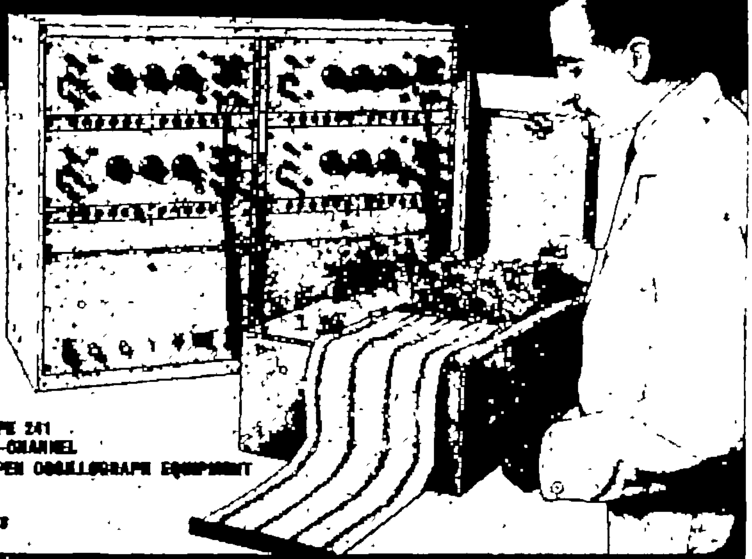

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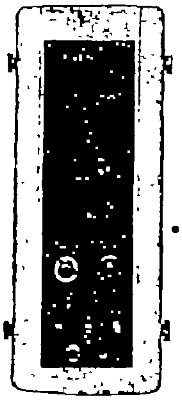

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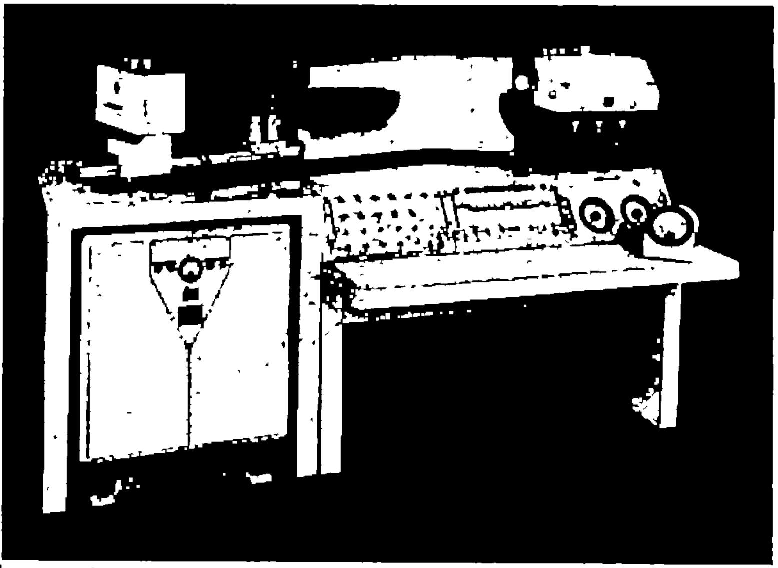

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with Myrobalan *B*. Barbara Mosse shows that on a tree successfully established on a Brompton rootstock, incompatibility was induced by ring-grafting the Brompton stem with Myrobalan *B* bark, and the histology of the union is described. Papers on varietal performance and fruit management include two papers by A. P. Preston, on the results of variety trials of black currants over seven years, and an assessment over nine years of two systems of pruning the crop. Dorothy J. Wilson has measured the loss in yield due to the genetic conditions of Auchincruive Climax known as transient yellows and 'streak'. M. M. McNeill finds that apples grown in pots under glass require applications of dried blood to supplement the normal John Innes potting compost. D. W. Way and G. H. Freeman have bravely undertaken a very careful tasting trial of strawberries and raspberries, with results which are, nevertheless, somewhat of a surprise—at least to the present writer. Temperatures during night frosts were higher over compacted ground than over loose soil, according to C. H. W. Slater and J. P. Ruxton.

It is important that materials for the control of pests should not themselves cause damage, but H. W. B. Barlow, G. H. L. Dicker and J. B. Briggs found that parathion sprays against apple sawfly caused marked fruit drop. Yet parathion gave more significant increases in yield than gamma-benzene hexachloride and nicotine. Such increases were not due to control of the sawfly, and the mechanism by which they were obtained requires further investigation. H. W. B. Barlow, C. R. Hancock and H. J. Lacey have isolated certain heat-stable growth-inhibiting substances from woody shoots of crab *C* and Myrobalan *B* rootstocks. Changes in mineral nutrients in the leaves of the 'biennial bearer' apple Miller's Seedling were investigated by A. C. Mason, who has shown that larger concentrations of nitrogen, phosphorus, magnesium, calcium and manganese occur in the fruiting years than in the non-fruiting ones. A laboratory study by E. L. Frick of thirty materials for their relative ability to inhibit spore germination of *Botrytis cinerea* brought out some interesting divergencies between laboratory and field performance. Two of the substances—tecnazene and pentachlornitrobenzene—are already in use against the fungus, but did not inhibit spore germination. Thiram and the ferric, zinc and manganese dithiocarbamates, moreover, inhibited spore germination at two different concentration ranges.

Leaf roll, a new virus disease of the sweet cherry, is described by A. F. Posnette and R. Cropley. An attempt to clarify the relations between nettlehead and split leaf blotch viruses of hops has been made by J. T. Legg. Evidence for the view that the latter is a component of a complex causing the former is as yet inconclusive; but in this particular field trial, the relevant clones of College Cluster and Malling Midseason had the lowest amount of nettlehead of any variety tested. A. M. Massee contributes fifteen short notes on interesting insect records in 1954, perhaps the most important of which is an attack by cockchafers in two localities. He also reviews problems arising from the use of insecticides, and makes a plea for entomologists to study their effects upon the whole orchard fauna. Joan R. Groves reports that mercury-vapour light traps were found more efficient than bait traps for catching codling moths, while D. A. Chant and R. C. Muir find that the brushing machine method is superior to the imprint method for estimating numbers of fruit-tree red-spider mites. In the realm of statistics, G. H. Freeman and Margaret J. Hall point out that variations in number of red-spider mites from leaf to leaf, between trees, and also between plots, should all be considered when estimating the significance of control treatments.

There are, in the report, also accounts of all the activities of research sections and a description of the organization of the experimental farm. There are weather records and the texts of three bulletins for fruit-growers: on the search for better fungicides, by M. H. Moore; an illustrated description of capsid bugs, by Elsie Collyer; and on some impressions of apple orchard practices in Canada, by G. H. L. Dicker and A. H. M. Kirby. The volume is produced to the usual high standards of printing and illustration, and—most welcome—there is an index.

JOHN GRAINGER

# PATHOLOGY OF BIRDS IN ZOOLOGICAL GARDENS

A STUDY of the pathology of birds in the Zoological Gardens of Antwerp has been made by Prof. L. M. G. Geurden, of the University of Ghent (Bulletins de la Société Royale de Zoologie, d'Anvers, No. 4).

Bird diseases in zoological gardens are numerous and mortality is very high. The primary cause may be either in the country of origin or in the transportation, or in the zoological garden itself. In captivity, malnutrition, deficient food or lack of movement influence a large number of birds, although their susceptibility varies within wide limits from one individual to another.

In the period under review, Prof. Geurden dissected thirty-five dead birds; a laboratory analysis was often required for a definitive diagnosis. The most common causes of death were pneumonia (5), visceral gout (13) and hæmorrhagic enteritis (22). Pneumonia, quickly followed by death, is common in birds originating from tropical countries when exposed to low temperature. Isosporosis involving a primary disease is likewise very frequent. Captive birds often suffer from visceral gout; the great change in the way of living and in the nature of the food is doubtless the starting-point of this disease, although the susceptibility of different individuals varies considerably. Diseases such as cæcal coccidiosis and black head will affect all members of the gallinaceous group in the same way.

The majority of birds had died from hæmorrhagic enteritis. In the absence of intestinal parasites, the bacteriological test for detecting *Salmonellae* often shows a negative result. *Salmonellae* were cultivated seven times from the intestinal contents.

Birds are commonly considered as the biggest reservoir of *Salmonellae*; powdered eggs used during the War have shown this on a very large scale. In some cases latent infections occur, in others acute diseases develop. Although several internal organs may be the seat of these infections, they are more often found in the intestines and in the genital organs. Owing to the large number of *Salmonella*-types, the epidemiology of *Salmonella*-infections is quite confused, and, in his work, Prof. Geurden clarifies a number of points which have previously caused difficulties with various species and types.

# COMBINED AMINO-ACID CONTENT OF TUMOUR AND HOMOLOGOUS NORMAL TISSUE

By Dr. G. C. EASTY and Dr. E. J. AMBROSE

Chester Beatty Research Institute, Royal Cancer Hospital, London, S.W.3

IN the course of an investigation into the chemical and structural difference between tumour and homologous normal tissue, the combined amino-acid content of the normal kidneys of the male golden hamster was compared with that of tumours produced in them by treatment with stilbœstrol. This material is particularly convenient for such a study, since the tumours are very compact, consisting almost entirely of tumour cells, and are easily separated from surrounding non-tumour tissue. All tissue samples analysed were subjected to histological examination. Fourteen amino-acids were analysed by paper chromatography, using mainly the method of Roland and Gross[1], and to a lesser extent McFarren and Mills[2].

Initially, all hydrolyses were carried out in tubes sealed in air with 10 *N* hydrochloric acid, and a tumour hydrolysate was first compared with that of a whole normal kidney. The proportion of methionine in the tumour was 30–40 per cent lower than in the normal kidney, the other thirteen amino-acids being present in both tissues in almost identical proportions. The tumours arise from the cortex of the kidney, and it was thought possible that the cortex of the normal kidney might contain less fixed methionine than the inner medulla. This could account for the lower proportion of methionine in the tumour arising from the cortex. To test this a second tumour was compared with the normal cortex, normal medulla, and cortex adjacent to the tumour but free of any visible tumours. From the results in Table 1 it can be seen that, relatively, the cortex of the normal kidney contained if anything slightly more methionine than the medulla. Hence the decrease in methionine content of the tumour was not due to its being derived from the cortex. Furthermore, the methionine content of the tumour-free cortex of the tumour-bearing kidney was the same as that of the cortex of the normal kidney. A hamster kidney cortex, which had not formed tumours on treatment with stilbœstrol under the conditions which gave rise to tumours in other hamsters, contained the same proportion of methionine as the normal untreated kidney. Thus it appeared that a lower content of combined methionine is characteristic of this tumour. Significantly lower quantities of tyrosine were found in the tumour compared with most of, but not all, the other tissues; but the deficiency was not so great. Ten tumours have been analysed so far, most of them at least twice, and in no case has the methionine content failed to be less than that of the whole normal kidney, cortex and medulla.

Tissues to be compared were so far as possible obtained at the same time, fixed as soon as possible by immersion in 3 volumes of ethyl alcohol and 1 volume of glacial acetic acid, or in absolute ethyl alcohol alone for one hour, washed with absolute ethyl alcohol and stored in that solvent. The chopped samples were extracted for equal lengths of time with chloroform to remove lipids, dialysed in the same vessel to remove low-molecular weight compounds, and equal weights sealed in tubes containing hydrochloric acid, either with enclosed air or evacuated; they were hydrolysed at 110° in an oven, side by side, for 18 hr. Two analyses of one hydrolysate on the same sheet of paper almost always agreed to within ±5 per cent for each amino-acid, and hydrolysates to be compared were always run on the same sheets.

On comparison with previous analyses for kidney and liver, it was found that we were obtaining lower values for the quantities of methionine and tyrosine present. As most previous workers had hydrolysed their tissues in 6 *N* hydrochloric acid and not 10 *N*, it was thought that lower values might be due to more extensive degradation of these amino-acids by the more concentrated acid. On hydrolysis of the same sample of normal kidney with 6 *N* and 10 *N* hydrochloric acid in sealed tubes with air it was found, however, that as much loss of tyrosine and

Table 1. RELATIVE CONCENTRATIONS OF EACH AMINO-ACID PRESENT IN EACH PAIR OF TISSUE HYDROLYSATES, ASPARTIC ACID BEING TAKEN AS 1·00, AND THE VALUES FOR THE OTHER AMINO-ACIDS ADJUSTED ACCORDINGLY. LAST THREE COLUMNS WITH IDENTICAL MATERIAL

| | Tumour/whole normal | | | Tumour*/ cortex from tumour-bearing kidney | Tumour*/ normal cortex | Tumour*/ stilbœstrol cortex (no tumours) | Normal cortex*/ normal medulla | Tumour†/ whole normal | Tumour*/ normal | (Same tumour + methionine*)/ (same normal + methionine) |
|---|---|---|---|---|---|---|---|---|---|---|
| Aspartic acid | 1·00 | | | 1·00 | 1·00 | 1·00 | 1·00 | 1·00 | 1·00 | 1·00 |
| Glutamic acid | 0·93 | | | 1·04 | 1·00 | 1·05 | 1·00 | 1·02 | 0·96 | 0·95 |
| Serine | 0·94 | | | 0·94 | 0·80 | 0·79 | 1·03 | 0·93 | 0·88 | 0·92 |
| Glycine | 0·90 | | | 1·12 | 1·15 | 1·21 | 0·98 | 1·01 | 0·97 | 0·99 |
| Threonine | 0·95 | | | 0·92 | 0·97 | 0·90 | 1·00 | 0·96 | 1·02 | 0·96 |
| Alanine | 0·93 | | | 1·01 | 0·95 | 1·01 | 1·09 | 0·99 | 0·98 | 1·01 |
| Lysine | 0·92 | 0·94 | 1·00 | 1·09 | 0·93 | 0·96 | 1·15 | 0·94 | 1·00 | 1·01 |
| Arginine | 0·96 | 1·00 | 0·93 | 1·15 | 0·97 | 1·04 | 1·09 | 0·97 | 0·97 | 0·96 |
| Proline | | | | 1·00 | 1·09 | 0·97 | | 0·96 | | |
| Tyrosine | 0·96 | | 0·95 | 0·76 | 0·78 | 0·88 | 1·08 | 0·94 | 0·64 | 0·68 |
| Valine | 0·90 | 0·96 | 0·94 | 0·97 | 0·95 | 0·88 | 1·13 | 0·93 | 0·97 | 0·95 |
| Methionine | *0·58* | *0·61* | *0·66* | *0·62* | *0·65* | *0·60* | *1·22* | *0·94* | *0·51* | *0·58* |
| *iso*Leucine | 1·00 | | | 0·95 | 0·91 | 0·95 | 1·02 | 0·96 | 0·98 | 0·99 |
| Leucine | 1·01 | | | 1·02 | 1·06 | 0·90 | 1·06 | 0·98 | 1·01 | 0·95 |

* All hydrolysed in sealed tubes with air. † Hydrolysed *in vacuo*

methionine occurred in 6 *N* acid as in 10 *N* acid. But it was found that when the same sample was hydrolysed in 6 *N* or 10 *N* acid *in vacuo*, the values for methionine and tyrosine rose, and they compared favourably with those obtained by previous workers. It appears that the presence of air rather than the concentration of acid is causing the loss of methionine and tyrosine.

Of greater importance was the observation that, when hydrolysed *in vacuo*, the normal and tumour tissues contained on analysis equal quantities of methionine and tyrosine. There are several possible explanations for the observed and consistent difference in the degree of degradation of individual amino-acids present in normal and tumour tissues hydrolysed side by side under identical conditions.

(1) The tumour tissue could contain more of certain contaminating substances such as nucleic acids and polysaccharides which might catalyse degradation. The hydrolysis of normal kidney and tumour in the presence of added 10 per cent deoxyribonucleic acid and 10 per cent polysaccharide in 6 *N* hydrochloric acid *in vacuo* was therefore carried out. It resulted in no significant loss of any amino-acid compared with the hydrolysis of these tissues alone under the same conditions. Possible losses of methionine during chromatography caused by the presence of more contaminating substances in the tumour hydrolysate than in the normal hydrolysate were tested for by adding equal known quantities of methionine to both hydrolysates. The recovery of added methionine in both cases was the same, about 90 per cent, that is, a 10 per cent loss, similar in magnitude to that found by Moore and Stein[3] using polystyrene columns.

(2) The tumour tissue might contain more of certain catalysts, such as trace metals, which are known to catalyse the oxidation of methionine. This was investigated by adding equal quantities of methionine to equal weights of tumour and normal tissue before hydrolysis *in air*. If there is no greater loss of the methionine added to the tumour than of that added to the normal tissue, then the difference in degradation observed with normal and tumour tissue alone cannot be caused by catalysts. Thus, if no more catalysis occurs in the tumour hydrolysate than in the normal hydrolysate, then:

$$\underset{\text{(Normal tissue + added methionine)}}{\text{Methionine}} - \underset{\text{(Normal tissue)}}{\text{Methionine}}$$

$$= \underset{\text{(Tumour tissue + added methionine)}}{\text{Methionine}} - \underset{\text{(Tumour tissue)}}{\text{Methionine}}$$

The figures found, in milimoles, were:

$$\underset{(N + A)}{\text{Me}} - \underset{(N)}{\text{Me}} \quad \text{and} \quad \underset{(Tu + A)}{\text{Me}} - \underset{(Tu)}{\text{Me}}$$

$$1{\cdot}4 - 0{\cdot}65 = 0{\cdot}75, \qquad 1{\cdot}15 - 0{\cdot}33 = 0{\cdot}82$$

Therefore, the added methionine was degraded to an almost equal extent with both tissues—if anything to a slightly smaller extent in the tumour hydrolysate.

This leaves explanation (3), namely, that there are significant differences in the structure and/or amino-acid sequence of the proteins of the normal and tumour tissues. It is known that free methionine is partially oxidized during acid hydrolysis in the presence of air[4], and it seems probable that the greater loss of methionine and tyrosine in the tumour hydrolysate than in the normal kidney hydrolysate is due to the fact that the tumour proteins are hydrolysed more rapidly, the amino-acids being released more quickly, thus allowing more time for oxidation to occur.

Recent work by Smith and Stockell[5] on the composition of carboxypeptidase has shown that the apparent loss of certain amino-acids on hydrolysis depends on factors which appear to vary with different proteins. In addition, it is now recognized that peptide bonds involving, for example, isoleucine and valine are difficult to hydrolyse. Hirs, Moore and Stein[6], in their work on the composition of ribonuclease, found that no decomposition of acidic amino-acids was observed when synthetic mixtures were 'hydrolysed', whereas some loss was observed when ribonuclease was hydrolysed under the same conditions. Similarly, Smith *et al.*[7], found that no destruction of glutamic acid occurred on hydrolysis of carboxypeptidase, but that destruction occurred on hydrolysis of crystalline papain under identical conditions. Differences in the rates of release and degradation of the same amino-acids from tumour and homologous normal tissue might account for different results obtained by different workers on the same materials. Schweigert[8] found that the whole homogenates of tumours obtained from the livers of rats treated with 4-dimethylaminoazobenzene contained 33 per cent less methionine and 28 per cent more cystine than the normal livers. Sauberlich and Baumann[9] carried out similar analyses on the same tumours but found no deficiency of methionine or increase of cystine. The conditions of hydrolysis were not, however, identical in both cases, different concentrations of acid being used for different periods of time.

The suggested greater ease of hydrolysis of tumour proteins under these conditions fits in with the idea put forward by Ambrose[10] that the tumour proteins are characterized by a more random structure which should facilitate attack by hydrolytic and other agents. There is evidence[11] that proteolytic enzymes first act by denaturing the protein, reducing the degree of order. Thus, increased randomness of tumour proteins might facilitate hydrolysis even in acid solution without the intervention of enzymes. It is of interest to recall that Rondoni[12] has suggested that carcinogenesis is accompanied by denaturation of the cell proteins. The observations of Kögl and Erxleben *et al.*[13] concerning the presence of more D-glutamic acid in tumours than in normal tissues, about which there has been much controversy, might be explicable in terms of differences of protein structure leading finally to the isolation of a more highly racemized glutamic acid from the tumour than from the normal tissues.

From our work we conclude that, within the limits of error of the analytical method used, there appears to be no significant difference in the overall amino-acid composition of normal hamster kidney and the tumour induced by stilboestrol. There is evidence, however, that overall differences of structure of the proteins occur consistently between the normal and tumour tissue. This conclusion is in agreement with that of Cruft, Mauritzen and Stedman[14], who found evidence that the physical properties of histones from malignant cells exhibit pronounced differences from those of normal cells, although there was no difference in the amino-acid composition.

We wish to thank Prof. Alexander Haddow and Prof. F. Bergel for their advice and encouragement in the course of the work, and Dr. E. S. Horning, who also kindly supplied all the tissues used throughout this work. This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Aug. 11

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# SIGNIFICANCE OF GLUTAMIC ACID IN METABOLIC PROCESSES IN THE RAT BRAIN DURING PHYSICAL EXERCISE

By Dr. R. VRBA

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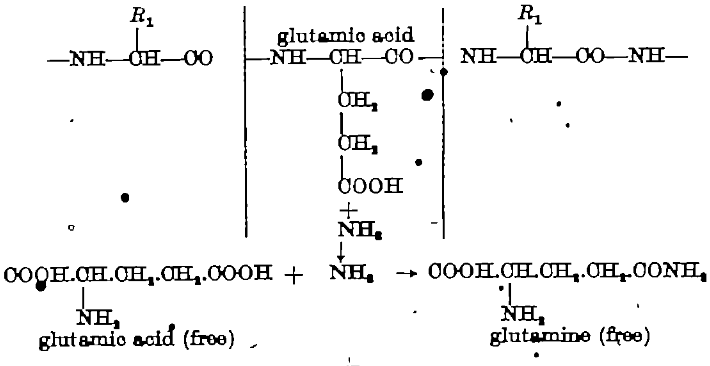
PHYSICAL exercise is associated with an increased functional activity of large areas of brain, since, during physical exercise, impulses are sent to peripheral organs, signals come back from proprioceptors, and simultaneously the nerve centres are in action which co-ordinate the internal organs, the blood circulatory system, the respiration, etc., with active muscles. We consider the diffuse neuromuscular activity an appropriate model of the increased functional activity of the brain nervous tissue. The functional activity of the nervous tissue is always associated with the formation of ammonia[1]. In our previous experiments we found that during physical exercise the ammonia formed in the brain is bound in the form of glutamine[2]. Simultaneously with this process, the splitting of ammonia off amide bonds of proteins of the brain nervous tissue takes place[3]. On the basis of these experiments we assume that during functional activity of the brain associated with the performance of physical exercise, metabolic processes as shown in scheme (I)[2] take place in the brain nervous tissue.

This scheme is supported by the following facts: (1) during functional activity of rat brain nervous tissue, a decrease of the actual concentration of the amide group in the brain protein fraction occurs[3]; (2) as has been described many times, during functional activity of the nervous tissue ammonia is formed[1]; (3) during functional activity of the brain nervous tissue in association with physical exercise, an increase of the actual concentration of free glutamine in the brain takes place[2]; (4) functional activity of the nervous tissue is associated with structural changes in the nervous tissue proteins[3].

One of the further assumptions of this scheme is that with the increase of the concentration of free glutamine in the brain a decrease in the concentration of the free glutamic acid in the brain during physical exercise should take place. The correctness of this assumption has now been examined experimentally.



$$COOH.\underset{NH_2}{CH}.CH_2.CH_2.COOH + NH_3 \rightarrow COOH.\underset{NH_2}{CH}.CH_2.CH_2.CONH_2$$

(I)

The experiment was performed on 72 rats weighing 150–200 gm., which were divided into six experimental series. Each experimental series contained twelve rats of approximately the same weight and age. Each experimental series of twelve rats was divided into two groups of six animals. One group swam for 4½ hr. under conditions described previously[2]. The swimming served us as a model of diffuse neuromuscular activity. The second group served as controls. After the cessation of swimming, the rats both of the experimental and the control group were thrown into liquid air and frozen *in vivo*. The frozen brains of the experimental animals were dissected, homogenized to powder by crushing at low temperature and put in a weighed flask containing 100 ml. of 12 per cent trichloroacetic acid. Into a second flask the brains of animals of the control group were put in the same way. The wet weight of the brains was determined by differential weighing. The trichloroacetic acid was then filtered off, and the rest of the tissue was extracted three times with 50 ml. of 12 per cent trichloroacetic acid solution. From the combined trichloroacetic extract, after removal of glutamine and trichloroacetic acid, an aqueous solution of amino-acids contained in the acid-soluble rat brain fraction was prepared according to the method of Ansell and Richter[4]. This aqueous solution was used for the chromatographic separation of amino-acids. On the chromatographic paper, 15-$\mu$l. volumes of the aqueous amino-acid solution were applied, which corresponds to 30 mgm. of wet brain tissue. Under our conditions of chromatography, no desalting procedure was necessary.

As shown in the paper of Fischer and Dörfel[5], only one-dimensional chromatography is suitable for quantitative determination of amino-acids on paper. Amino-acids of the control and the fatigued group of one experimental series were applied on a sheet of filter paper Whatman No. 1, using always on one paper four samples of the control group of a series and four samples of the fatigued group of the same series, alternately. The amino-acids were separated one-dimensionally by repeated (10–12 times) descending chromatography with a butanol/acetic acid/water mixture[6]. After complete separation of amino-acids, which takes about a fortnight, the chromatogram was developed by ninhydrin, photographed on microfilm and the microfilm evaluated microphotometrically on a Soviet microphotometer (*MF-2*). For the separation and the quantitative evaluation of amino-acids, the method described by Keil[6] was used with slight modifications.

Fig. 1 represents a chromatogram of one experimental series (series No. 5). The sample of the experimental group is marked with the letter $N_1$ (first column from the left), next is the sample of the fatigued group, marked with the letter $P_1$ (second column from the left). Then follows the sample of the control group ($N_2$) and again a sample of the fatigued group ($P_2$). In the middle of the chromatogram, a sample of ovalbumin hydrolysate ($O$) is applied, the composition of which is known, and which is applied for the identification of amino-acids. To the right from the ovalbumin sample are again applied alternately the sample of the control and the fatigued group ($N_3$, $P_3$, $N_4$, $P_4$).

Fig. 2 gives a typical microphotometric evaluation (column $N_3$ and $P_3$ from chromatogram No. V) of our chromatograms. The 'spectra' of the free amino-acids of the control group are drawn with a full line,

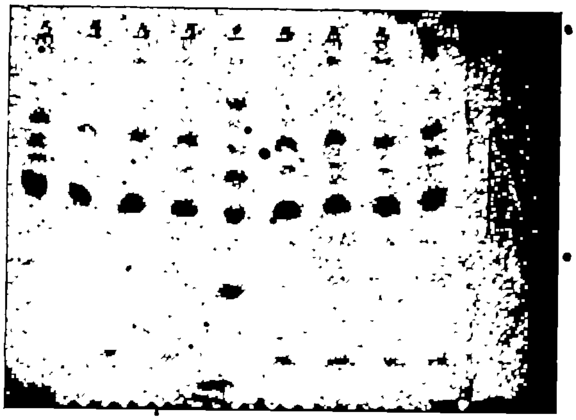


Fig. 1

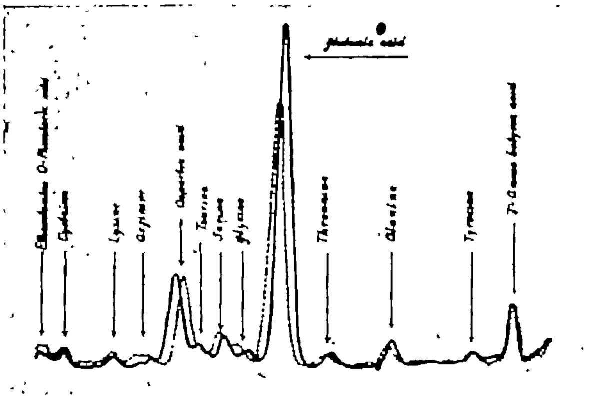


Fig. 2

and the dotted line corresponds to free amino-acids in the brains of the fatigued group of animals. Each maximum corresponds to one amino-acid, and the area below the maximum is proportional to the concentration of the respective amino-acid. The difference between the control and the fatigued group is shown by the fact that in the acid-soluble fraction of brains of the fatigued group the concentration of glutamic acid is always lower than in the control group. The curves were checked planimetrically. As to the rest of the amino-acids, their concentration either does not change during physical exertion, or minute variations upwards or downwards appeared, as is usually the case with biological materials. The concentrations of the free glutamic acid, however, were in all six experimental series lower in the brains of the fatigued animal group in comparison with the respective control group ($P < 0.01$). From each experimental series four parallel pairs of curves of the 'spectra' of amino-acids of both the control and the fatigued group were constructed on one chromatogram. The results fully confirm our previous assumption[2] that during the functional activity of brain nervous tissue in association with the performance of physical exercise a decrease of the concentration of free glutamic acid in the rat brain takes place. One of the effects of the participation of glutamic acid in this physiological process is the increase of the concentration of free glutamine[2]. A logical conclusion from this fact would be that during the restitution period (that is, during rest after physical exertion) a decrease of the glutamine concentration in the brain should take place. This assumption has been proved experimentally.

The experiment was carried out on eighty-four rats weighing 120–160 gm. each, which were divided into seven experimental series of twelve animals each. The twelve animals of one experimental series swam for 4½ hr. under the conditions described previously[2]. After the cessation of swimming, the twelve experimental animals were divided into two groups of six animals each. One group, the controls, was killed at once, the other group was killed after a rest period of 20 hr. Glutamine was determined in the average sample of brains of the fatigued and the rested group by the modified method of Richter and Dawson[1]. The results are given in Table 1.

The experimental results confirm that, during rest after physical exertion, a statistically significant decrease of the free glutamine concentration in the rat brain takes place. This result confirms, and

Table 1. Effect of Rest on the Free Glutamine Concentration in the Rat Brain

(Each number represents a pooled sample of six brains, determined in each case by four parallel determinations. The results are expressed in µmoles amido-N/gm. wet brain tissue*)

| Series | After 4½ hr. swimming (*A*) | After 4½ hr. swimming + 20 hr. rest (*B*) | Difference (*B* − *A*) | Difference in % |
|---|---|---|---|---|
| 1 | 12·4 | 9·6 | − 2·8 | − 22·6 |
| 2 | 7·95 | 7·75 | − 0·2 | − 2·6 |
| 3 | 7·6 | 7·2 | − 0·4 | − 5·3 |
| 4 | 9·7 | 8·35 | − 1·35 | − 13·9 |
| 5 | 8·5 | 8·0 | − 0·5 | − 5·9 |
| 6 | 11·1 | 10·8 | − 0·3 | − 2·7 |
| 7 | 11·8 | 9·1 | − 2·7 | − 22·9 |
| | | | − 1·18 ± 0·43<br>$P < 0·05$ | |

* The values are not corrected for the free ammonia. During physical exertion no changes of the concentration of free ammonia in the rat brain take place (ref. 2). Maximal error of the method is 2–3 per cent

completes at the same time our previous findings[2], that during physical exercise an increase of the actual concentration of the free glutamine in the rat brain takes place.

The question is raised, however, of the significance of the free glutamine in the brain during rest. The glutamine in the brain is not only the form in which ammonia is transported for excretion from the organism, but it has also another role[7]. In recent years, the great importance of glutamine for the synthesis of polypeptides and proteins has been clarified in a series of papers[8]. In one of our previous papers we examined the effect of physical exertion on the Kjeldahl-nitrogen concentration in the protein fraction of the brain. (By the term 'protein fraction' we understand the rest of the nervous tissue of the rat brain after extraction with trichloroacetic acid and removal of lipids by extraction with organic solvents[3].) The results of this experiment are given in Table 2.

Table 2. Effect of Physical Exertion on the Kjeldahl-Nitrogen Concentration in the Rat Brain Protein Fraction

| Series | Normal (*A*) | After 4½ hr. swimming (*B*) | Difference (*B* − *A*) |
|---|---|---|---|
| 1 | 1116·7 | 1108·4 | − 8·3 |
| 2 | 1002·6 | 931·1 | − 71·5 |
| 3 | 1072·8 | 978·1 | − 94·7 |
| 4 | 958·7 | 936·7 | − 22·0 |
| 5 | 958·6 | 987·6 | + 29·0 |
| 6 | 1040·3 | 1014·1 | − 26·2 |
| | 1024·9 | 992·7 | − 32·2 ± 18·1<br>$P < 0·1$ |

In the course of physical exertion, a decrease in the average concentration of Kjeldahl-nitrogen from 1024·9 µmoles/gm. to 992·7 µmoles/gm. of wet weight brain tissue took place. The difference was −32·2 ± 18·1 µmoles/gm. This decrease is not statistically significant, and we could therefore only state that, on the basis of these figures, we did not find a statistically significant decrease of the Kjeldahl-nitrogen in the brain protein fraction during physical exertion[3].

There is, however, a tendency towards decrease of the Kjeldahl-nitrogen during physical exertion. In six experimental series, each containing twelve experimental animals, a decrease of the Kjeldahl-nitrogen in the brain protein fraction occurred in five cases. We decided, therefore, to study this phenomenon further. Other experimental series were so arranged that all experimental animals were allowed to swim for 4½ hr. Some were killed immediately after cessation of this physical exertion, the others after resting for 20 hr. If the tendency to decrease in the actual concentration of Kjeldahl-nitrogen in the protein fraction of rat brain during physical exertion, as seen in Table 2, is not incidental, then we would expect the protein fraction of rat brain of animals rested after physical exertion to show an increase in the Kjeldahl-nitrogen concentration, in comparison with that of the brain protein fraction of rats killed immediately after physical exertion. The results of this experiment are shown in Table 3.

Table 3. Effect of Rest after Physical Exertion on the Kjeldahl-Nitrogen Concentration in the Rat Brain Protein Fraction

| Series | After 4½ hr. swimming (*A*) | After 4½ hr. swimming + 20 hr. rest (*B*) | Difference (*B* − *A*) |
|---|---|---|---|
| 1 | 889·3 | 939·3 | + 50·0 |
| 2 | 850·0 | 900·0 | + 50·0 |
| 3 | 872·9 | 935·7 | + 62·8 |
| 4 | 983·6 | 985·7 | + 2·1 |
| 5 | 960·7 | 986·2 | + 25·5 |
| 6 | 989·3 | 1064·3 | + 75·0 |
| | 924·3 | 968·5 | + 44·2 ± 10·8<br>$P < 0·01$ |

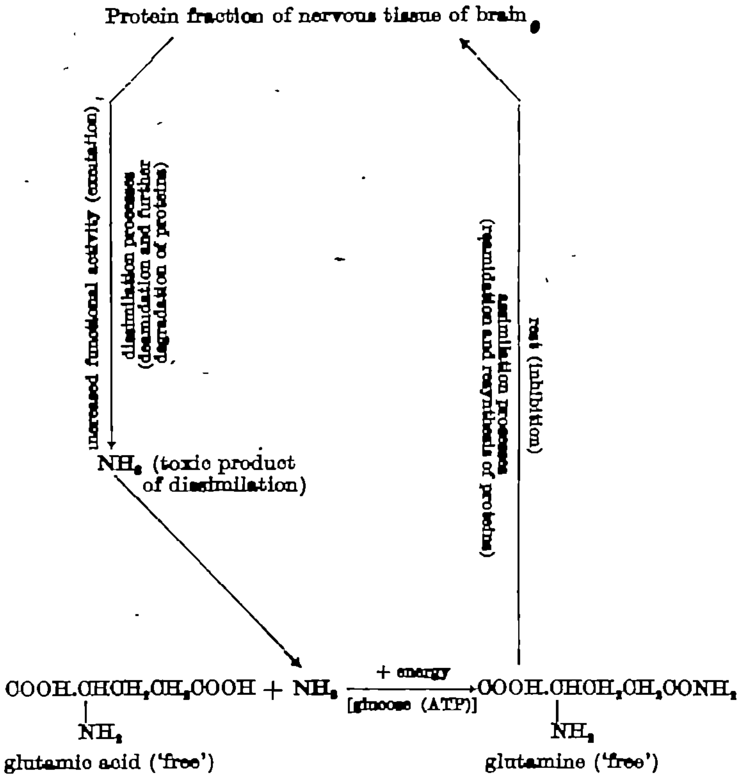
The method we used for Kjeldahl-nitrogen estimation was strictly checked, and it was found that the maximum error of estimation was less than 1 per cent

From Table 3 it is apparent that an increase of the Kjeldahl-nitrogen in the brain fraction of experimental rats takes place in all six series during rest after physical exertion. The difference (+ 44·2 ± 10·8 µmole Kjeldahl-nitrogen/gm. wet brain tissue) is statistically significant ($P \sim 0·01$).

On the basis of the results in Tables 2 and 3, we conclude that during the functional activity of the brain nervous tissue in association with physical exertion, a decrease of the Kjeldahl-nitrogen concentration in the rat brain protein fraction occurs, whereas during rest an increase takes place.

Recently it was shown, using $^{35}$S-methionine, that the metabolic activity of brain proteins is relatively high[9]. Similarly, the cytochemical studies of Hydén showed that the protein and polynucleotide content of the nervous tissue changes during functional activity of the nervous tissue[10]. Our experimental results also show that the metabolic activity of brain proteins is relatively high, and that the processes of functional activity of nervous tissue are associated with metabolic processes in the protein fraction of the brain nervous tissue. During increased functional activity, dissimilation processes are predominant in the protein fraction of the brain nervous tissue, whereas during rest, assimilation processes prevail in this fraction.

On the basis of experimental results given in this and the previous papers, we believe that the following scheme of the chemical processes in the brain provides a working hypothesis: (1) During the functional activity of the brain nervous tissue a degradation of nitrogen substances in the brain protein fraction takes place. One of the first processes indicating the participation of the proteins in the functional activity of the brain nervous tissue is the splitting of the amide-nitrogen off the polypeptidic chain of proteins of the brain nervous tissue. During these degradation processes, ammonia is formed; and the processes mentioned above may be the cause of the well-known fact[1] that the functional activity of the nervous tissue and the formation of ammonia are closely related. (2) Ammonia formed during the functional activity of the brain nervous tissue is a toxic product to the nervous tissue, and it is bound in the brain *in vivo* by the free glutamic acid. This process is manifested by the increase of the concentration of the free glutamine during increased functional activity of the brain nervous tissue in association with diffuse neuromuscular activity[2] and a decrease of free glutamic acid concentration. (3) The free glutamine formed during functional activity of the brain nervous tissue is not only a detoxication product serving for the excretion of ammonia; it is also the basis for the resynthesis of the high-molecular nitrogen-containing substances in the brain nervous tissue during rest. This is shown by the fact that during rest a decrease of the free glutamine in the brain takes place which is associated with the parallel increase in the concentration of Kjeldahl-nitrogen in the brain protein fraction. (4) The functional activity and the rest of the brain nervous tissue are chemically related as a cyclic process of degradation and resynthesis of the protein fraction of the brain nervous tissue. In this cyclic process, the free glutamic acid and the free glutamine occurring in the brain in molecularly dispersed form have an important role. The free glutamic acid has great significance in the final phase of the degradation process of the cyclic changes of brain nervous tissue proteins, as an intercepting link for ammonia, this being the final product of this degradation phase. During this process free glutamine is formed from the free glutamic acid, which is simultaneously an initial link for the phase of resynthesis. The free glutamic acid and the free glutamine represent in the brain a system lying at the turning point for degradation and resynthesis of the protein fraction of brain nervous tissue, and connecting the catabolic and anabolic processes in the brain nervous tissue. The increased functional activity of the brain is characterized by catabolic processes, the decreased functional activity (rest) by the predominance of anabolic processes in the protein fraction of the brain nervous tissue.


Protein fraction of nervous tissue of brain
increased functional activity (excitation)
dissimilation processes (desamidation and further degradation of proteins)
NH₃ (toxic product of dissimilation)
rest (inhibition)
assimilation processes (reamidation and resynthesis of proteins)
+ energy
[glucose (ATP)]
glutamic acid ('free')
glutamine ('free')

$$\underset{\displaystyle NH_2}{COOH.CHCH_2CH_2COOH} + NH_3 \xrightarrow[\text{[glucose (ATP)]}]{+\text{ energy}} \underset{\displaystyle NH_2}{COOH.CHCH_2CH_2CONH_2}$$

(II)

From the formulation of points 1 to 4 results our view of the unity and close relation of the processes of excitation and inhibition from the chemical point of view. During excitation, dissimilation processes in the brain nervous tissue are predominant, but simultaneously also synthetic processes are taking place. During inhibition, synthetic processes predominate, but simultaneously dissimilation processes also take place. The chemical basis of the processes of excitation and inhibition appears to us, in the light of our experiments, as a shift of the equilibrium to one side or the other.

Our findings are in good agreement with the conceptions of I. P. Pavlov, and provide concrete evidence supporting the hypothesis formulated by him in the following way: "The process of inhibition is probably associated with assimilation, similarly, the process of excitation is naturally associated with dissimilation"[11] (inhibition in Pavlov's terminology is understood as an active process).

We wish to emphasize, however, that the chemical basis of the process of excitation and inhibition is undoubtedly represented by a wide complex of chemical processes, and the scheme we have suggested can be only considered as a contribution to the partial clarification of these processes. Similarly, the participation of glutamic acid in the chemical processes associated with the functional activity of the brain nervous tissue cannot be limited only to the chemical process described above.

I wish to thank Mrs. Rosa Ehrmann, Mr. J. Karaus and Mr. J. Vesely for assistance in the experimental work.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Carbon-13 Isotope Effects in the Decarboxylation of some Oxaloacetates

The effect of isotopic substitution on the rate of fission of carbon–carbon bonds has been the subject of many studies over the past eight years. The balance of the experimental evidence indicates that for some decarboxylation reactions the ratio of $^{14}$C- to $^{13}$C-isotope effects may not be readily accounted for by statistical rate-theory on the basis of changes in isotopic mass alone[1]. It has been suggested that apparently anomalous isotope-effect ratios may be due to some effect of carbon-13 nuclear spin[2]. In this connexion, it is of interest that some decarboxylation reactions have been found to be catalysed in aqueous solution by paramagnetic ions[3-5].

We have now measured the carbon-13 isotope effect in the decarboxylation of 'natural' oxaloacetic acid in aqueous solution at 25°, alone, and in the presence of diamagnetic yttrium ($Y^{3+}$) and paramagnetic dysprosium ($Dy^{3+}$) ions.

$$(M^{3+}), {}^{-}OOC.COCH_2 \,|\, {}^{12}COO^{-} \rightarrow {}^{-}OOC.COCH_3 + {}^{12}CO_2 \qquad (1)$$

$$(M^{3+}), {}^{-}OOC.COCH_2 \,|\, {}^{13}COO^{-} \rightarrow {}^{-}OOC.COCH_3 + {}^{13}CO_2 \qquad (2)$$

$M^{3+}$ represents $Y^{3+}$ or $Dy^{3+}$.

The effluent carbon dioxide was analysed with a Metropolitan-Vickers *MS*-2 mass-spectrometer, and the ratio of the rate constants for reactions (1) and (2) was calculated from the measurements of carbon-13 dioxide to carbon-12 dioxide ratios at 5 per cent and at 10 per cent decarboxylation (with the measured ratio for 100 per cent reaction).

CARBON-13 ISOTOPE EFFECTS AT 25°

| | Oxaloacetic acid ($p$H = 1) | $Y^{3+}$ oxaloacetate | $Dy^{3+}$ oxaloacetate |
|---|---|---|---|
| $100\left(\frac{k_{12-12}}{k_{12-13}} - 1\right)$ | 6 | 5 ± 1 | 10 ± 1 |

The mass-spectrometer was not used at its highest level of accuracy, but the above preliminary values show that there is a definite 'magnetic' isotope effect, well in excess of any probable error.

At $p$H = 1, in the absence of added trivalent ions, the carbon dioxide comes in approximately equal amount from undissociated acid and monovalent anion[6]. The isotope effects for these two species are not expected to differ greatly[6], and this is supported by the reasonable agreement with the isotope effect for yttrium oxaloacetate. The experiments in the presence of trivalent ions were so designed that decarboxylation was mainly due to oxaloacetate complexes[5]; thermodynamic association constants for yttrium and dysprosium oxaloacetates are nearly equal[7].

The carbon-13 isotope effects for oxaloacetic acid and for yttrium oxaloacetate are close to those previously observed for decarboxylation reactions, taking into account the observed dependence on temperature[6]. The carbon-13 isotope effect for dysprosium oxaloacetate is very considerably higher. The dysprosium ion is known to cause an acceleration in the rate of fission of $^{12}C-^{12}C$ bonds specifically by virtue of its unpaired 4*f* electrons[4,5]. A comparison of the isotope effects we have found shows that the paramagnetic dysprosium ion catalyses the fission of $^{12}C-^{12}C$ bonds about 4 per cent more strongly than the fission of $^{12}C-^{13}C$ bonds.

One possible interpretation of this 'magnetic' isotope effect is that carbon-13 nuclear spin – electron spin interactions are of the same order of magnitude as the electron spin – electron spin interactions produced at a greater distance by the paramagnetic ion. The effect of the paramagnetic dysprosium ion will then be greater on $^{12}C-^{12}C$ bonds than on $^{12}C-^{13}C$ bonds, where the carbon-13 nuclear spin effect will already be operative. Confirmation of this hypothesis will be sought in a series of similar experiments on carbon-14 isotope effects, carbon-14 having zero nuclear spin.

A full account of this work will be published in due course.

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## Counting Tritiated Water at High Humidities in the Geiger Region

A METHOD for the direct counting of tritiated water in the Geiger region at high humidities would be most useful. Heretofore, tritiated water has been counted in the Geiger region at pressures less than 2 mm.[1]; or the water has been allowed to react with zinc[2], and the resulting hydrogen counted in a Geiger–Müller tube; or the water has been allowed to react with calcium carbide[3] or aluminium carbide[4] to produce acetylene, which could then be counted. Recently, Nilsson and Aniansson[5] developed a flow counter which would operate in the proportional region with high-humidity gas. They attributed their success to the use of gases such as ethane, propane or *n*-butane, which have ionization potentials lower than that of water vapour. I have succeeded in counting in the Geiger region with a high-humidity gas, a 1·3 per cent *iso*butane-in-helium mixture (Nuclear Chicago *Q*-gas) being used as the flow gas.

A brass counter 5¾ in. long and 1⅛ in. inside diameter was built. An 'Amphenol 82–805' 'Teflon'-insulated connector in the closed end of the brass tube served as the high-voltage connector, and also carried a brass rod ⅛ in. in diameter and 1⅜ in. long to which was attached the anode—a tungsten wire 4 mils in diameter and 1¼ in. long. An opening ⅜ in. in diameter and 2⅜ in. from the top of the tube served as a window over which a source of activity could be placed. The metal planchet carrying the activity was sealed to the tube with 'Apiezon-*Q*'. The window looked directly into the middle of the sensitive volume of the tube. The flow gas entered through a copper tube at the top and left through a copper tube at the

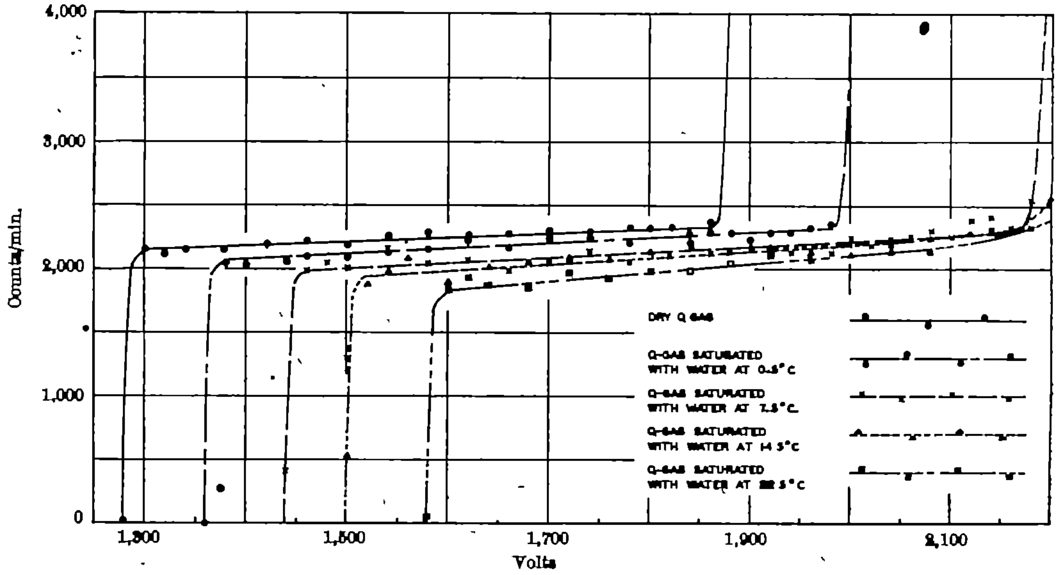

Fig. 1. Geiger plateaux for Q-gas containing various amounts of water vapour

bottom of the counter. The bottom of the brass tube was sealed by a metal plate and 'Apiezon-Q'.

The Q-gas left the storage cylinder through a reducing valve, entered a coil of copper tubing immersed in a Dewar flask, entered a saturator also in the same Dewar, entered another copper coil in a second Dewar, entered the counter, and then escaped through a bubbler which indicated the rate of gas flow. The first Dewar flask was filled with water at the temperature at which it was desired to saturate the gas. The second Dewar contained water at a degree or so below room temperature and served to warm the gas-plus-water vapour back to room temperature.

Sodium-22 in the form of sodium chloride was used as a source of activity. The source contained on a small aluminium planchet was placed over the window of the counter. Table 1 gives the temperatures of the water in the saturator, the vapour pressure of water at these temperatures, and the corresponding relative humidities at a room temperature of 33° C.

Table 1

| Dewar 1 temperature, ° C. | Vapour pressure of water (mm. mercury) | Per cent relative humidity (room temperature, 33° C.) |
|---|---|---|
| 0·5 | 4·75 | 12·6 |
| 7·5 | 7·78 | 20·6 |
| 14·5 | 12·38 | 32·3 |
| 22·0 | 19·82 | 52·6 |

Fig. 1 shows the Geiger plateaux obtained with the 'dry' Q-gas and with the gas containing varying quantities of water. The slopes of these plateaux increase as the water vapour in the gas increases. The slope for Q-gas alone is 1·64 per cent per 100 V. and that for Q-gas at a relative humidity of 52·6 per cent is 3·64 per cent. All of the plateaux are long, ranging from 600 V. to 400 V. The downward displacements and the changes in the slopes of the plateaux are probably caused by a change in the sensitive volume of the tube as a result of the presence of water vapour. The water dipoles apparently modify the electric field between anode and cathode.

0·01 ml. of tritiated water having a specific activity of 10 mc. per ml. was diluted to 10 ml. in a volumetric flask. 5 ml. of this solution was diluted to 10 ml. in a second volumetric flask, etc. A series of five solutions, each differing from the previous one by a factor of ½, was thus prepared. About 3 ml. of a given solution was placed in the saturator, which was then put in the Dewar and brought to 0° C. by means of an ice–water mixture. The voltage on the scaler was set at 1,660 V. Q-gas was allowed to flow through the system and counts were taken over successive 5-min. intervals until the counting-rate became constant within the statistical error involved. This process took about one hour. The results are plotted on a relative basis in Fig. 2. The points all lie on a straight line and intersect the zero con-

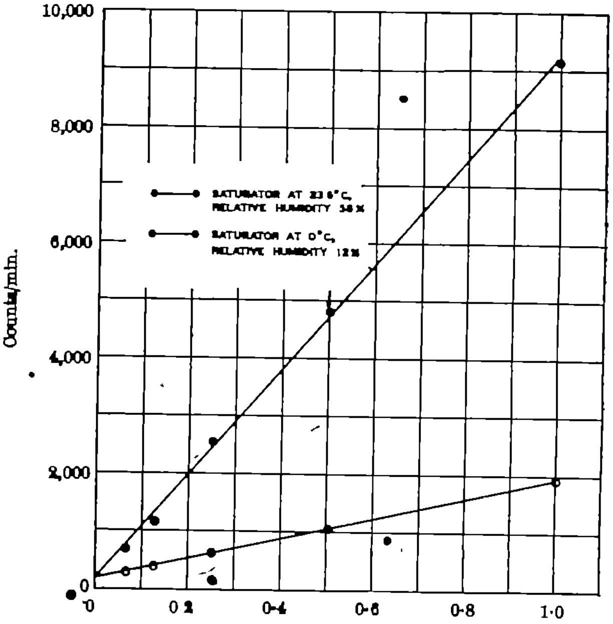

Fig. 2. Linear response of the counter as a function of the concentration of tritiated water

centration axis at 175 c./min., which agrees well with the measured background of 162 c./min., as it should. Another set of results for this series of tritiated water solutions was obtained with the water in the saturator maintained at 23·6° C.; these, which are also plotted in Fig. 2, show much more scatter than do the results obtained at 0° C., because the temperature was not maintained at exactly 23·6° C. but fluctuated about this value.

The results obtained demonstrate the feasibility of counting in the Geiger region at high relative humidities. They point to the almost certain possibility of absolute counting for tritium in the form of THO. The results also indicate the possibilities for the design of counters specifically to be used at high humidities. The paper by Cockcroft and Curran[6] is particularly suggestive in this light.

More complete and extensive results will be presented elsewhere as the work progresses. I wish to thank Dr. W. H. Johnson of Purdue University for his helpful comments.

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## Measurement of Tritium in Water Samples

THE concentration of tritium in water samples has been measured by a new method which is both simple and rapid. The beta-rays of very low energy which are emitted by tritium are very difficult to count because of their inability to penetrate the windows of conventional Geiger counters. It has therefore been the practice for some time to introduce the tritium in various chemical combinations into the interior of a counter.

The method to be described consists of introducing the tritium in the form of water vapour as part of the filling of an internal gas counter. Any tritium atoms disintegrating inside the sensitive volume of the counter give rise to counts, and from the observed count-rate the number of tritium atoms present is evaluated.

The water vapour at saturation vapour pressure is introduced and the filling completed with 10–15 cm. pressure of a standard argon–alcohol mixture. An accurate measure of the pressure of the water vapour is obtained from the temperature and tables of saturation vapour pressures.

The argon–alcohol mixture is prepared beforehand in the normal ratio of 9 to 1, and stored in a 5-litre glass bulb at an initial pressure of 30 cm. Absolute alcohol is used and the argon is purified by flowing through a charcoal trap at liquid-nitrogen temperature.

Counters manufactured by Twentieth Century Electronics, type GA.10.M., are used. The outer envelope is made of glass and the cathode is of steel. The sensitive volume of the counter is about 50 c.c.

Using these counters in conjunction with an external quench unit, type 1014A, consistent plateaux are obtained with a length of more than 400 V. and a slope less than 2 per cent per 100 V. The threshold voltage is about 1,400. The efficiency, as compared with a 10-cm. argon filling and using an external source of cobalt-60, is 98 per cent. The counters are not sensitive to light. If, after counting at a rate of 10,000 per min., the counter is pumped only for a few minutes, the residual contamination produces about 200 counts per min. This is easily removed by flushing two or three times with pure water vapour and if necessary heating slightly.

The normal working pressure of the vacuum apparatus is 1 micron, which can easily be obtained with a single-stage rotary vacuum pump and a liquid-nitrogen trap.

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## The Reduction of Vitamin $B_{12}$

Two distinct reduction products of vitamin $B_{12}$ have been described in the literature, by Diehl and Murie[1] and by Boos, Carr and Conn[2]; we shall refer to these as I and II respectively. They differ in their method of preparation, and have widely different absorption spectra in the visible and ultra-violet, but may both be re-oxidized to vitamin $B_{12a}$ by exposure to air, and from polarographic and titrimetric evidence both are claimed to contain divalent cobalt.

Compounds with spectra closely resembling that of I may be obtained by the action of a variety of reducing agents on vitamin $B_{12}$. Diehl and Murie employed catalytic hydrogenation; but cysteine in alkaline solution, lithium boron hydride, heating in 96 per cent ethanol for 12 hr. at 100° C. in a nitrogen atmosphere, and chromous acetate in aqueous solution, all give similar products, at least initially.

Hydrogenation, using palladium on barium sulphate as catalyst, readily continues beyond the stage represented by I, which in consequence cannot be obtained in a pure state by this method. For this reason, vitamin $B_{12a}$ is obtained in yields of only 60–70 per cent on re-oxidation (Boos *et al.*[2]; Brockman *et al.*[3]). Hydrogenation finally results in visually colourless products with ill-defined ultra-violet absorption; but intermediate compounds with diminished visible colour may also be obtained. On exposure to air, these give brown compounds with spectra somewhat similar to that of I, but which are altered by *p*H changes. They also form reddish cyanide derivatives. They are characterized by rather broad bands in the 435–450-mμ region, and the benziminazole of the nucleotide is no longer co-ordinated to the cobalt, as indicated by the sensitivity[4] of the spectra in the 280 mμ region to *p*H. A very similar sequence is obtained by reduction with lithium boron hydride in aqueous solution. Reduction with chromous acetate in aqueous solution (*p*H *c.* 5), however, was found to give a solution of I which was stable indefinitely in a hydrogen atmosphere, even in the presence of excess reducing agent. Its spectrum (see Fig. 1) is very similar to that given by Diehl and Murie, and re-oxidation to vitamin $B_{12a}$ appears to be substantially quantitative.

Boos *et al.* obtained II by reduction of vitamin $B_{12}$ in ethylenediaminetetraacetate buffer at *p*H 9·5 with chromous chloride. They observed, however, that the product obtained by the addition of one equivalent of the chromous salt was brown, whereas II has a characteristic grey-green colour (see Fig. 1). We have reduced vitamin $B_{12}$ in a similar manner, by addition of small amounts of solid chromous acetate to a de-aerated solution of the vitamin in a hydrogen atmosphere, and have found that in ethylenediaminetetraacetate buffer at *p*H 3 the reduction product is exclusively I. At *p*H 9·5 II results if an excess of the reducing agent is used; but I appears as an intermediate product, and with smaller amounts of chromous salt the reduction may be stopped at this stage. The sequence may be reversed by cautious aerial oxidation of a solution of II, which thus appears to be a more highly reduced form of vitamin $B_{12}$ than I.

Both I and II are formed as readily from vitamin $B_{12a}$ as from vitamin $B_{12}$, and II may also be prepared from a solution of vitamin $B_{12}$ (as the purple dicyanide) in dilute potassium cyanide solution at *p*H 9·5. Its formation does not therefore depend on the presence either of cyanide ion or of ethylenediaminetetraacetate. The oxidation of I by cyanide as described by Diehl is questionable.

The ready re-oxidation of both I and II to vitamin $B_{12a}$ suggests that in both cases the organic part of the molecule has not been significantly affected, and that the changes have concerned the state of oxidation of the cobalt only. In this case the differences between the spectra of I and II are remarkable. That of II even suggests increased conjugation of some kind, possibly resulting from a rearrangement of double bonds, accompanied by release of the benziminazole from co-ordination, as is indicated by increased resolution of the benziminazole fine-structure.

In this connexion it might perhaps be suggested here that the spectrum of vitamin $B_{12}$ may be better accounted for by the addition of one extra double bond to the structures given as alternatives by Crowfoot *et al.*[5] and by Todd and co-workers[6]. The possibility of such an additional double bond is mentioned by Crowfoot *et al.*, and the two alternative structures would then be capable of resonance. The evidence, based on chlorination, in support of the structures as given does not seem sufficiently weighty to rule out completely this possibility. Activated positions susceptible to chlorination still remain in the structures with six conjugated double bonds, and although a further increase in conjugation by elimination of hydrogen chloride cannot then occur so obviously, the spectrum of reduction product II suggests that a long-wave shift of the vitamin $B_{12}$ spectrum may not necessarily require the introduction of additional unsaturation into the molecule.

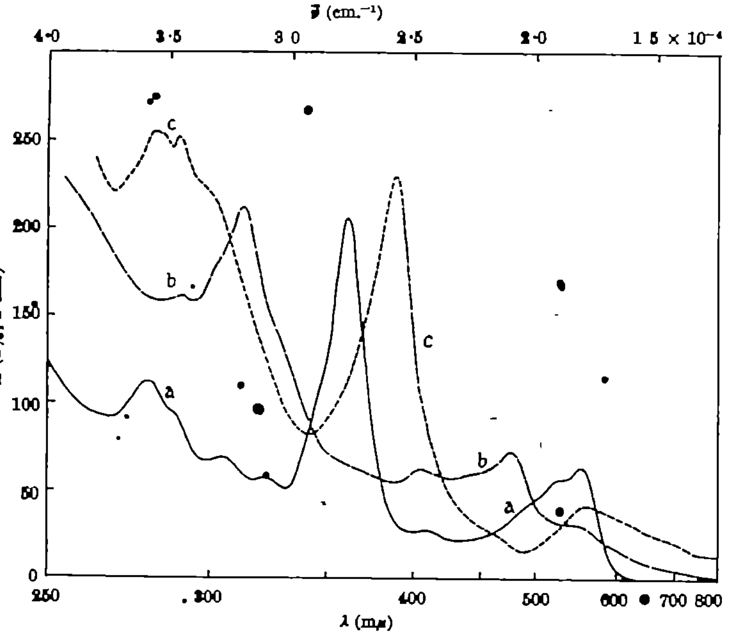

Fig. 1. (*a*) ———, vitamin $B_{12}$ in water; (*b*) — — —, brown reduction product (I), (*c*) - - - - - - -, grey-green reduction product (II). The abscissa is linear in wave-number ($\bar{\nu}$), and the ordinate in extinction coefficient, E(1%, 1 cm.)

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## Genetic Control of some Serum Proteins in Normal Humans

IN a previous communication[1], one of us described the grouping of normal individuals into three groups (I, II*A* and II*B*) on the basis of differences in their serum proteins. A full account of the starch-gel electrophoretic method used for demonstrating these differences and a discussion of the validity of the consequent groupings are now in the press[2]. In these two papers it was suggested that the serum group of a given individual might be fixed and determined by genetic factors.

The distribution of the serum groups in forty-one normal adults unrelated by consanguinity or marriage was found in the earlier work to be: group I, 8; group II*A*, 21; and group II*B*, 12; that is, approximately 1 : 2 : 1. No significant difference was observed in the distribution in males and females. These results suggested to us that the serum group of an individual is controlled by two autosomal genes with incomplete dominance, the frequency of occurrence of the two genes being approximately equal. If this hypothesis is correct, individuals in group I have one type of homozygous combination of genes, those in group II*A* have the heterozygous combination, and those in group II*B* have the other type of homozygous combination of genes.

Table 1

| Types of mating | Expected proportions of offspring | | |
|---|---|---|---|
| | Group I | Group II*A* | Group II*B* |
| I × I | 1·0 | — | — |
| I × II*A* | 0·5 | 0·5 | — |
| I × II*B* | — | 1·0 | — |
| II*A* × II*A* | 0·25 | 0·5 | 0·25 |
| II*A* × II*B* | — | 0·5 | 0·5 |
| II*B* × II*B* | — | — | 1·0 |

We have therefore commenced a study of families to investigate the hypothesis, and this communication reports on the results obtained so far from eighteen families. It is our intention to increase the number of families to at least fifty; but the results have been sufficiently definite to warrant an interim report on the present smaller number.

Table 1 shows the possible types of matings and the expected frequencies of the offspring among the three serum groups for each mating.

Table 2 shows the results we have obtained from the eighteen families. In every case the offspring were found to have serum groups in complete agreement with the genetic theory, and the observed and expected distribution of the offspring among the three serum groups for all the matings observed were not significantly different. Consequently, on the basis of the eighteen families so far studied, we suggest that the genetic hypothesis here described is correct, and that the serum group of an individual is indeed controlled by two autosomal genes with incomplete dominance.

It will be noted that we have not observed matings of the types I × II*A* and I × II*B*, although the frequencies of occurrence of the three serum groups in unrelated individuals led us to expect five or six of these matings out of eighteen. This may well be a reflexion of the smallness of our present sample; but the possibility of an incompatibility between certain of the groups with a consequent decrease in the fertility of the respective marriages is receiving our attention.

Through the kindness of Dr. Bruce Chown (Children's Hospital, Winnipeg) a determination of the previously known blood groups [*ABO*, *MNS*, *CDE* (*Rh* factor), *K* (Kell), *JK* (Kidd), *Fy* (Duffy), *Le* (Lewis) and *Lu* (Lutheran)] has been made for all individuals comprising the eighteen families so far studied. No direct correlation of any of these blood groups with the new serum groups has been observed. Consequently the medico-legal aspects of the new inherited serum groups will be appreciated, especially as the two genes which control the serum groups occur with approximately equal frequencies.

Table 2

| Types of mating | Total matings | Total offspring | Offspring serum groups | | | | |
|---|---|---|---|---|---|---|---|
| | | | | I | II*A* | II*B* | |
| I × I | 1 | 2 | Observed | 2 | 0 | 0 | |
| | | | Expected | 2 | 0 | 0 | |
| I × II*A* | 0 | 0 | Observed | – | – | – | |
| | | | Expected | – | – | – | |
| I × II*B* | 0 | 0 | Observed | – | – | – | |
| | | | Expected | – | – | – | |
| II*A* × II*A* | 8 | 20 | Observed | 8 | 8 | 4 | $\chi^2 = 2\cdot4$ |
| | | | Expected | 5 | 10 | 5 | $P = 0\cdot3$ |
| II*A* × II*B* | 5 | 8 | Observed | 0 | 5 | 3 | $\chi^2 = 0\cdot5$ |
| | | | Expected | 0 | 4 | 4 | $P = 0\cdot5$ |
| II*B* × II*B* | 4 | 9 | Observed | 0 | 0 | 9 | |
| | | | Expected | 0 | 0 | 9 | |

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## Production of 'O Inagglutinability' in Erythrocytes coated with Typhoid Vi and O Antigens

STRAINS of *Salmonella typhosa* resistant to agglutination by *O* antibody, although containing the characteristic *O* antigen, were observed by Felix and Pitt to be considerably more virulent for mice than strains which were readily agglutinated by *O* antibody. This '*O* inagglutinability' of virulent typhoid cultures was eventually shown by these workers to be associated with the presence of an additional component, the Vi antigen, which had a pronounced effect on the behaviour of the *O* antigen[1].

The phenomenon of '*O* inagglutinability' which led to the discovery of the Vi antigen is the most distinctive and also the most vulnerable property of the Vi antigen of *S. typhosa*. During the past decade, analogous phenomena have been described in certain coliforms and shigella. It therefore seems likely that it is of rather frequent occurrence among enteric species.

The fact that the presence of Vi antigen prevents the agglutination of typhoid bacilli by *O* antibody has been interpreted by some to mean that the Vi antigen is a more superficially located component covering or blanketing the *O* antigen, whereas others favour the view that the Vi antigen so affects the bacterial surface that, by steric hindrance, union of the *O* antigen, also at the cell surface, with its own antibody is prevented.

During the course of studies on the interaction of purified bacterial polysaccharides and erythrocytes, we observed that the phenomenon of '*O* inagglutinability' could readily be reproduced experimentally. Thus when purified Vi and *O* antigens were adsorbed on washed human or sheep erythrocytes either simultaneously or consecutively in either sequence, increasing concentrations of the Vi antigen resulted in a progressive reduction in the agglutinability of the erythrocytes by typhoid *O* antiserum. On the other hand, the Vi agglutinative properties of the suspension remained unaffected.

The Vi antigen employed was isolated from *Escherichia coli* 5396/38. This acidic, highly polymerized polysaccharide is believed to be composed of units of N-acetylamino-hexuronic acid[2]. In its immunological specificity it is indistinguishable from the Vi antigen of *Paracolobactrum ballerup*, *S. typhosa*, and *S. paratyphi* C[3]. The *O* antigen was isolated from the 0901 strain of *S. typhosa* and characterized as a protein-free phosphorylated lipopolysaccharide possessing the immunological and endotoxic attributes of the intact organism[4]. The technical details of sensitization of red cells with these products and their reactions in the hæmagglutination procedure have been described elsewhere[5].

It was reported earlier that erythrocytes could be sensitized with a number of purified bacterial polysaccharides either simultaneously or consecutively without discernible interference of one antigen with the activity of any other[4]. However, the concentration of antigens employed (generally 1 µgm. per ml. of 1 per cent red-cell suspension) was only slightly in excess of the amount required for maximal agglutinative activity. In the present study it was observed that when erythrocytes were treated with *O* and Vi antigens, suppression of agglutination by typhoid *O* antibody occurred when the concentration of Vi antigen employed was 10 µgm. or more per ml. of a 1 per cent red-cell suspension. The results of a typical experiment are given in Table 1. Washed erythrocytes were treated with various concentrations of the purified antigens, singly, consecutively or simultaneously, the treated cells washed three times to remove unadsorbed antigen, made up to a 1 per cent suspension, and set up with *O* and Vi antibacterial sera. Inspection of this arrangement shows that concentrations of Vi antigen sufficient to bring about maximal hæmagglutination by Vi antibody have no discernible effect on the typhoid *O* reactivity of these erythrocytes. However, when the amount of Vi antigen employed for sensitization is increased to 10 µgm., a significant reduction in reaction with typhoid *O* antibody occurs. This diminution of *O* agglutinability becomes more pronounced as the quantity of Vi antigen is increased, and at the highest level tested (100 µgm.) the agglutination titre with *O* antiserum was reduced from 1 : 2,560 to 1 : 80. These results indicate that the extent to which erythrocytes treated with *O* antigen react with specific antibody is inversely related to the concentration of Vi antigen to which the cells were exposed.

These findings are in harmony with the early observations of Felix[7] that *O* inagglutinable strains of *S. typhosa* contain the maximum amount of Vi antigen, whereas strains which are readily agglutinated by *O* antibody contain considerably less. Recently, a comparison of the Vi antigen content of the well-known *O* inagglutinable *Ty2* and fully *O* agglutinable '58' strains of *S. typhosa* showed that, in terms of immunogenic potency and the quantity of Vi antigen actually isolated, the *Ty2* strain contained five to ten times as much Vi antigen as the *O* agglutinable strain '58'[8].

Table 1. '*O* INAGGLUTINABILITY' IN BACTERIA AND IN ERYTHROCYTES CONDITIONED BY VI ANTIGEN

| Agglutinating systems | Agglutinating antisera (reciprocal of end titres) | |
|---|---|---|
| | Anti *O* (*S. typhosa* 0901) | Anti Vi (*P. ballerup*) |
| Bacterial suspensions | | |
| *S. typhosa Ty2* viable | 40 | 320 |
| ,, heated 1 hr. at 98° C. | 2,560 | < 20 |
| Erythrocyte suspensions (human, group *A*1) treated with*: | | |
| (*a*) *O* antigen followed by Vi antigen | | |
| 10 µgm. *O* No Vi | 2,560 | Neg. |
| ,, 1 µgm. Vi | 2,560 | 640 |
| ,, 10 ,, | 640 | 640 |
| ,, 30 ,, | 160 | 640 |
| ,, 100 ,, | 80 | 640 |
| (*b*) Vi antigen followed by *O* antigen | | |
| 10 µgm. Vi No *O* | Neg. | 640 |
| 10 ,, 10 µgm. *O* | 640 | 640 |
| 30 ,, ,, | 160 | 640 |
| 100 ,, ,, | 80 | 640 |
| (*c*) Vi and *O* antigens simultaneously | | |
| 30 µgm. Vi 10 µgm. *O* | 160 | 640 |
| 100 ,, 10 ,, | 80 | 640 |

* Per ml. of 1 per cent red-cell suspension.

Thus the phenomenon of *O* inagglutinability, so well known in typhoid serology, has been in large part duplicated in an experimental model employing erythrocytes and purified Vi and *O* antigens. The interference with *O* agglutination has been shown to be related to the concentration of Vi antigen employed to treat the red cells. These observations provide supporting evidence for the thesis that *O* inagglutinability is an indicator of high or maximal content of Vi antigen in typhoid cultures. They may also be pertinent to the controversy concerning the relative positions of the Vi and *O* antigens on the bacterial surface. The fact that the suppression of *O* agglutinability by Vi antigen occurs regardless of the order in which the Vi and *O* antigens are adsorbed on erythrocytes suggests that '*O* inagglutinability' is not attributable to the 'covering' of the *O* antigen by Vi, but rather is brought about by steric hindrance or a non-specific stabilization of the cell by certain physico-chemical properties peculiar to the Vi antigen. Suppression of agglutination is not restricted to the typhoid *O* antigen adsorbed on red cells, since other bacterial polysaccharides applied to red cells are similarly affected by the Vi antigen. The non-specificity of this blocking action by Vi antigen is further attested in experiments (unpublished results) in which we found that adsorption of Vi antigen on human erythrocytes, in addition to affecting the reaction of other bacterial antigens adsorbed on the red cell, as here described, also suppresses or interferes with blood-group agglutinability, that is, antigens native to the red cell.

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## Fat Production by Inositol-deficient Yeast

THE growth of a yeast (*Saccharomyces cerevisiae*) and a bacterium in mixed culture in a defined medium containing an abnormally low concentration of growth factors has been studied by Challinor and Rose[1], who observed a number of inter-relationships between the two organisms under these conditions. During the continuation of this work, growth of the yeast in a medium in which the concentration of a single growth factor (inositol) was reduced below the normal level was studied, and interesting changes in the morphological and physiological characters of the yeast were observed. Thus, microscopical examination revealed that the deficient cells formed large aggregates and were more granular than normal cells. These differences were clearly seen after two days growth and became more marked during further incubation. After about three days, the deficient cells were obviously unhealthy in appearance and were easily ruptured, for example, by pressing the coverslip lightly once only. The ease with which rupturing took place increased on further incubation, and after five days very little pressure indeed was required to release the cell contents. A large part of the material so released was oily in nature, and the small droplets coalesced to form large globules which gave typical staining reactions for fats when treated with sudan III and with osmic acid. Normal cells behaved very differently, considerable pressure being required to cause rupture, and then only a proportion of the cells were broken, releasing very little fatty material.

Smith[2] has studied the role of inositol in the nutrition of *S. carlsbergensis*, and he observed that under conditions of inositol-deficiency the yeast grew abnormally, forming aggregates; but he did not comment on the strength of the cell wall or upon fat formation. In view of (1) the apparent high proportion of fatty substances in our deficient cells as compared with the normal cells, and (2) the ease with which these substances were liberated, it was decided to measure the fat production by inositol-deficient cells. Fat production was followed in media containing normal and deficient amounts of inositol, and with ammonium monohydrogen phosphate as the source of nitrogen. The effect of variation of the carbon–nitrogen ratio was studied by reducing the amount of ammonium phosphate to 50 per cent and to 37·5 per cent of the amount in the normal medium. This medium contained: glucose (6 per cent), ammonium hydrogen phosphate (0·237 per cent), adenine, guanine and uracil each 10 μgm./ml., D-biotin 2·2 mμgm./ml., calcium-D-pantothenate 2·5 μgm./ml., thiamine hydrochloride 2 μgm./ml., pyridoxin hydrochloride 2·5 μgm./ml., nicotinic acid 2 μgm./ml., pteroylglutamic acid 0·1 μgm./ml., salts, and inositol 10 μgm./ml. In the deficient media the amount of inositol was reduced to only 0·6 μgm./ml.

The yeast was grown in culture bottles (Glaxo pattern, 2·5 litres capacity; 300 ml. medium per bottle) at 30° C., harvested after five days and the cells ground in a Griffiths tube and dried overnight; the fatty substances were then extracted with 40–60° light petroleum (five consecutive extractions). The yield of fatty substances from the inositol-deficient cells (274 mgm.) was 67 mgm. (24·5 per cent) as compared with only 7·9 mgm. (1·6 per cent) from the normal cells (489 mgm.).

These extractions were carried out at room temperature, and the amount of fat taken out by each extraction was weighed separately so that the ease of extraction from cells grown in the different media could be ascertained. Results indicated that this procedure gave satisfactory extraction from the inositol-deficient cells grown in the medium containing the full amount of ammonium phosphate; but the cells grown in each of the two media containing the reduced amounts of ammonium phosphate did not liberate fat quite so easily and extraction was not quite complete. The yields of fat from the cells grown in each of the latter two media were 60 mgm. (24·7 per cent) and 54 mgm. (22·6 per cent) respectively and, having regard to the above considerations, these yields would not appear to be materially different from that obtained from inositol-deficient cells grown in the medium containing the full amount of ammonium phosphate.

If fat is to be produced commercially from micro-organisms, ease of extraction would be a factor of importance. In view of the ease with which the fat was released from the inositol-deficient yeast, it was decided to extract the cells directly with light petroleum without previous grinding. The yield of fatty substances thus obtained was 59 mgm. (22·3 per cent of the dry weight of the cells), that is, approximately 91 per cent of that extracted from cells which had been ground before extraction. The difference in ease of extraction of the ground and unground cells was therefore small, and it seems likely that it would be narrowed still further by using a higher temperature for the extraction.

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## Autoradiographic Localization of Iodine-131 in the Salivary Glands of the Hamster

THE concentration of iodide in human saliva is known to be many times greater than the concentration in the plasma[1]. We have identified the structures associated with a similar iodide-concentrating mechanism in the submaxillary and parotid salivary glands of the hamster. Radioiodide (500 μc. of iodine-131) was injected intraperitoneally into an adult hamster. One hour later, with the animal under ether anæsthesia, the right submaxillary and parotid glands, together with a piece of muscle, were removed and dropped immediately into a vessel containing difluorodichloromethane cooled in liquid air. The frozen tissues were crushed in a mortar cooled in liquid air, and the fragments freeze-dried at − 40°. Contact autoradiographs were then made from sections 7μ thick by a method already described[2]. The concentration of iodine-131 was also measured in portions of the opposite salivary glands, in muscle, and in plasma and saliva removed immediately after the samples were taken for autoradiography. Table 1 shows the ratio of the concentrations of iodine-131 in tissue and plasma in each of the samples.

Table 1

| Tissue | Concentration ratio |
|---|---|
| Submaxillary gland | 5·3 |
| Parotid gland | 1·7 |
| Muscle | 0·4 |
| Saliva | 28·0 |

In sections of the submaxillary gland stained with hæmatoxylin and eosin the ducts could be distinguished by their palely staining cells, and the areas of blackening in the autoradiograph were found to be confined to the ducts. Under high magnification it is possible to distinguish the proximal (acinar) parts of the duct system from the distal ones. Proximally, the lumen is inconspicuous and the lining cells are tall with basal nuclei, whereas the distal part has a wider lumen and is lined by cuboidal cells with central nuclei. Fig. 1*a* shows a branched duct cut longitudinally, with a blood vessel adjacent to it. The intensity of blackening in the autoradiograph (Fig. 1*b*) is no greater over the acini than that over the blood vessel. Blackening is most intense over the proximal portion of the branched duct and over other ducts in which the proximal part has been cut transversely. Over some of the distal portions of ducts the intensity of blackening is only a little greater than that over blood vessels or acini.

In sections of the parotid gland stained by the periodic acid – Schiff method, two types of ducts can be distinguished (Fig. 2*a*). The proximal portions have a narrow lumen and are lined by dark flat cells, whereas the distal portions have a wide lumen and are lined by large pale cuboidal cells. The pattern of blackening in the autoradiograph (Fig. 2*b*) is seen to correspond with the distal ducts. The intensity of blackening over the acini and over the proximal ducts is no greater than that over blood vessels. The concentration of iodine-131 in the parotid ducts was much less than that in the submaxillary ducts, as judged by the times of exposure needed to give the same degree of blackening in the two sections.

Autoradiographs made from frozen sections of muscle treated in the same way as the sections of submaxillary and parotid glands showed no blackening. Autoradiographs made from frozen sections of submaxillary and parotid, treated with water after alcohol fixation, showed no blackening.

From the pattern of blackening described above, we conclude that the mechanism responsible for concentrating iodide in the saliva of the hamster is present in certain parts of the duct system of the submaxillary and parotid glands. The slight blackening over some of the distal ducts of the submaxillary gland could be explained by the presence of radioactive saliva in the lumen formed farther up the duct, since iodine-131 was shown to be highly concentrated in the saliva. However, we cannot exclude the possibility that the distal parts of the ducts are also able to concentrate iodide feebly. The blackening over the proximal ducts of the submaxillary gland cannot be due to iodine-131 concentrated in the acini and carried down in the saliva. The concentration of iodine-131 in the plasma of the hamster does not begin to decrease until more than an hour after an intraperitoneal injection. If, therefore, it were continually secreted at a high concentration by the acini and carried down the ducts, the intensity of blackening over the acini would have been at least as great as that over the ducts. By an analogous argument the blackening over the distal parts of the parotid ducts cannot be due to iodine-131 concentrated in the acini or in the Schiff-positive ducts. From the degree of resolution in these sections it is impossible to decide whether the blackening is due to iodine-131 in the cells lining the ducts, in the lumen, or in both. Therefore we cannot say whether the high concentration of iodine-131 in the saliva is due to a direct secretion from the duct cells or to selective reabsorption of water and other solutes from the saliva as it passes down the duct.

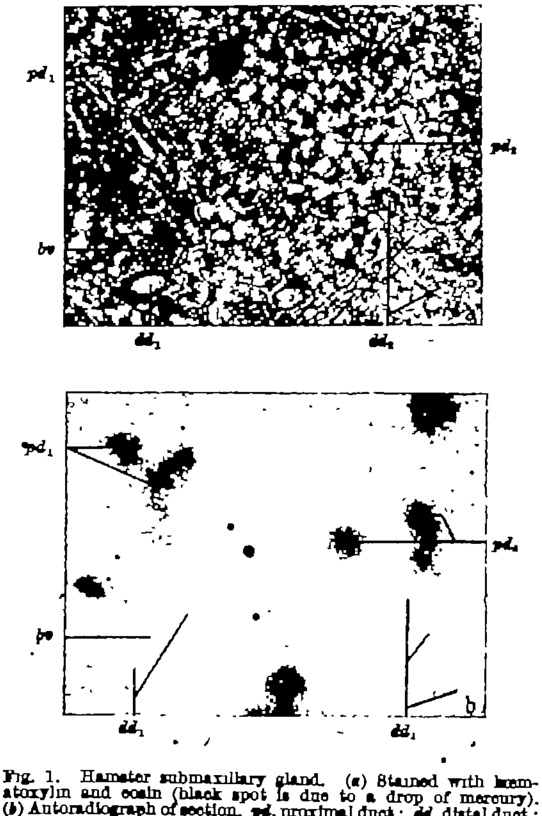

Fig. 1. Hamster submaxillary gland. (*a*) Stained with hæmatoxylin and eosin (black spot is due to a drop of mercury). (*b*) Autoradiograph of section. *pd*, proximal duct; *dd*, distal duct; *bv*, blood vessel. × 80

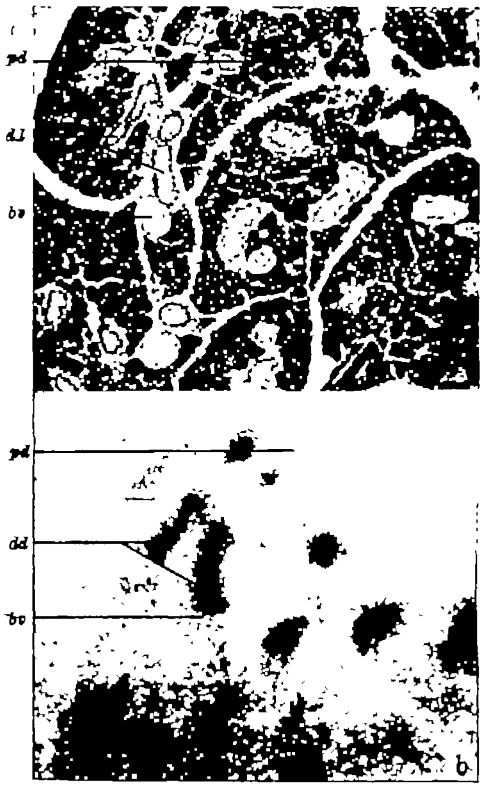

Fig. 2. Hamster parotid gland. (*a*) Stained by periodic acid – Schiff method. (*b*) Autoradiograph of section. *pd*, proximal duct; *dd*, distal duct; *bv*, blood vessel. × 40

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## Occurrence of the Alga *Gloeocapsa* in the Air

THE pollen and fungus spore content of the air has been investigated extensively during recent years in connexion with respiratory allergy and crop diseases. Less is known of other constituents of the air spora. The occurrence of unicellular algæ in the air or in air-borne dust has been demonstrated by several investigators[1].

In quantitative studies of the air spora, we have observed the regular occurrence of a blue-green alga identifiable microscopically as belonging to the Chroococcaceae, probably *Gloeocapsa* (Fig. 1). This is a minute unicellular alga forming loose colonies on moist surfaces, either inland or on the sea-shore. The origin of these air-borne *Gloeocapsa* colonies is at present unknown; they do not appear to be lichen soredia, because most of the colonies observed were free from fungus hyphæ. The mechanism by which they get into the air is also obscure.

Data are available from three centres at each of which air was sampled almost continuously during June 30–July 13, 1954, at a height of 2 metres above ground-level, using the Hirst[2] automatic volumetric spore trap, in which the solid particles in a measured volume of air are deposited in a continuous trace on a slowly moving microscope slide. The deposit on our slides was examined microscopically at distances along the trace corresponding to two-hourly intervals. The areas scanned provided estimates of the number of particles in 12 litres of air for each 2-hr. period. The highest concentration of the alga was observed at Thorney Island, Hants, where an average of 110 colonies per cubic metre of air was recorded over the period of observation. On the roof of the Botany Department, Imperial College of Science and Technology, South Kensington, and in an arable field at Rothamsted Experimental Station, Harpenden, Herts, the average concentration was only 1/20 of that at Thorney Island. Table 1 shows the frequency of occurrence of *Gloeocapsa* colonies in the 12-litre samples, and also the mean and maximum concentration at each centre.

Table 1. OCCURRENCE OF *Gloeocapsa* COLONIES IN THE AIR DURING JUNE 30–JULY 13, 1954

| Site | No. of 12-litre samples with *Gloeocapsa* | | Concentration per cubic metre of air | |
|---|---|---|---|---|
| | Present | Absent | Average | Maximum |
| Thorney Island, Hants | 55 | 95 | 110 | 800 |
| South Kensington, London | 5 | 134 | 7 | 100 |
| Rothamsted, Harpenden, Herts | 7 | 137 | 5 | 100 |

At Thorney Island the air-borne *Gloeocapsa* colonies averaged about eight cells each. There was a marked diurnal periodicity of occurrence: the maximum at 23.00 hr. averaged 210 colonies per cubic metre, and the minimum, between 04.00 and 13.00 hr., averaged about 30 colonies per cubic metre. Their occurrence was not obviously related to the state of the tide. At Rothamsted and South Kensington, concentrations are known to have been somewhat higher during mid-June 1954 than they were during the period described when sampling was also in progress at Thorney Island.

The concentrations recorded so far are small in comparison with those normal for pollen or fungus spores. They are nevertheless high enough at Thorney Island to indicate that air dispersal may be important in *Gloeocapsa*. With an average concentration of about 800 cells per cubic metre of air for at least three weeks, this organism warrants further study as a potential allergen, especially as the cells of *Gloeocapsa* are embedded in a thick sheath of mucilage.

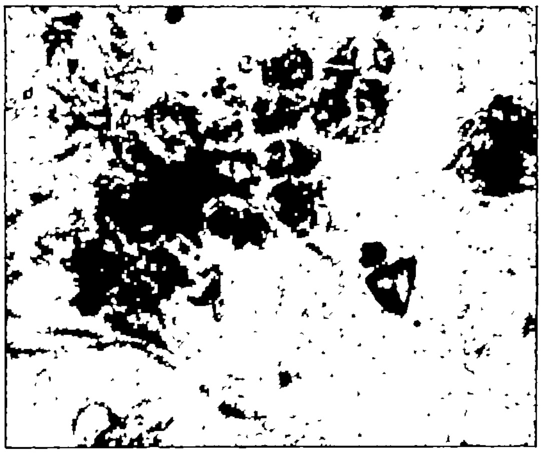

Fig. 1. Group of cells of *Gloeocapsa* type from air sampled at Thorney Island, 21.00 hr., July 8, 1954. × 500 approximately

In connexion with these observations, acknowledgment is made to the Medical Research Council; to the Director of the Meteorological Office for the assistance given by the meteorological staff at R.A.F., Thorney Island; and to Dr. J. M. Hirst, Rothamsted Experimental Station, Harpenden.

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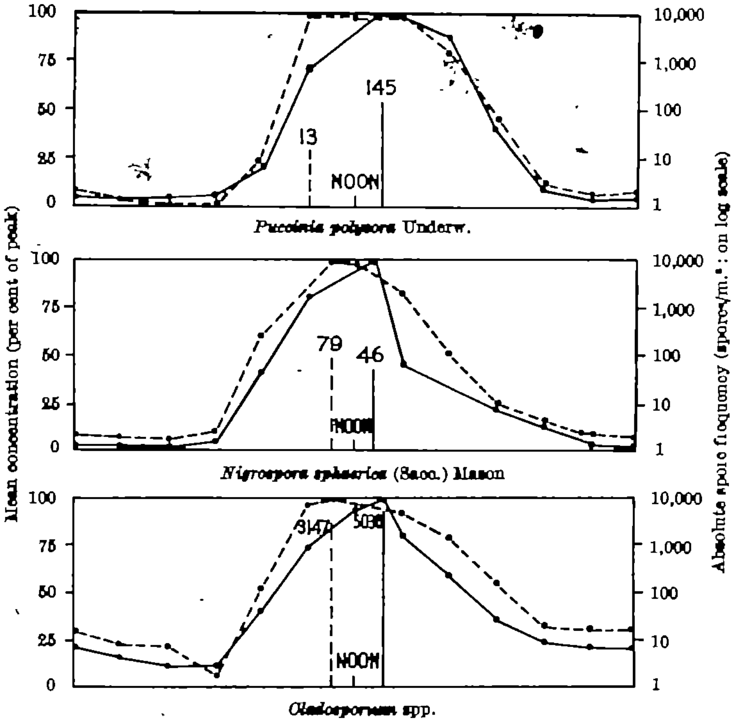
## Seasonal Changes in Three Common Constituents of the Air Spora of Southern Nigeria

FLUCTUATIONS in the air spora have been studied in a temperate climate by Hirst[1,2] and others. Less is known of the changes which occur in the tropics. The study of these changes is valuable in assisting the prediction and analysis of epidemics of plant disease due to air-borne fungi.

The observations described below were made at the Federal Department of Agricultural Research, Ibadan, Western Region, Nigeria. The station is at lat. 7° 23′ N., long. 3° 50′ E. at an elevation of 600 ft. above mean sea-level and lies on the edge of the lowland rain forest belt. The annual rainfall is 45–50 in. and typically there is a dry season from December to March and a rainy season from April to November, with a short break during the first half of August. Further details of the vegetation are given by Keay[3] and of the climate by Brooks[4].



*Puccinia polysora* Underw.

*Nigrospora sphaerica* (Sacc.) Mason

*Cladosporium* spp.

Fig. 1. Mean diurnal periodicity curves of three common constituents of the air spora at Ibadan, Nigeria. ———, wet-season results; - - - -, dry-season results

The air spora was sampled with an automatic volumetric spore trap sited in the middle of a 7-acre field of close-mown grass. This field is centrally situated within 850 acres of mixed annual and perennial crops. The orifice of the trap was two metres above ground-level.

It was found necessary to modify the methods described by Hirst[2], in order to overcome the effects of high temperature and humidity. The best primer of the microscope slide was 'Solvar 3515'. When applied in a thin film and allowed to dry in a desiccator at laboratory temperature, this priming film was least prone to wrinkling, which has proved to be a troublesome artefact. Ordinary 'Vaseline' when used as an adhesive was found to have too low a melting point, resulting in distortion of the trace. A satisfactory adhesive was B.D.H. Paraffinum mollo album, with the addition of 1½ per cent ceresin wax (congealing point 60° C.). This mixture was suitable for use in the high day temperatures experienced and retained good optical properties.

Slides were exposed for periods of 24 hr. and fluctuations in spore concentrations determined by counting 14 mm. traverses at right angles to the long axis of the trace, at distances corresponding to 2-hourly intervals. Counts were expressed as numbers of spores per cubic metre of air. The following spores were studied during both wet and dry seasons:

(*a*) *Puccinia polysora* Underw., a leaf rust of maize the uredospores of which are found in considerable numbers during both wet and dry seasons. (In separating *P. polysora* from other uredospore constituents on the traces, phase contrast was found to be advantageous in recognizing spore numbers and other spore characters.)

(*b*) *Nigrospora sphaerica* (Sacc.) Mason, a dry rot of maize. A common component of the air spora at all times of the year.

(*c*) *Cladosporium* spp., abundant during both wet and dry seasons.

Diurnal periodicities were obtained from counts made over the rainy period April–June 1954, and during the dry months of December 1954–March 1955. In Fig. 1, for comparative purposes, the mathematical treatment is that employed by Hirst[2], periodicities being expressed as percentages of the peak geometrical mean concentrations. The means were calculated from counts made over eighty-seven days in the case of *Puccinia polysora*, and fifty days for both *Nigrospora sphaerica* and *Cladosporium* spp. Corrections for the trapping efficiency of the volumetric trap were applied to *Puccinia polysora* and *Nigrospora sphaerica*. The efficiency of the trap is defined by Gregory[3].

To illustrate the differences in position and size of the peak concentrations of the curves in the wet and dry seasons, the values have been given as the mean peak concentrations of spores per cubic metre of air. This figure was calculated from the average of the daily values of the peak concentration during the wet and dry seasons respectively, and is represented on a logarithmic scale by the vertical lines in Fig. 1.

The general forms of the wet and dry season curves are similar, but peak concentrations occur at an earlier hour of the day during the dry season. This may be due in part to higher temperatures and lower humidities during the dry season, the fall in humidity with rising temperature being more rapid than in the wet season, and consequently minimum relative humidities occur earlier in the day. Highest concentrations of the three spore types mentioned are found under conditions of high temperatures and low humidities coinciding with the peaks of the curves. The wet season curves of *Puccinia polysora* and *Cladosporium* spp. agree generally in form with those obtained by Hirst in Britain for the uredospore group and species of *Cladosporium* respectively.

The absolute values of spore concentrations illustrate that the wet season numbers of *Puccinia polysora* are much higher than those of the dry season, and that *Cladosporium* spp. concentrations are high in both seasons. *Nigrospora sphaerica* is higher in the dry season. The variations in spore numbers depend largely on the availability of hosts in the two seasons as well as on climatic factors, and this is being further investigated.

A correlation of fluctuations in the atmospheric spore load with temperature and humidity values indicates that these variables are two of the more important causal factors influencing the seasonal change in the concentration and diurnal periodicity of the spores mentioned. This will be discussed more fully elsewhere.

Acknowledgments are due to the Director, Federal Department of Agricultural Research, Nigeria, for making facilities for these observations available. I am indebted to Dr. W. R. Stanton for sponsoring

the project and to Dr. J. M. Hirst, Rothamsted Experimental Station, for many helpful suggestions.

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## A Statistical Information Theory of Visual Thresholds

It is well known that, for constant stimulus duration, the visual threshold intensity, $I$, is a function of the stimulus area $A$. In the case of absolute thresholds it has been generally accepted that: (i) for areas up to about 6′, $AI =$ constant (Ricco's law); (ii) for areas between about 6′ and perhaps 20°, $AI^2 =$ constant (Piper's law).

It seems reasonable to regard the absolute threshold as a special case of the differential threshold. It is then important to discover whether these relations in fact hold for the differential case. Brindley[1] has shown that Piper's law holds for differential thresholds where the test field is discriminated against a large field of constant area. Ricco's law is also found to hold for blue light, optical effects making it difficult to test for other colours. Piper's law for differential threshold where the background area is large and fixed has been formulated:

$$\frac{\Delta I}{I} = \text{const.} \sqrt{\frac{1}{A}} \qquad (1)$$

We find, by using various small background areas, that the more general case where either area is variable may be written, at least approximately,

$$\frac{\Delta I}{I} = \text{const.} \sqrt{\left(\frac{1}{A_1} + \frac{1}{A_2}\right)} + C \qquad (2)$$

This would give the Weber–Fechner law, $\Delta I/I = C$, for very large areas $A_1$ and $A_2$, which would make $\left(\frac{1}{A_1} + \frac{1}{A_2}\right)$ negligibly small.

We also find that this may be further generalized to cover low intensities in the region of breakdown of the Weber–Fechner law by adding a small constant thus:

$$\frac{\Delta I}{I + k} = \text{const.} \sqrt{\frac{1}{A_1} + \frac{1}{A_2}} + C \qquad (3)$$

The value of $k$ in terms of equivalent intensity we estimate at about 0·04 ft. l. For the absolute threshold, when $I = 0$, we should then have $\Delta I/k = C$ when the areas are large.

It appears that these, and perhaps other threshold and summation phenomena, may be described in terms of statistical information available in neural information channels. If we suppose that the area $A$ inspected is to be regarded as a set of $n$ independent observations, where $n$ is approximately proportional to $A$, and that each of these observations is subject to random variation through noise in the system, then for $\Delta I$ to be detected against $I$, in some fixed proportion of the number of trials (for example, an 80 per cent experimental criterion), we must have

$$\frac{[(r + \Delta r) - r] - C}{\sqrt{\left(\frac{1}{A_1} + \frac{1}{A_2}\right) V}} = \text{constant} \qquad (4)$$

where $(r + \Delta r)$, $r$, are the mean neural pulse-rates corresponding to intensities $I + \Delta I$, $I$, and $V$ is the variance of neural pulse-rate over the sample.

We have introduced the constant $C$ to explain the fact that few false positives occur in threshold experiments. Without some criterion of difference greater than zero, we should expect about 50 per cent false positives. The proportion of false positives may change with the observer's attitude, or 'set', indicating that $C$ may vary within limits. It is tempting to regard $k$ as arising from the internal noise present in the system, and to think of the absolute threshold as the case where the signal is to be distinguished against noise background.

If, as seems possible from electrophysiological data, $r$ is proportional to $\log (I + k)$, (4) reduces to (3) above for $\Delta I$ somewhat less than $I + k$, and we expect this to hold for relatively small values of $\Delta I$ even when $I = 0$, that is, for absolute thresholds. In the latter case, as the test area diminishes, however, and the value of $\Delta I$ consequently increases, the approximation $\Delta I/k$ used for $[(r + \Delta r) - r]$ is no longer valid, and the more accurate expression $[\log (k + \Delta I) - \log k]$ is required. For $A_2$ large, (4) can then be written

$$1 + \frac{\Delta I}{k} = \exp\,(C + \alpha\sqrt{1/A}),$$

writing $A$ for $A_1$ and denoting the constant involved by $\alpha$.

For very large $A$, the terms containing $A$ are negligible; therefore

$$1 + \frac{\Delta I}{k} = \text{const., or } \Delta I = \text{const.} \qquad (5)$$

For smaller $A$:

$$1 + \frac{\Delta I}{k} = \exp C\,(1 + \alpha/\sqrt{A})$$

or

$$\sqrt{A}\ \Delta I = \text{const.} + \text{const.} \sqrt{A} \qquad (6)$$

For even smaller $A$:

$$1 + \frac{\Delta I}{k} = \exp C \left(1 + \frac{\alpha}{\sqrt{A}} + \frac{\alpha^2}{2A} + \ldots\right) \qquad (7)$$

It thus appears that Ricco's and Piper's laws might be regarded as the different approximations to the logarithmic equation which can be used at different levels. The expression (7) appears to fit Willmer's[2] data satisfactorily. We are undertaking experiments to determine the various constants involved.

Mr. R. T. Leslie, Mr. E. R. F. W. Crossman and Dr. G. S. Brindley have been most helpful in discussing these and related ideas.

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## Ascorbic Acid Content of Baobab Fruit

In the course of investigations into the nutritional value of traditional African foodstuffs, samples of the fruit of the baobab (*Adansonia digitata* L.) were taken for analysis. This tree, which is particularly noteworthy for the massive girth which its boll eventually attains, is widespread in the low-veld areas of Southern Rhodesia, and the pulp or matrix surrounding the seed in the fruit capsule is commonly chewed or sucked by the indigenous population, or made into a pleasant acidic drink, thus giving rise to the colloquial name of 'cream of tartar' tree.

While there appears to be some difference of opinion regarding the composition of the pulp[1], I have found no recent references in the literature regarding its nutritional value, and it was therefore decided to carry out ascorbic acid assays.

Samples of fruit, which had been collected by the inhabitants, were taken from a kraal in the Kariba gorge area of the Zambesi valley. The fruit was broken open and the seeds and pulp removed. The pulp was scraped from the seeds and ground to give a fine yellow-white powder passing through a B.S.S. No. 60 sieve.

The moisture content was determined and the pulp assayed for ascorbic acid by the 2 : 6-dichlorophenolindophenol visual titration method, as originally described by Bessey and King[2], and also by the 2 : 4-dinitrophenylhydrazine method of Roe and Oesterling[3], in this case determining reduced ascorbic acid, dehydroascorbic acid and diketogulonic acid. In both cases, the technique described by the Association of Vitamin Chemists[4] was followed.

The figures obtained on the pulp were as follows :

| | |
|---|---|
| Indophenol method : | 328 mgm. ascorbic acid/100 gm. |
| 2 : 4-Dinitrophenylhydrazine method: | 307 mgm. ascorbic acid/100 gm. |
| Moisture content : | 11·8 per cent |

Fairly reasonable agreement between the methods suggested that no appreciable amounts of interfering substances were present, and that the bulk of the vitamin was present in the reduced form.

The relatively high concentration of ascorbic acid present in the pulp suggested that further investigations be carried out, as the fruit is available where fresh fruit and vegetables are normally difficult to obtain. Further samples of baobab fruit were therefore obtained, in this case from the Sabi Experimental Station. Fruit was collected from ten trees, and the pulp obtained from the fruit of each tree was bulked and prepared for analysis as with the previous sample. No attempt was made to differentiate between the degrees of ripeness of the different fruit capsules.

The analytical figures obtained from the fruit pulp were as follows :

| | Ascorbic acid (mgm./100 gm.) | Moisture (per cent) |
|---|---|---|
| Minimum | 175 0 | 10 0 |
| Maximum | 445 4 | 13·1 |
| Mean | 306·2 | 10·9 |

The results confirmed the view that the baobab fruit is an important source of ascorbic acid ; and, in fact, the concentration of this vitamin in the baobab is one of the highest in any food in Southern Rhodesia.

Further investigations are in progress to establish the optimum ripeness for maximum ascorbic acid content, and also the stability of the vitamin on keeping, as the fruit is likely to remain on the tree for long periods before dropping.

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## 'Self-Cure' in Nematode Infestations of Sheep

Earlier studies with sheep infested with *Haemonchus contortus* or with *Trichostrongylus colubriformis*[1–3] showed that the 'self-cure' phenomenon was caused by the intake of infective larvæ by sheep rendered hypersensitive as a result of previous infestations. The hypersensitive reaction was evidenced by a transient rise in blood-histamine within four days, by the development of skin-sensitivity to an antigen prepared from larvæ and by the development of œdema in the portion of the alimentary tract infested.

To obtain more direct evidence about the 'self-cure' reaction, selected sheep were anæsthetized by intravenous injection of 'Kemithal', which does not disturb infestations with *H. contortus*, the abomasum was exposed by laparotomy, massive doses of exsheathed larvæ were injected into the abomasum, and the reaction of the organ was observed for several hours.

In two worm-free lambs, which had not been exposed to infestation previously, the abomasum remained flaccid and normal for the whole period of observation. In two hypersensitive sheep infested with *H. contortus*, the abomasum showed increased peristalsis and segmentation within 10 min. of injection and, within 1 hr., was pale and œdematous and had contracted in diameter. The reaction commenced to subside in 1½–2 hr. Both sheep showed 'self-cure' ; in one the worm egg-count fell from 3,500 eggs per gm. of fæces to 0 in four days, and in the other, from 3,600 eggs per gm. to 400 in seven days. There was no increase in blood-histamine within 4 hr. of the injection of the larvæ. The abomasum was collected from two other hypersensitive sheep at the height of the reaction after the injection of larvæ. No deviation from normal values of histamine could be demonstrated in extracts of the abomasal wall, although the presence of œdema was confirmed by histological examination.

The reaction of several sheep, resistant to *H. contortus*, was examined in the same way and was found to be similar to that of the infested sheep.

It was also reported previously[3] that the intake of *H. contortus* larvæ produced 'self-cure' both of an infestation with the same species or with *T. colubriformis* which infests the duodenum. Further work showed that the intake of *H. contortus* larvæ will also cause 'self-cure' of infestations with other abomasal parasites such as *Ostertagia circumcincta* and *T. axei*, and that the intake of larvæ of these two species will cause 'self-cure' of infestations with *H. contortus* or with *T. colubriformis*.

The direct observation of the abomasum of hypersensitive sheep after the injection of exsheathed larvæ provides further support for the hypothesis that there is a change in environmental conditions at the time of the 'self-cure' reaction. The effect of the intake of larvæ of one species of nematode upon existing infestations with other species appears to depend upon their respective location in the alimentary tract, and again suggests a local rather than a systemic reaction. Antigenic material from larvæ in the abomasum could pass readily to the small intestine, whereas similar material from the small intestine could not pass readily to the abomasum.

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## Polygenic Inheritance in *Neurospora*

ASCOSPORES of *Neurospora crassa* two to three times the normal size occur in many strains, though the frequency is low, probably less than one per thousand ascospores. A particular cross made in this laboratory produced an abnormally high frequency of giant ascospores (about 3·4 per cent), and since a number of these germinated and gave good cultures, a study of the phenomenon has been initiated.

Crosses between the cultures derived from these giant spores gave 11·4 per cent giant ascospores, and selection was started from one of these. In each generation giant spores were selected and cultures derived from them were set up as crosses. The successful crosses provided the next generation of ascospores. The response to selection is illustrated in Fig. 1, the frequency of giant ascospores in each generation being based on a sample of more than five hundred ascospores.

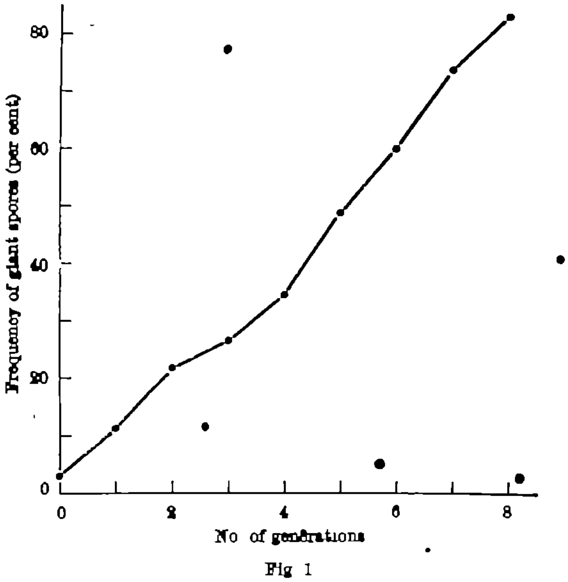

Fig 1

It should be pointed out that the classification into 'normal' and 'giant' spores is arbitrary. Both types vary, and during the course of the experiment the average size of both classes has increased. However, the great majority of asci gave either four 'giant' or eight 'normal' ascospores, and this results in a definitely bimodal size distribution. Selection has also changed the number of spores maturing in the asci. At the beginning of the experiment most asci contained eight mature, 'normal' spores; in the few asci which gave four 'giant' spores, only one spore matured, the rest of each ascus aborting. In later generations, asci with two, three and four mature 'giant' ascospores occurred. By the eighth generation the frequency of asci containing four mature 'giant' spores approached one per perithecium, and asci containing eight mature 'normal' spores were rare. No asci have been seen with more than four 'giant' spores. A few asci have been seen with spores of both types.

In the third generation, reciprocal crosses were made with a wild-type strain. The resulting asci were all normal. Thus the eight-spored character is 'dominant' to the four-spored, and the size of ascospore and type of ascus apparently depend on nuclear and not cytoplasmic factors.

A further cross was set up between a fifth-generation culture and a wild type. Again all the resulting asci contained eight spores, although the ascospores were rather plumper than the usual wild type. Cultures were derived from a number of these ascospores and crosses set up between them. In this way, twenty-six fertile *F*1 crosses were obtained and samples of ascospores from each of them classified. The results were:

| Frequency giant spores (%) | < 1 | 1–1·9 | 2–2·9 | 3–3·9 | 4–4·9 | 5–5·9 | 6–6·9 | 9–9·9 |
|---|---|---|---|---|---|---|---|---|
| No. of crosses | 13 | 3 | 3 | 2 | 1 | 2 | 1 | 1 |

The wide range of frequencies of giant spores from these crosses indicates that a considerable number of genes affecting the frequency of giant spores differentiate the selected and wild-type strains. The steady response to selection also indicates a polygenic character.

Additional evidence is provided by a cross between two strains from the third generation of selection. A normal eight-spored ascus from this cross was dissected in the usual manner into the four different spore pairs. The resulting four cultures were designated 1, 2, 3 and 4 and the four possible crosses were set up between them. The results were:

| Cross | Giant spores (%) |
|---|---|
| 1 × 3 | 12·2 |
| 1 × 4 | 17·0 |
| 2 × 3 | 18·1 |
| 2 × 4 | 21·1 |

It seems clear that segregation of polygenes affecting the frequency of giant spores occurred during the formation of the dissected ascospores.

One further phenomenon deserves mention: out of 110 giant spores which have so far been cultured, four have been self-fertile and presumably heterozygous for the mating-type alleles. Other markers are being introduced in order to discover if heterozygosity of other loci occurs in these strains.

The analogy between these strains and *N. tetrasperma* is obvious. Dodge[1] showed that in crosses between *N. sitophila* and *N. tetrasperma* the resulting asci were all eight-spored, and that continued backcrossing to *N. tetrasperma* restored the four-spored ascus character. It will be of considerable interest to see if the present low incidence of homothallic giant spores increases in the future generations of selection. In any event, it seems possible that further investigation of these strains may afford some evidence concerning the usually accepted origin of *N. tetrasperma* from an eight-spored form[2].

These strains may prove of experimental value in that they permit the study of a polygenic character in an organism in which ordered tetrads may be isolated. A further advantage is that all generations of a selection experiment may be preserved, since the ascospores remain viable for several years.

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## Widespread Distribution of Mutant Alleles (t-Alleles) in Populations of Wild House Mice

FOLLOWING the proof that mutant changes at one locus ($t$) occur rather frequently in laboratory stocks of mice kept in the balanced lethal condition[1] $T/t^n$, we turned our attention to the problem whether such mutations are to be found also in wild populations. In the laboratory we had detected such mutations only in stocks which already contained a $t$-allele at this locus; stocks containing $T$ (brachyury = short tail) had been under continuous observation in the laboratory since 1932, but no occurrence of mutation to a $t$-allele (revealed by the tailless condition $T/t^n$) had been detected. Seven different $t$-alleles were detected and isolated[1] by testing the rare normal-tailed exceptions which were found after inbreeding the balanced-lethal tailless stock $T/t^1$. All such exceptions proved to be $t^1/t^x$, $t^x$ being a new allele at this locus. This suggested that $t^x$ had arisen either by recombination or rearrangement at the complex locus $t$ (Dunn, 1954) or that $t^1$ had induced mutation to a new allele. The fact that the new mutants were different from $t^1$ and from each other and that no recombination gametes containing the normal allele (+) were found was taken as evidence against the recombination hypothesis. The locus thus appeared to be unstable in the balanced lethal laboratory stocks. A question of interest was whether there was any evidence of this in wild populations remote from the few laboratories at which $t$-alleles were maintained.

The first tests of this point[2] showed decisively that $t$-alleles are normal components of some wild populations in the United States. Samples of mice caught in the wild were tested by mating them in the laboratory to a standard testing stock $T/+$ (brachy). Some wild mice when so tested produced, in addition to the expected brachy ($T/+$) and normal offspring, tailless offspring which, on further testing, proved to be $T/t^n$ and gave rise to new tailless balanced lines $T/t^{w1}$, $T/t^{w2}$, $T/t^{w3}$ and $T/t^{w4}$. The first three of these alleles were different from each other and from previously known $t$-alleles; the fourth was indistinguishable from a previously known allele $t^0$. Thus these first wild populations to be tested revealed a variety of alleles, as had the laboratory stocks.

Such tests have now been extended to include samples, usually small ones, from seventeen American populations. In addition, one Japanese population has been tested at the National Institute of Genetics of Japan by crossing with brachy testers ($T/+$) sent from our laboratory and a $t^w$ allele found in three animals. Of these eighteen populations, twelve contained animals heterozygous for a $t$-allele. Each occurrence of tailless offspring from a new population is given a number in the order of discovery. This does not necessarily indicate that the $t$-allele thus revealed is new and different from the others; this can be proved only by crossing balanced lethal lines, each derived from a different population, and such tests have been only partially completed. Of the newer alleles $t^{w5}$ (N.Y. 2) is lethal and different from $t^0$, $t^1$, $t^9$, $t^{w1}$ and $t^{w3}$; $t^{w6}$ (Florida 1) is lethal and different from $t^0$, $t^1$, $t^{12}$, $t^{w1}$; and $t^{w3}$, $t^{w5}$ and $t^{w6}$ cannot be distinguished by the usual test of viability at birth of the compound $t^{w5}/t^{w6}$. The hypothesis is being tested that this compound, which if found should have a normal tail, dies during embryogeny. $t^{w7}$ (Texas 1) is viable, hence different from $t^{w5}$, $t^{w6}$ and all previously known lethals, although its difference from other viables ($t^3$, $t^7$, $t^8$, $t^{11}$, $t^{13}$ and $t^{w2}$) cannot be directly tested. $t^{w8}$ (Virginia 1) is viable, hence different from any of the lethals. Occurrences $t^{w9}-t^{w14}$ have not yet been tested. These are as follows: $t^{w9}$ (Radford, Virginia) viable; $t^{w10}$ (Misima-sen, Japan); $t^{w11}$ (Storrs, Connecticut); $t^{w12}$ (Oakland, California); $t^{w13}$ (El Paso, Texas); $t^{w14}$ (Norwich, Vermont). It is already clear that not all alleles found in the wild are the same, and that many wild populations are polymorphic for this locus.

No single population has been proved not to carry a $t$-allele, since all the negative samples are quite small.

In the populations shown to contain a $t$-allele, the frequency of heterozygotes is very high. Of forty-seven animals tested from such populations, twenty-seven have proved to be heterozygous $+/t^w$. This does not include an extensive sample of ninety-two mice from one such population ($R3$), tested after eight years of inbreeding in the laboratory, in which fifty-two mice were heterozygous; their retention in such high frequency shows that evolutionary forces of some magnitude must oppose their extinction. One of these forces is the altered segregation ratio $t^w$ : + in males, in which the $t^w$ gamete is regularly favoured[3] by ratios of 0·8–0·9. The other may be selection in favour of $+/t^w$, and this is being tested experimentally. A preliminary experiment[4] suggests that $+/t^w$ males may be more fertile than $+/+$.

Many problems remain to be studied with this material. The ubiquity of $t$-alleles in wild populations is taken as proof of their evolutionary significance and justification for further study. Experiments now in progress are designed to test: (1) whether new alleles arise by mutation directly from the normal allele of wild $+/+$ mice (this event has never been detected in laboratory stocks); (2) whether the adaptive value of $+/t^w$ heterozygotes in wild populations differs from that of $+/+$; (3) whether any single wild population contains more than one variety of $t$-allele (no such instance has yet been noted); (4) whether the presence of a particular allele, or the absence of any such allele, bears any relation to the geographical or ecological situation of the population.

This work was carried out at Nevis Biological Station, Irvington-on-Hudson, New York, and since June 1, 1955, under contract $AT$(30–1–1804) U.S. Atomic Energy Commission. Many persons were concerned with collecting mice in the wild and others

with testing them in the laboratory. The co-operation of the former will be acknowledged in more extensive reports. The work depended very much on the skill in handling wild populations in the laboratory of Prof. W. C. Morgan, jun. (now at South Dakota Agricultural College), at the initiation of the experiment, of Mrs. Joan Suckling and Mary Anne Dann during its continuation, and most recently of Dr. Louis Levine, Andrew D. Beasley, Frank Burnett and Robert E. Stephenson, of the Nevis Laboratory.

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[1] Dunn, L. C., and Gluecksohn-Waelsch, S., *Genetics*, 38, 261 (1953).

[2] Dunn, L. C., and Morgan, W. C., *Proc. U.S. Nat. Acad. Sci.*, 39, 391 (1953).

[3] Dunn, L. C., *Amer. Nat.*, 87, 327 (1953).

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[5] Schneider, H., *Proc. Soc. Exp. Biol. and Med.*, 63, 161 (1946).

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## An Instrument for measuring Soil-Moisture Deficit

The estimation of residual available soil moisture should be an essential part of irrigation practice. Penman's method[1], based on meteorological observations. gives excellent results ; but in its present form it is somewhat cumbersome for use by commercial growers. Various alternative methods are available ; for example, measured evaporation from an open water surface may be expressed as potential evapotranspiration by means of a suitable conversion factor[1]. Garnier has measured evapo-transpiration directly using a standard grass surface[2]. There is, however, a need for a simple device which will integrate rainfall and evaporation measurements and give a reading expressed as soil-moisture deficit.

We have devised a combined rain-gauge and evaporimeter which ultimately may prove suitable for use by growers for day-to-day control of irrigation. It would also provide valuable data if installed in meteorological stations. The instrument is intended to be placed in a growing crop, so that it collects rain and irrigation water in a common receiver ; an evaporation surface, consisting of an unglazed ceramic disk, draws its water supply by capillarity from this receiver. Successful operation of the instrument depends upon correct adjustment of the ratio between the area of the collecting surface and the area of the evaporating surface. The total effective area of the evaporating surface is therefore determined by comparison with a free water surface. This is expressed in terms of area of soil completely covered by plants, using Penman's conversion factor (0·8 for south-east England, March–August). The instrument is then constructed so that the area of its collecting surface equals the area of its evaporating surface thus expressed in terms of plant-covered soil. It is necessary to provide means of adjusting the effective area of evaporating surface to compensate for differences in rate of water-loss between wet soils and dry soils, and between soils completely covered by plants and those only partially covered. An overflow is provided in the receiver at a level corresponding to field capacity, so that any rain which falls when the instrument is indicating field capacity is collected separately and gives a measure of the amount of drainage which has taken place through the soil. The water supply to the evaporating surface is so arranged that when the instrument is indicating wilting point, the water-level in the receiver is just below the level of the outlet, thus cutting off the supply and preventing further evaporation.

When the instrument is correctly adjusted, the amount of water in the receiver at any time corresponds to the amount of water remaining in the soil, so indicating directly the current soil-moisture deficit.

Many workers are carrying out experiments to determine the maximum permissible deficit at various growth stages of the major crop plants. The results of such experiments will enable this instrument to be used for deciding when to irrigate, in addition to indicating how much water is required to restore the soil to field capacity.

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Aug. 17.

[1] Penman, H. L., *Proc. Roy. Soc.*, A, 193, 120 (1948).

[2] Garnier, B. J., *Nature*, 170, 286 (1952).

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## Index of Translations of Foreign Scientific Material

The editorial article in *Nature* of November 19 raises once more the problem of how to ensure that foreign scientific material is economically translated and made available. The index of unpublished scientific translations maintained by Aslib, and covering the principal countries of the Commonwealth, is, I believe, one step in the right direction. May I appeal to readers of *Nature* to help make the index more effective by arranging, whenever possible, for details of partial or complete translation, made or about to be made by their organizations, to be notified systematically to Aslib ? The details required are : author, name of periodical, volume, issue number, inclusive pagination, date and translated title, as well as the form of translation (for example, typescript, microfilm, etc.), whether it is complete, partial or a summary, whether it can be bought or borrowed, and the name and address of the holding organization.

Many inquirers now systematically check with Aslib before starting a translation. Their intention to undertake the translation, if one is not known to exist, is recorded at once, so that it is sometimes possible to suggest a joint task with expenses shared to a subsequent inquirer. Last year (the third year of operation) the cost of 137 translations, representing perhaps some £3,000 and possibly unwelcome delays as well, was saved by the index ; the figure will doubtless be increased considerably as more firms and institutions collaborate.

The language barrier, however, is only one of many problems in the dissemination of knowledge. Paradoxically, Great Britain spends substantial sums (something like £300 million a year) on research to produce new knowledge, but only trifling amounts on research into ways of putting it where it can be of the widest practical use. Perhaps the time is ripe for the principal organizations representing scientists and information workers to consider jointly how the country's needs in this respect can best be met.

Leslie Wilson

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# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

### Tuesday, January 3—Wednesday, January 4

Institute of Physics, Electron Microscopy Group (in the Textile Industries Department, The University, Leeds).—Conference on "The Electron Microscopy of Textile and Other Industrial Fibres".

### Tuesday, January 3—Friday, January 6

Geographical Association (at the London School of Economics and Political Science, Houghton Street, London, W.C.2)—Annual Conference.

### Wednesday, January 4

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. P. M. Grundy, Mr. M. J. R. Healy and Mr. D. H. S. Rees: "Economic Choice of the Amount of Experimentation".

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. R. L. Brown: "Some Coal Research Problems and their Industrial Implications".*

### Wednesday, January 4—Thursday, January 5

Physical Society, and the Royal Meteorological Society (in the Department of Meteorology, Imperial College, London, S.W.7), at 9.30 a.m. daily—Joint Conference on "Cloud Physics".

### Thursday, January 5

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 3 p.m.—Wing Commander R. P. Beamont: "Test Flying—Current Problems and Techniques" (Young People's Lecture).

Institute of Refrigeration (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. H. H. Egginton: "Refrigeration Controls".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Paper by the late Mr. T. Lawrie on "Highland Water Power—The Development of the North of Scotland Hydro-Electric Board" (the paper will be read by an Officer of the Board).

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. M. B. Martin and Mr. D. L. A. Smith: "Domestic Tape Recording Applications with special reference to Stereophonic Reproduction".

### Friday, January 6

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. C. de Duve (University of Louvain): "Intracellular Distribution Patterns of Enzymes".* (Further Lecture on January 9.)

### Saturday, January 7

British Mycological Society (in the Large Physics Lecture Theatre, Birkbeck College, Malet Street, London, W.C.1), at 11 a.m.—London Meeting.

British Interplanetary Society (in the York Hall of Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Dr. H. P. Wilkins: "Evolution of Our Galaxy".

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chemical Engineers (with a good honours degree in chemical engineering or A.R.I.C. or A.M.I.Chem.E., or equivalent qualifications) to investigate plant control techniques, and the technical performance of plant in relation to programming or flowsheeting—The Recruitment Officer, Industrial Group Headquarters, United Kingdom Atomic Energy Authority, Risley, near Warrington, Lancs (January 6).

Chief Training Officer (with a science or engineering honours degree, and a wide experience with a large industrial organization in the selection and training of scientific and technical staff) to form and operate staff training schemes for professional, scientific and non-technical staff—The Senior Recruitment Officer, United Kingdom Atomic Energy Authority, Risley, near Warrington (January 6).

Assistant Lecturer (with a degree in science or agriculture and an interest in dairy chemistry) in Chemistry—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (January 10).

Assistant Educational Psychologist (with a degree in psychology and approved clinical training) for duties consisting of advisory work in the schools and diagnostic work in the Hampshire County Council Child Guidance Clinic and Remand Homes—Education Officer, The Castle, Winchester (January 14).

Guide Lecturer (with a degree in science or engineering, preferably with lecturing experience and a knowledge of French and German) at the Science Museum, for duties including the preparation and delivery of lectures (with visual aids and practical demonstrations) on the Engineering Sections and to conduct parties round the Museum—Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4536/56 (January 14).

Assistant (with a degree in electrical engineering, and preferably with some research or industrial experience) in the Department of Engineering—The Secretary, The University, Edinburgh (January 15).

Lecturer, Grade II (graduate in mining with underground experience and preferably with some research experience) in Coal Mining—The Registrar, The University, Edgbaston, Birmingham 15 (January 16).

Livestock Research Officer (Poultry) (with a university degree with emphasis on animal nutrition) at the Poultry Experiment Station, Department of Agriculture, Seven Hills, N.S.W., Australia, to plan and undertake research work in the field of poultry nutrition—The Agent General for New South Wales, 56 Strand, London, W.C.2 (January 24).

Lecturer (with special qualifications in inorganic chemistry, including experience in teaching from elementary level upwards) in Chemistry in St. Salvator's College—Joint Clerk to the University Court, The University, St. Andrews (January 31).

Head of the Chemistry Department, Senior Principal Scientific Officer grade—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (February 1).

Reader in Experimental Physics at the Royal Holloway College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 7).

Reader in Zoology at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 9).

Lecturer or Assistant Lecturer (with a special interest in physico-organic chemistry) in Chemistry—The Secretary, The University, Exeter (February 11).

Lecturer in Zoology—The Secretary, The University, Edinburgh (February 11).

Chair of Electrical Engineering at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 13).

Senior Lecturer or Lecturer in Pharmacology at the University College, Ibadan—The Secretary, Senate Committee on Colleges Overseas in Special Relation, University of London, Senate House, London, W.C.1 (February 13).

Reader in Mechanical Engineering at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 14).

Reader in Aeronautics at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 16).

Assistant Trials Officers (2) (with a degree in botany or agriculture, or equivalent qualification, with practical experience in crop production) to work at the Seale-Hayne Agricultural College, Newton Abbot, Devon, and Leeds University Farm, Headley Hall, Yorks—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Head (with a good degree in zoology and competent to undertake the planning and supervision of the filming and televising of zoological subjects) of the Television and Film Unit, Zoological Society of London and Granada T.V. Network, Ltd.—The Director and Permanent Secretary, The Zoological Society of London, Regent's Park, London, N.W.1.

Laboratory Assistant (with experience in either physical or biological laboratory work), to assist in research work involving the application of physical methods in biological problems—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks, quoting 55/25.

Master to take charge of the Science Department and advise on the building and equipment of new laboratories—The Headmaster, Berkhamsted School, Herts.

Produce Officer (with a university degree in agriculture or economics or a national diploma in agriculture, with experience in the handling of agricultural products, particularly grading inspection and storage, and some knowledge of prevention and control of pest infestation of stored products) with the Government of the Northern Region, Nigeria—Crown Agents, 4 Millbank, London, S.W.1, quoting M1B/42896/TA.

Research Assistant (with an honours degree in metallurgy, physics or chemistry) to the Joseph Lucas Research Fellow, to undertake research on the structure and mechanical properties of electrodeposits—Department of Industrial Metallurgy, The University, Birmingham 15.

Research Officer (with a university degree in forestry, or a university degree in botany and a diploma in forestry) in the Department of Forest Research, Federation of Nigeria, to carry out sylvicultural investigation, chiefly in the highest forest regions of the Federation, but with a possibility of work in the savannah regions also—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.61/14/06.

Scientist (with a good degree in chemistry or physics, or equivalent qualification, analytical experience and administrative ability), as a deputy to the Area Chief Scientist, Cannock Chase Area Laboratory, for work covering a wide field involving the analysis of coal, water, mine air and stores testing (oil, etc.)—The Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Worcs.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Science Masters' Association. Report of the Sub-Committee on Laboratory Technicians, 1955. Pp. 16. (London: John Murray (Publishers), Ltd., 1955. Published for the Science Masters' Association.) 1s. 2d., post free. [2110

University of Birmingham Metallurgical Society. Annual Newsletter. Fiftieth Anniversary Edition, 1955. Pp. viii+44. (Birmingham: University of Birmingham Metallurgical Society, 1955.) [2110

Commonwealth Agricultural Bureaux. Notes on Progress in the Agricultural Sciences, 1953–54. Pp. 24. (London: H.M. Stationery Office, 1955.) 2s. net. [2110

Department of Scientific and Industrial Research. Building Research Station. National Building Studies—Research Paper No. 22: Studies in Composite Construction. Part 2: The Interaction of Floors and Beams in Multi-Story Buildings. By Dr. R. H. Wood. Pp. vii+124+8 plates. (London: H.M. Stationery Office, 1955.) 5s. net. [2210

Readers' Guide to Books on Electrical Engineering (New Series—No. 29, August, 1955.) Pp. 36. (London: Library Association, 1955.) 1s. [2510

Institution of Electrical Engineers. List of Members. Part 1: Corporate Members and Companions. Pp. 579. (London: Institution of Electrical Engineers, 1955.) [2510

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1955. No. 4: Chemical Aspects of Oceanography. By Dr. H. Barnes. Pp. ii+29. (London: Royal Institute of Chemistry, 1955.) 4s 6d. [2510

Agricultural Research Council: Soil Survey Research Board. Report No. 7, 1954. Pp. iv+38. (London: H.M. Stationery Office, 1955.) 4s. 6d. [2510

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 945, Vol. 248 (20 October 1955): The Moments of the Number of Points of a Lattice in a Bounded Set. By C. A. Rogers. Pp. 225–251. 8s 6d. No. 946, Vol. 248 (20 October 1955): An Assessment of the System of Optimum Coding Used on the Pilot Automatic Computing Engine at the National Physical Laboratory. By J. H. Wilkinson. Pp. 253–281. 9s. (London: Royal Society, 1955.) [2510

Proceedings of the West African International Cacao Research Conference held at the West African Cacao Research Institute, Tafo, Gold Coast, 12th to 16th December, 1953. Pp. vii+100. (London: Crown Agents for Oversea Governments and Administrations, 1955.) 12s. 6d. [2510

Gurr's Quick Reference Laboratory Notes: Directions for Preparing Solutions from Compound Stains. Second edition. Pp. 6. Gurr's Commentary on Current Laboratory Methods. No. 16. (September, 1955.) Pp. 59–62. (London: George T. Gurr, Ltd., 1955.) [2610

The Sources of Animal Behaviour. By Prof. G. P. Wells. (An Inaugural Lecture delivered at University College London, 5 May, 1955.) Pp. 20. (London: H. K. Lewis and Co., Ltd., 1955.) 2s. 6d. [2610

Hull Bulletins of Marine Ecology. Edited by A. C. Hardy and Dr. C. E. Lucas. Vol. 3. Pp. i-ix. (June, 1955): Title Page, Contents Table, List of Personnel, Explanation. (Hull: At the University College, 1955.) 2s. 6d. [2610

Department of Scientific and Industrial Research and Fire Offices' Committee. (Joint Fire Research Organization.) References to Scientific Literature on Fire. Part 7, 1953. By Miss H. M. Shakeshaft and Mrs. B. F. W. Rogowski. Pp. 122. List of Reports etc. published by H.M. Stationery Office and in Technical Journals. (August, 1955.) Pp. 11. (Boreham Wood, Herts: Fire Research Station, 1955.) [2710

Ministry of Agriculture, Fisheries and Food. Report on the Animal Health Services in Great Britain, 1954, including Report of Proceedings under the Diseases of Animals Act, 1950. Pp. iv+106. (London: H.M. Stationery Office, 1955.) 4s. net. [2710

Institute of Personnel Management. Annual Report, 1954–55. Pp. 20. (London: Institute of Personnel Management, 1955.) [2710

*Planning*. Vol. 21. No. 387 (24 October 1955): Graduates' Jobs. Pp. 193–208. (London: Political and Economic Planning, 1955.) 2s. 6d. [2710

Agricultural Research Institute of Northern Ireland. Twenty-eighth Annual Report, 1954–55. Pp. 37. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1955.) [2810

International Association for the Exchange of Students for Technical Experience. Eighth Annual Report (November, 1955). Pp. 84. (London: International Association for the Exchange of Students for Technical Experience, 1955.) [2810

Queen's University of Belfast. The Anatomy of the Cold War. By Salvador de Madariaga. (Montague Burton Lecture on International Relations, delivered in the Queen's University of Belfast on April 21, 1955.) Pp. 27. (Belfast: Marjory Boyd, Printer to the Queen's University of Belfast, 1955.) 6d. [2810

A Scientist In and Out of the Civil Service. By Sir Henry Tizard. (The Twenty-second Haldane Memorial Lecture delivered at Birkbeck College, London, 9th March 1955.) Pp. 21. (London: Birkbeck College, 1955) [2810

## Other Countries

*Giornale di Microbiologia*. Vol. 1, No. 1 (Luglio-Agosto, 1955). Pp. 96+10 plates. Abbonamenti: Italia—il volume di sei numeri L. 2500. Estero L. 3000. Numero separato L. 500. (Milano: Casella Postale 3279. Viale Italia 74–76.) [2110

Reports of the Haffkine Institute, Bombay. For the years 1942 and 1943. By Major-General Sir Sahib Singh Sokhey. Pp. ii+60. Annas 6; 6d. For the years 1944–1946. By Major-General Sir Sahib Singh Sokhey. Pp. iii+85. Annas 5; 6d. For the years 1947–1948. By Major-General Sir Sahib Singh Sokhey. Pp. ii+77. Annas 7; 9d. For the year 1949. By Dr. P. M. Wagle. Pp. ii+56. Rs. 1; 1s. 8d. For the year 1950. By Dr. P. M. Wagle. Pp. iii+60. Rs. 2; 4s. For the year 1951. By Dr. P. M. Wagle. Pp. ii+59. Rs. 1/7/-; 2s. 6d. For the year 1952. By Dr. P. M. Wagle. Pp. ii+74. Annas 5; 6d. For the year 1953. By Dr. P. M. Wagle. Pp. iii+88. Annas 7; 9d. (Bombay: Superintendent, Government Printing and Stationery; London: High Commissioner for India, 1948–55.) [2210

Scientific Reports of the Indian Agricultural Research Institute for the year ending 30th June, 1954. Pp. 127. (Delhi: Manager of Publications, 1955.) [2210

Tanganyika: Geological Survey Department. Report No. 1: The Tunduru-Ruvuma Area of the Southern Province—a Reconnaissance of the Geology, Soils, Vegetation and Hydro-electric Potential. By Dr. D. R. Grantham. Pp. iii+14+1 map. Shs. 3. Bulletin No. 24: The Soils of Mbozi (Mbeya District)—a Study in Relation to the Geology and Physiography. By A. M. M. Spurr. Pp. vii+35+4 plates+3 maps. Shs. 7/50. (Dar-es-Salaam: Government Printer, 1955.) [2210

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Technique, No. 45: Le Ravitaillement en Calcium et en Phosphore et le Comportement du Squelette du Bétail au Congo Belge. Par Prof. L. Hennaux et R. Compère. Pp. 45+6 plates. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1955.) 60 francs. [2210

Chicago Natural History Museum. Fieldiana: Botany. Vol. 29, No. 2: Revision of the Hawaiian Members of the Genus Tetraplasandra A. Gray. By Earl Edward Sherff. (Publication 749.) Pp. ii+49–142. 1.50 dollars. Fieldiana: Anthropology. Vol. 44, No. 2: Old Akkadian Inscriptions in Chicago Natural History Museum—Texts of Legal and Business Interest. By Ignace J. Gelb. (Publication 748.) Pp. iv+161–338. 5 dollars. Fieldiana Zoology. Vol. 37: Karl Patterson Schmidt Anniversary Volume in Honor of his Sixty-fifth Birthday. (Publication 747.) Pp. viii+728. 10 dollars. (Chicago: Chicago Natural History Museum, 1955.) [2510

International Scientific Radio Union. Proceedings of the 11th General Assembly held in The Hague from August 23rd to September 2nd 1954. Vol. 10, Part 3: Commission 3 on Ionospheric Radio. Pp. 194. (Bruxelles: International Scientific Radio Union, 1955.) 200 francs; 29s.; 4 dollars. [2510

Shooting Stars. By Prof. Hans Pettersson. Pp. 16. (Särtryck ur Sjöfartsmuseets i Göteborg festskrift för Tor E. J:son Broström, 1955.) [2510

Fisheries Research Board of Canada. Progress Reports of the Atlantic Coast Stations. No. 62 (July, 1955). Pp. 43. General Series Circular No. 26 (July, 1955): Watch for the Green-Crab—a New Clam Enemy. By J. C. Medcof and L. M. Dickie. Pp. 1. (Ottawa: Fisheries Research Board of Canada, 1955.) [2510

British Guiana. Geological Survey Bulletin No. 25: The Geology of British Guiana and the Development of its Mineral Resources. Compiled from Geological Survey Records by G. M. Stockley. Pp. 102+6 plates. (Georgetown: Geological Survey, 1955.) 3 dollars; 12s. 6d. [2510

National Research Council of Egypt. Bulletin of the Scientific and Technical Documentation Centre. Vol. 1, No. 1 (July, 1955): Part 2—Abstracts of Scientific and Technical Papers published in Egypt, and papers received from Afghanistan, Cyprus, Iran, Iraq, Lebanon, Pakistan, Sudan and Syria. Edited with the collaboration of the Unesco Middle East Science Cooperation Office, Cairo. Pp. 13. (Cairo: National Research Council of Egypt, 1955.) [2510

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